Draft papers

The Geopolitical Economy of Energy Transition
Comparing China's Belt and Road Initiative and the European Union

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In cooperation with Durham University

Professor José Luís de Sales Marques,

Dear Jose,

Hereby, I would like to send requested status of the papers based on the following content: (i) a numbered list of the status of all the papers in the context of the joint research project, (ii) a list of the involved researchers and their affiliation, and (iii) the draft versions of the papers from projects that concluded their fieldwork.

A total of 32 scholars are involved with this joint research project as (co-)author and/or participants of our research programme and research network. The publications of their research output consist of two forms: individual and/or team research papers.

A selection of papers will be published as articles in selected peer-reviewed ISI journals and the other part as chapters in a book volume to be published in the Routledge Series on the Belt and Road Initiative.

The selected specialised peer-reviewed ISI journals for publication are Energies (published by MDPI), Journal of Contemporary China (published by Routledge), Asia-Europe Studies (published by Routledge), the Chinese Journal of International Politics (published by Oxford University Press), China Quarterly (published by Cambridge University Press), and Mediterranean Politics (published by Routledge).

Paper 1 is already published in the Journal of Contemporary China on 2 January 2024.

Papers numbered 2-3-4-5-6-7 are in the final steps of the publication procedures and need to be send to the English editor and/or internal peer-reviewers. Papers 8-9-10 have concluded their fieldwork and are in the process of finalizing their drafts. Papers 11-12-13-14-15-16-17 are still in the process of fieldwork. Their draft versions are expected to be submitted in the end of April 2024.

The reason why not all papers are completed yet has to do with the fieldwork that is required. The authors have requested an extension for this part of their research to ensure the quality of their paper. One author (paper 17) has requested more time, because the author is in the final stages of the author's PhD project and graduation.

Please see the attached files. The first file contains the two lists and the latest versions of papers numbered 2-4-5-6-7-8-9-10-11-12 (paper 3 is at the reviewer), as well as the research outline of paper 16 and the abstract of paper 17. The second file contains the published version of paper 1.

Please let me know if you have any questions.

With best wishes,

Mehdi Amineh

Table 1: List of papers and their status

Nr	*Researcher(s)*	*Provision title*	*Status*
1	Rafael Abrao, Mehdi Amineh	*Brazilian Perception of the China-led Belt and Road Initiative*	Published in Journal of Contemporary China (online 2 Jan 2024)
2	Wang Yongzhong, Mehdi Amineh	*Geopolitical Challenges of Energy Transition Minerals and China's Supply Security*	To be send to journal (*Energies*)
3	Paulo Canelas e Castro	*Evaluation of the EU Energy Law: from beginnings to the REPowerEU Plan*	At reviewer
4	Lin Shen, Mehdi Amineh	*The Belt and Road Initiative and Africa's Green Energy Development – China's Photovoltaic Commodity Exports to Africa*	To be send to English editor
5	Mehdi Amineh, Wina Crijns-Graus, Liu Hui, and Claudia Charquet	*Comparing the Dynamics of the Energy Transition in the European Union and China*	To be send to English editor
6	Wei Wei	*Energy Cooperation under the Polar Silk Road*	To be reviewed
7	Tian Huifang	*Hydrogen energy development under the background of carbon neutralization ：Experience and enlightenment of Japan, Korea and China*	To be reviewed
8	Mehdi Amineh, Emre Demirkiran, Amjed Rasheed, Laura Linck	*Geopolitical economy of China-led BRI in Central Asia and West Asia – the cases of Kazakhstan, Turkmenistan, Iran, Iraq, and Turkey*	Finalising draft
9	Mehdi Amineh, Laszlo Maracz, Richard Turcsanyi, Kevin Spinner	*Re-evaluation of China's BRI activities in Central and Eastern Europe and its domestic and geopolitical and geoeconomic-dimensions*	Finalising draft
10	Site Li, Mehdi Amineh	*The Geopolitical Economy of BRI Activities in Pakistan*	Finalising draft
11	Jeroen van Wijk, and Antonella Maes-Anastasi	*Africa's role in the European supply chain of hydrogen: the cases of Morocco and Egypt*	Research underway
12	Wang Kunjie	*Transitioning to Carbon Neutrality in China's Energy Sector: A Review of Law and Policy Evolution*	Research underway
13	Anoush Ehteshami	*Geopolitical economy of BRI in West Asia*	Research underway
14	Amjed Rasheed	*China's Comprehensive Strategic Partnership with Iraq*	Research underway
15	Ben Houghton	*The PRC-UAE Comprehensive Strategic Partnership*	Research underway
16	Ana Treza Marra, William Daldegan, Rafael Abrao, Mehdi Amineh, in cooperation with Jiang Shixue, Li Zhijing, Shen Huaqiao*	*China-led BRI investment in the Green Energy in Brazil and its geopolitical and geo-economic challenges*	Research underway (to be completed after field work in three months)
17	Junyi Hao**	*Understanding the Localization of External Climate Change Governance Norms in China*	Delay due to PhD project

* Professor Jiang Shixue sent his student Ms Li Zhijing in his stead to the first international workshop on 20 June 2023, but her paper did not meet the criteria. Later, Prof Jiang Shixue proposed to work with Dr Shen Huaqiao to write an outline paper of 2500 words about the political relations between China and Brazil. Dr Shen Huaqiao was supposed to present this during the second international workshop in Leiden but was unfortunately not present nor did she write the paper. Currently, they support research by cooperating with this group.

** Ms Junyi Hao has asked for an extension of her paper due to her PhD project and graduation, which requires more attention currently.

Table 2: List of involved researchers

Name	*Affiliation*
Mehdi P. Amineh	International Institute for Asian Studies, Leiden, the Netherlands; University of Amsterdam, Amsterdam, the Netherlands
José Luís de Sales Marques	Institute of European Studies, Macau, China
Anoush Ehteshami	H.H. Sheikh Nasser al-Mohammad al-Sabah Programme, School of Government and International, Durham University, Durham, UK
László Marácz	University of Amsterdam, Amsterdam, the Netherlands
Wina Crijns-Graus	Copernicus Institute of Sustainable Development, Utrecht University, Utrecht, the Netherlands
Jeroen van Wijk	Maastricht School of Management, Maastricht, the Netherlands
Antonella Maes-Anastasi	Maastricht School of Management, Maastricht, the Netherlands
Emre Demirkiran	International Institute for Asian Studies, Leiden, the Netherlands
Kevin Spinner	International Institute for Asian Studies, Leiden, the Netherlands
Laura Linck	International Institute for Asian Studies, Leiden, the Netherlands
Rafael Almeida Ferreira Abrão	Federal University of ABC, Sao Paolo, Brazil
Willian Daldegan	Federal University of Pelotas, Brazil
Ana Tereza Marra	Federal University of ABC, Sao Paolo, Brazil
Claudia Charquet	International Institute for Asian Studies, Leiden, the Netherlands
Irina Pătrăhău*	Hague Center for Strategic Studies, the Hague, the Netherlands
Paulo Caneles e Castro	University of Macau, Macau, China
Wang Kunjie	University of Macau, Macau, China
Liu Hui	Shijiazhuang University, China
Site Li	Catholic University of Leuven, Belgium
Amjed Rasheed	King's College, UK
Jia Liu*	H.H. Sheikh Nasser al-Mohammad al-Sabah Programme, School of Government and International, Durham University, Durham, UK
Ben Houghton	H.H. Sheikh Nasser al-Mohammad al-Sabah Programme, School of Government and International, Durham University, Durham, UK
Jacopo Scita*	H.H. Sheikh Nasser al-Mohammad al-Sabah Programme, School of Government and International, Durham University, Durham, UK
Junyi Hao	H.H. Sheikh Nasser al-Mohammad al-Sabah Programme, School of Government and International, Durham University, Durham, UK
Wang Yongzhong	Institute of World Economics and Politics, Chinese Academy of Social Sciences, Beijing, China
Tian Huifang	Institute of World Economics and Politics, Chinese Academy of Social Sciences, Beijing, China
Wei Wei	Institute of World Economics and Politics, Chinese Academy of Social Sciences, Beijing, China
Zhou Yimin*	Institute of World Economics and Politics, Chinese Academy of Social Sciences, Beijing, China
Lin Shen	Institute of World Economics and Politics, Chinese Academy of Social Sciences, Beijing, China
Jiang Shixue	Institute of Latin American Studies, Chinese Academy of Social Sciences, Beijing, China
Li Zhijing	City University of Macau, China
Shen Huaqiao	Institute of BRICS Studies, Sichuan International Studies University

* These were invited to take part in the international scholarly network and/or give a presentation during the International Research-Oriented Meetings

2- Geopolitical Challenges of Energy Transition Minerals and China's Supply Security

Authors:
Wang Yongzhong
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Geopolitical Challenges of Energy Transition Minerals and China's Supply Security

Abstract

Historically, fossil fuels have been the driving force behind the industrial development of numerous economies and the global capitalist system. This has led to increased wealth, power, and energy consumption. However, this dependence has resulted in significant issues, including import dependence, fossil fuel scarcity, and global environmental degradation. The use of fossil fuels by certain nations can have negative impacts on energy security and the environment. Transitioning to a renewable energy–based economy can help reduce import dependence, mitigate scarcity, and address climate change through decarbonisation. Despite recent growth in renewable energy use, it still only accounts for a small proportion of total energy consumption. Simultaneously, the global shift towards clean energy technologies, such as wind power, photovoltaic power generation, and electric vehicle batteries, will lead to a significant increase in demand for energy transition minerals, including lithium, nickel, cobalt, copper, and rare earth elements. It is important to note that this growth in demand is expected to be rapid. However, during this period of energy transition, the supply of these materials is expected to grow slowly due to unbalanced distribution, declining quality, long investment cycles, and high environmental risks.

The shortage of supplies may lead to security and economic growth issues. Minerals have become the latest frontier of geopolitical and economic competition, triggering a new wave of resource nationalism in producing countries and competition for dominance of the supply chain among major economies.

The trend of resource nationalism has taken various forms, including increasing mineral royalty rates, renegotiating contracts, and imposing export bans. It is important to note that this trend is not new and has been observed in various countries throughout history.
The United States and the European Union have recently updated their list and strategy for critical minerals. They have jointly promoted the localisation and diversification of critical mineral supply chains through various initiatives, including energy resource governance initiatives, partnerships for mining security, an alliance for sustainable critical minerals, an inflation reduction act, and a critical raw materials act. These initiatives aim to reduce dependence on China and enhance the resilience of their critical mineral supply chains.

China's mineral supply chain for energy transition relies heavily on imported resources at the upstream end. However, it has a combative advantage in midstream processing and refining. The analysis in this paper highlights challenges to the key consumers (e.g., China and the EU) such as rising import costs, increasing import uncertainty, and growing overseas investment risks.. The paper analyses the gap between the demand and supply of critical minerals based on forecast data on demand, production capacity, and production and reserve concentration. This paper summarises the categories of behaviours of resource nationalism using manually collected cases. It tracks the strategic and policy trends of the United States and Europe regarding critical mineral supply chains. The evaluation is made from the perspective of upstream raw material supply and midstream refining and processing industry chains.

Keywords: Energy Transition Minerals, Supply Chain, Supply and Demand, Resource Nationalism, Geopolitical Challenges

Introduction

As the world continues to rely on scarce fossil fuels, a shift towards renewable energy (RE) is crucial to combat climate change and address the profound imbalance in the global supply and demand for critical minerals and metals. This imbalance is particularly pronounced for global supply and demand, as achieving carbon neutrality by the middle of this century has become a global consensus. Nations are vigorously developing clean energy industries, such as wind and solar energy, accelerating the transition from fossil fuels to clean energy. This shift, embraced by major economies, is not only a race to seize new opportunities in clean energy technologies but also a strategy to drive competitiveness in emerging industries and economic prosperity. Central to this global endeavour is the reliance on critical minerals, including lithium, nickel, cobalt, copper, and rare earth elements, whose wide use is set to drive rapid growth in demand [1].

This article aims to dissect the complex dynamics within the critical minerals and metals sector, spotlighting the economic, strategic, and geopolitical challenges the sector faces, with a particular focus on China's integral role in this global landscape. The European Union (EU) and China, as significant fossil fuel consumer-economies and leaders in renewable energy technology, face similar challenges and opportunities in transitioning from fossil fuels. The surge in prices for crucial metals, including lithium and nickel, reflects not only a supply-demand mismatch but also broader economic and geopolitical undercurrents. The emergence of resource nationalism, characterised by increased mineral royalties, renegotiated mining contracts, and the nationalisation of mining assets, is reshaping the global supply chain and international relations. At the heart of this narrative is China, a dominant force in clean energy technology yet heavily reliant on imported critical minerals. This reliance places China in a precarious position amid intense competition with the United States.

The article further explores Intense geopolitical competition over scarce critical minerals, underscored by the global push for carbon neutrality. The escalating demand from expanding clean energy industries contrasts sharply with constrained supply due to factors including resource concentration, extended investment cycles, and environmental risks. This tension, particularly evident in China's market and strategic positioning, has far-reaching implications for market stability, national security, and economic development. By providing a nuanced understanding of these challenges and the strategies essential for securing a sustainable and resilient supply chain, this article aims to inform policy decisions and strategic planning in navigating the complex global market of critical minerals and metals. As nations, especially China, confront these multifaceted challenges, the insight offered will be invaluable for a wide array of stakeholders, from policymakers and industry leaders to researchers and strategists. The distribution of critical minerals worldwide is highly uneven and concentrated in only a few countries. This, combined with long mining cycles and slow supply growth, adds complexity to the challenge of achieving a balanced and sustainable supply chain. It is therefore urgent to address this issue.

Why energy transition? A conceptual framework

Historically, fossil fuels have fuelled the development of numerous economies and the global capitalist system, correlating with increased GDP and energy use. However, this reliance has led to significant issues, including import dependence, fossil fuel scarcity, and environmental degradation, particularly in non-producing countries [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14]. The geopolitical leverage of fossil fuel–producing nations exacerbates threats to energy security and environmental stability. Transitioning to an RE-based economy offers compelling solutions by reducing import dependence, mitigating scarcity, and addressing climate change through decarbonisation [15, 16, 17, 18, 19, 20]. Despite recent growth in RE use, its overall share in total energy remains modest. This study focuses on China's approach to advancing RE technologies and policies, addressing the inherent feedback loop of industrialisation, fossil fuel reliance, and environmental impact [2, 14].

The shift from fossil fuels to renewable energy is crucial for a sustainable future and hinges significantly on the availability of energy transition minerals, including lithium, nickel, cobalt, copper, and rare earth elements. These minerals are fundamental to the technologies driving the energy transition, including wind turbines, photovoltaic cells, and electric vehicles. Their unique properties, such as high conductivity and energy capacity, make them irreplicable components of these technologies, underscoring their role in achieving a greener energy landscape. The demand for these minerals is surging, highlighting the necessity of secure supply chains amid geopolitical tensions and the challenges of resource nationalism. As China leads in the clean energy sector, its significant dependence on imported minerals underscores the importance of these resources in the global energy transition and the need for a stable, sustainable supply.

The demand for these critical minerals is rapidly growing, leading to heightened concerns over supply security and intensifying geopolitical tensions. Nations endowed with these resources, including those within the "lithium triangle" in South America or cobalt-rich Democratic Republic of Congo, are now geopolitical hotspots. They find themselves at the forefront of a global contest for resource control and access, as these minerals are not evenly distributed across the globe and are often located in geopolitically sensitive areas. In response to surging demand and potential supply vulnerabilities, nations and economic blocs are strategizing to secure their mineral needs. The US and EU, for example, have initiated policies such as the Critical Raw Materials Act and the Energy Resource Governance Initiative, aiming to diversify and secure their mineral supply chains. These initiatives reflect a profound understanding of the critical challenges that lie ahead in securing a stable supply of minerals. Concurrently, China's substantial dependence on imports for its burgeoning clean energy sector places it in a strategically precarious position. As a major player in the global energy and technology markets, China's approach to securing these resources has significant implications for global energy politics. Its strategies, investments, and international agreements are shaping the landscape of mineral supply and, by extension, the future of energy transition. Understanding the dynamics of China's mineral strategy is crucial for grasping the broader geopolitical and economic implications of the global race for energy transition minerals.

The crucial role of minerals in energy transition is evident in the dependency of key technologies on scarce resources. The electric vehicle revolution, pivotal to the energy transition, relies on lithium and cobalt, with forecasts predicting a dramatic increase in demand. Similarly, wind turbines and photovoltaic cells require materials that are subject to geopolitical tensions and supply vulnerabilities. China's dominance in rare earth production and the global implications of potential export restrictions emphasise the strategic importance of a secure mineral supply chain.

This study focuses on how China navigates the complex landscape of energy transition minerals. It examines China's strategies and responses to the challenges of securing a stable supply of these critical resources amid global competition and rising resource nationalism. Additionally, it explores the implications of these dynamics for China's energy transition politics, the global renewable energy market, and broader geopolitical and economic stability. This framework provides a comprehensive overview of the challenges and necessities driving the global energy transition, with a specific focus on China's role and strategies in securing critical minerals and metals. It sets the stage for an in-depth exploration of the economic, strategic, and geopolitical dimensions shaping the pursuit of a sustainable and resilient energy future.

Method and Data

This descriptive analytical research paper is mainly based on a number of datasets from international specialised institutions and analyses the role and challenges of critical minerals in the process of renewable energy transition.

The paper has four scholarly contributions: First, based on the comprehensive use of the datasets from the International Energy Agency's forecasting data on the demand and limited production capacity for growth of critical minerals, as well as the United States Geological Survey's data on production and reserve concentration of critical minerals, the paper analyses the demand and supply gap for critical minerals and provides empirical support for the global competition for critical minerals. Secondly, it manually collects cases of resource nationalism and summarises the behaviours of resource-rich countries, dividing these behaviours into four categories: raising tax rates and royalty rates, implementing expropriation or nationalisation of foreign mining assets, renegotiating or suspending existing contracts, and restricting or prohibiting the export of raw ores. Third, the paper tracks and studies the strategic and policy trends of the United States and Europe Union in the field of critical mineral supply chains and analyses their contents, objectives, and impacts. Fourth, it evaluates China's competitive advantages and challenges in the critical minerals supply chain from the perspective of upstream raw material supply and midstream refining and processing industry chains, using data on trade, processing, and foreign direct investment in critical minerals.

1. Critical minerals and metals

The global supply of and demand for critical minerals and metals is becoming increasingly imbalanced in the wake of the Covid-19 pandemic, insufficient investment, and global push to meet targets for the carbon peaking and neutrality. Such inequality is especially manifested in the severe shortages in the supply of critical metals that are essential for the batteries of electric vehicles. This has led to the soaring of international commodity prices, with the cost of certain metals, such as lithium and nickel, hitting historic record highs. This shortage in the supply of critical metallic minerals and the corresponding soaring prices have stimulated a new wave of resource nationalism,[1] which can be seen in the increase in mineral royalty rates, the suspension or renegotiation of existing mining contracts, the nationalisation of foreign-owned mining firms, and the prohibition of the export of mineral ores. China is a key supplier of clean energy products and technologies, with half of the global clean energy products for photovoltaic solar panels, wind power equipment, and electric vehicle batteries, but most of its critical minerals supply relies heavily on foreign imports, except rare earths and graphite. Under the current environment of fierce competition between China and the United States and the global scramble for critical minerals, the question of how to ensure the supply security of critical minerals and enhance the resilience of the critical minerals supply chain has become a major issue in accelerating energy transition and promoting high-quality economic development that China urgently needs to solve.

2. The background of geopolitical competition in critical minerals and the supply shortage

Under the global targets for carbon peaking and carbon neutrality, the rapid expansion of photovoltaic, wind power, electric vehicle, and battery energy storage industries has led to long-term structural growth in the demand for critical minerals such as lithium, nickel, cobalt, and

[1] The nationalisation of oil resources and companies globally is a multifaceted phenomenon, deeply rooted in both post-colonial responses and strategic national economic development. Middle Eastern nations, including Iran, Saudi Arabia, and Iraq, initiated this shift in the 1970s, significantly altering the global oil market and impacting energy supply security [21, 22]. The same strategy was later adopted in resource-rich regions, including Russia, Latin America, and North Africa, to regain control over natural resources and address past exploitation. In addition to serving as a tool for reclaiming sovereignty, nationalisation functioned as a critical economic strategy for possibly fostering national socio-economic development [23]. Firstly, governments can strengthen control over economic development and income redistribution, promoting national pride, a trend observed in Russia and China. Secondly, SOEs can generate revenues and jobs, serving as political tools, as seen in Venezuela. Thirdly, state control over NOCs can internalise the value-added chain of the energy industry into the domestic economy, as occurred after Mexico's nationalisation of oil assets in the early twentieth century. China's nationalisation of its oil companies through SOEs including CNPC, Sinopec, and CNOC exemplifies this approach. Despite technological gaps compared to Western IOCs, these companies benefit from significant state support, enhancing their influence in the global market [24, 25]. The nationalisation of scarce resources sometimes causes dispute with consumer countries and transnational corporations concerning price and tax, among other issues. China also engages in resource nationalism through the extensive use of export restrictions on critical minerals and associated technology [26] and the involvement of state-owned enterprises in the mining and processing of natural resources [27, 28]. The China Rare Earth Group is the biggest SOE active in this space, controlling a quarter of global rare earth elements [29].

copper. However, the supply of critical minerals is subject to the concentration of resource distribution, long investment cycles, decreased resource quality, enhanced environmental standards, and increased climate risk, amongst other factors. These phenomena result in a slow growth, which further exacerbates the significant shortage of supply and skyrocketing prices. In turn, this attracts the attention of countries to the security of the supply chain. With the rapid development of the renewable energy industry, it is expected that the focus of the future geopolitical energy game may shift from oil and gas to lithium, cobalt, nickel, and other battery metals [30].

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Basic connotation of "critical minerals" and "energy transition minerals"

Currently, "critical minerals" is a high-frequency term that often appears in mainstream media, think-tank reports, and policy documents in Western countries. The United States Geological Survey defines critical minerals as "minerals that generally have important uses, have no viable alternatives under current technology, and are at risk of potential supply disruptions" [31]. The connotation and types of critical minerals change dynamically and are mainly affected by economic development, resource supply, and technological changes. From the post-war period to the mid-1970s, when Western countries were in the industrialisation stage, critical minerals were defined as elements that were essential to industry and national defence security and had a high supply risk. Ten minerals – namely chromium, manganese, nickel, copper, zinc, tin, antimony, tungsten, mercury, and lead – were listed as critical minerals, with poor endowment, high risk of unstable supply, and large demand for manufacturing and defence production [32].

From the mid-1970s to the end of the twentieth century, Western countries entered the post-industrialisation era, wherein industrialisation characterised by the large consumption of bulk minerals was coming to an end. The connotation of critical minerals expanded to minerals with greater supply risk and, more importantly, that were in demand as raw materials used for high-tech industries. As a result, minerals such as rare earths, niobium, alum, beryllium, thorium, bismuth, cadmium, aluminium, indium, gallium, titanium, lithium, vanadium, silicon, and natural graphite were added to the list of critical minerals, reflecting that developed countries attach importance to the supply security of critical minerals for industrial upgrading and economic transformation.

Since the beginning of the twenty-first century, with the rapid development of strategic emerging industries such as information technology, artificial intelligence, and renewable energy, competition between China and the United States has become increasingly fierce. The stability of raw material supply and the security of supply chains of strategic emerging industries have become the focus of attention. In this period, the definition of critical minerals was based on attention to the risk of regular supply, with further comprehensive consideration of the development needs of national defence security and strategic emerging industries. As a result, copper, lead, thorium, molybdenum, diamond, and potassium salts were successively removed from the list of critical minerals, and coking coal, magnesium, uranium, arsenic, germanium, rubidium, caesium, strontium, barium, zirconium, rhenium, hafnium, tellurium, and helium were added.

Unlike Western countries, China often uses the concept of "strategic minerals." China's definition of strategic minerals not only takes supply risks into consideration but also pays attention to their importance for economic and industrial development. For example, rare earths, tungsten, tin, molybdenum, antimony, indium, germanium, gallium, phosphorus, fluorite, graphite, and other rich-endowment minerals without supply risk are included in the list of strategic minerals, along with oil, natural gas, uranium, iron, chromium, copper, lithium, cobalt, nickel, beryllium, niobium, tantalum, zirconium, and other scarce minerals with greater supply risks. Among them, large strategic minerals such as oil, natural gas, coal, iron, copper, aluminium, and phosphorus play a key role in supporting China's economic development. Generally speaking, the connotation of China's strategic minerals is in line with its status as the world factory and the largest consumer of minerals and the development stage of the rapid rise of strategic emerging industries such as clean energy [33, 34].

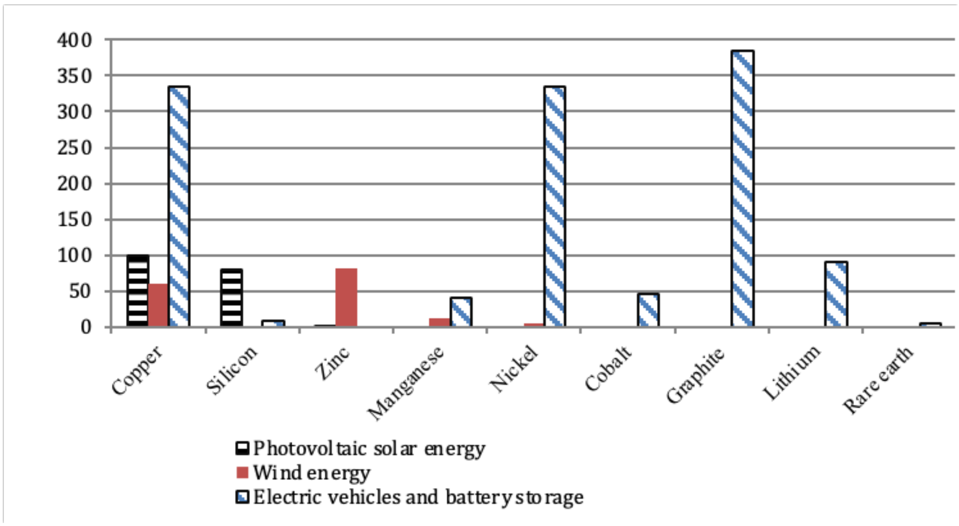
In the past several years, with the acceleration of efforts towards global carbon neutrality and energy transition, as well as the rapid development of digital and network technologies, the renewable energy industry, mainly based on photovoltaic solar energy, wind energy, and electric vehicles, has offered huge development opportunities. Compared to fossil fuels, renewable energy has a high metal intensity. As a result, the development of renewable energy will inevitably and significantly increase the demand for critical minerals such as lithium, nickel, cobalt, and copper. However, the Covid-19 pandemic, insufficient investment, and the Ukraine crisis have severely limited the supply growth of these clean energy–related minerals, and their prices have soared, global attracting great attention. In a 2021 study entitled *The Role of Critical Minerals in Clean Energy Transitions*, the International Energy Agency (IEA) listed a catalogue of minerals widely used in clean energy, including cobalt, copper, lithium, nickel, rare earth elements (neodymium, dysprosium, praseodymium, terbium), and other minerals, including arsenic, boron, cadmium, chromium, gallium, germanium, graphite, hafnium, indium, iridium, lead, magnesium, manganese, molybdenum, niobium, platinum, selenium, silicon, silver, alum, tellurium, tin, titanium, tungsten, vanadium, zinc, and zirconium [34]. Some Western scholars refer to these minerals widely used in renewable energy as "energy transition minerals" [34].

Strong growth in demand for energy transition minerals

The rapid development of renewable energy has led to a sharp rise in the long-term demand for energy transition minerals. The production processes for renewable energy equipment require much input of metal resources. Each material is used for a particular industry: rare-earth permanent magnets are key raw materials for wind turbines; copper and aluminium are widely used in photovoltaic products; lithium is an indispensable input for the manufacture of electric vehicle batteries and energy storage devices; and nickel, cobalt, manganese, and graphite are important for the efficiency, life, and energy intensity of batteries. The power grid calls for an abundance of copper and aluminium. Clean energy sources such as photovoltaic solar energy, wind energy, and electric vehicles are the largest consumers of energy transition minerals. Electric vehicles use six times as much metal as regular gas-powered vehicles, and onshore wind power plants require ten times as much metal as gas-fired power plants. According to the 2021 prediction of the IEA, the pace of global energy transition needs to be further accelerated if the goal of global carbon neutrality is to be achieved by 2050. The renewable energy industry will be the largest consumer sector of lithium, nickel, cobalt, copper, and rare earth elements, and the global demand for energy transition metals is expected to increase by more than six times between 2020 and 2040. Furthermore, the IEA predicts that the demand for lithium will increase more than 40 times; the demand for graphite, cobalt, and nickel will increase by around 20–25 times; demand for copper will double; and the metal demand of electric vehicles and energy storage batteries will increase by at least 30 times as we near 2040 [34].

It is worth mentioning that energy transition and technological innovations have led to significant changes in the automobile power system. Electric vehicles are road transportation tools powered by on-board power, which has fundamentally changed the power source of automobiles, compared with traditional fuel vehicles powered by fossil fuels such as petrol. In recent years, global electric vehicle sales have witnessed explosive growth, as the market penetration of electric vehicles is greatly improving. According to research firm Canalys, about 6.5 million electric vehicles were sold globally in 2021, up 109% from 2020 and accounting for about 9% of all passenger vehicle sales. As of April 2021, 20 countries had announced plans to phase out sales of internal combustion engines or achieve 100% zero-emission vehicle sales by 2050. The battery and electronic control system of electric vehicles are mainly composed of energy transition metals, so the prosperity of the electric vehicle market will drive a significant increase in the demand for nickel, cobalt, lithium, copper, rare earths, graphite, and other minerals. According to the IEA's forecast, the consumption of nickel, cobalt, lithium, copper, graphite, and rare earths in the electric vehicle and battery industries will reach 3.343 million tons, 455 thousand tons, 904 thousand tons, 3.849 million tons, and 47 thousand tons, respectively, in 2040 under the sustainable development scenario (Figure 1) [34].

Figure 1 Forecast of the demand for some energy transition minerals in 2040
(in ten thousand tons)



Data Source: IEA, *The Role of Critical Minerals in Clean Energy Transitions*, May 2021.

Supply risk of energy transition minerals

Compared to the reserves of mainstream minerals in the era of industrial civilisation, such as iron ore and copper, the global reserves of energy transition minerals are much smaller and the resource-rich areas, lesser. Moreover, many energy transition minerals are not independent ores but associated ores with other minerals, which require complex processes to separate and refine. Therefore, whether energy transition minerals can be timely and fully mined, and whether the supply chain has enough resilience, will become important factors affecting the progress of global energy transition.

Energy transition minerals are mainly distributed in a few resource-rich countries. According to the data of the United States Geological Survey (USGS) and the International Energy Agency (IEA) collected in 2021, the world's proven lithium resources equate to 89 million tons and are mainly distributed in South America (Bolivia, Argentina, and Chile), Australia, the United States, and China. More than 50% of this global production is in Australia. Furthermore, the reserves of global nickel ore are about 94 million tons, mainly in the form of nickel sulphide and laterite nickel ore. Nickel sulphide is mainly distributed in South Africa, Canada, and Russia, while laterite ore is mainly distributed in Indonesia, Australia, and the Philippines. The output of nickel ore from Indonesia, the Philippines, and Russia accounted for 55% of the world's total. The world's proven cobalt reserves account for around 7.6 million tons, mainly distributed in the Democratic Republic of Congo (DRC) and Australia, of which the DRC produces 120 thousand tons, accounting for 70% of global production. The world's proven copper reserves are about 880 million tons, mainly distributed in Chile, Australia, and Peru. The three countries account for 41% of the world's proven copper reserves, among which Chile is the country with the largest copper reserves, with amounts equating to 200 million tons, accounting for about 22.7% of the world's total copper count. Chile is also the country with the highest copper production, accounting for about 28% of total global production (Table 1) [34].

Table 1 Production concentration of the top three producers of energy transition minerals

Minerals	Production concentration ratio	The output share of the three major producing countries
Copper	49%	Chile (28%), Peru (12%), China (9%)
Nickel	55%	Indonesia (33%), Philippines (13%), Russia (10%)
Cobalt	79%	DRC (70%), Russia (5%), Australia (4%)
Graphite	82%	China (64%), Mozambique (10%), Brazil (8%)
Rare earth	83%	China (60%), USA (12%), Burma (11%)
Lithium	87%	Australia (53%), Chile (12%), China (12%)

Data Source: IEA, *The Role of Critical Minerals in Clean Energy Transitions*, May 2021.

The supply of energy transition minerals also faces many challenges and risks. Firstly, the production cycle is long, and global metal mineral resources are characterised by having low price elasticity of supply and demand. It is, therefore, difficult for the supply to respond quickly to changes in demand and price, making the price subject to significant fluctuations. At present, the energy transition minerals market is in an economic boom, and higher prices usually stimulate willingness to invest. Mineral investment, however, especially in large metal mines, has a long investment cycle, and it generally takes 16 years for mineral deposits to be discovered and produced, leading mining companies to be cautious about investing in new mines. Moreover, the electric vehicle and battery energy storage industries are currently in their preliminary period of industrial development. As a result, the technology and products are subject to frequent changes, given that the mainstream technology and leading products have not yet been confirmed by the market. Therefore, it is difficult to make a relatively accurate estimation of the long-term demand for some energy transition metals, which has inhibited the willingness to invest of mining enterprises. Secondly, mineral quality continues to decline. The quality grade of Chilean copper has dropped by 30% in the past 15 years, and refining low-grade metal ore entails higher energy consumption, production costs, and greenhouse gas emissions. Third, environmental standards have been enhanced. The environmental and social problems caused by the mining and processing of these mineral resources have attracted widespread negative attention. The call for more sustainable, responsible, and conscious production processes of mining enterprises is becoming more intense, which evidently increases the production costs of such companies. Fourthly, climate risks are on the rise. Most of the world's lithium mines, for example, are located in areas with water shortages, limiting the expansion of mining capacity [34].

3. The behaviours of the new wave of resource nationalism

Countries that have abundant resources adopt mercantile doctrines to strengthen their resource sovereignty, control resource flows, and enhance resource value. According to the Resource Nationalism Index (RNI) released by Verisk Maplecroft for 2021, the risk index of resource nationalism increased significantly in 34 countries, mostly resource-rich countries in Africa, Latin America, and Asia. The risk is especially high in 11 countries, namely, Venezuela, Tanzania, Mexico, Papua New Guinea, Zambia, Russia, North Korea, Kazakhstan, Democratic Republic of Congo, Zimbabwe, and Swaziland, ranked from high to low [35]. Contrary to the traditional resource nationalism under which assets are directly or indirectly expropriated, the new wave of resource nationalism means that countries are adopting more subtle methods, such as higher royalty rates and tax rates, suspension or renegotiation of existing mining contracts, or nationalisation and the prohibition of exports.

It should be pointed out that an important factor for the new wave of resource nationalism is the imbalance in the distribution of mineral extraction and development profits between consumer countries and resource-rich countries, with the consumer countries and multinational corporations benefiting more and the resource-rich countries benefiting less, as well as the latter being left with the consequences of environmental damage. Moreover, the economic difficulties of the vast majority of the resource-rich countries have also contributed to their resource nationalism, and it is clear that the lucrative mining sector has become the main source of tax income in the face of rising fiscal deficits and public debt due to the pandemic.

Higher tax rates and royalty rates

Increasing the royalty rates and tax rates of mineral resources is the most common method being adopted during this new wave of resource nationalism. In recent years, African countries have amended their mining laws to increase mining taxes and royalties. Burkina Faso, Cameroon, Democratic Republic of Congo, Gabon, Guinea, Côte d'Ivoire, Kenya, Madagascar, Mali, Mozambique, Namibia, Senegal, Sierra Leone, Tanzania, Zambia, and Zimbabwe have all done so. Most new mining laws have significantly raised taxes for investors by imposing additional taxes and increasing tax rates. Specifically, mining enterprises now have to pay the following taxes and fees: fixed fees for obtaining or updating mining rights, annual surface concession fees depending on the area of mining rights, proportional royalties depending on the value of mined products, special contributions to local development funds based on the monthly turnover net of tax, and capital gains tax on the transfer of mineral rights and export royalties. In some countries, new mining laws have included new taxes: special taxes on excess profits, progressive royalties for significant mineral price increases, taxes on capital gains from direct or indirect transfers of mining rights, taxes on income generated by services provided by non-resident entities, mandatory contributions by investors to local development funds, and taxes on contract processing and production.

Governments will revoke the mining rights of mining companies if they do not pay these additional taxes [36].

At the beginning of 2019, for example, the Zambian government increased the royalty for copper, announced its plan to amend the VAT law, and started imposing a 15% tax on precious minerals. The Zambian government is also currently considering a comprehensive reform of the mining tax system to effectively audit the profits reported by mining companies and ask them to fulfil more social responsibilities. South Africa, meanwhile, imposed a 50% windfall tax on excess profits of the coal and platinum industries and a 50% capital gains tax on the assignment of mineral exploration rights. The Ghanaian government might also new mining taxes and royalties, imposing a 35% corporate income tax on the diamond and gold industries and a 10% windfall tax on excess profits.

The Democratic Republic of Congo's dominance in cobalt resources gives it a wide margin for increasing fiscal revenue. In 2018, the DRC enacted a new mining law to increase the resource tax rate from 2% of the net sales revenue (sales revenue minus deductible costs) to 3.5% of the gross sales revenue, increase the tax rate for cobalt and other strategic resources to 10% of the gross sales revenue, impose an additional 50% tax on unexpected windfall profits, increase the royalties for "strategic goods" during the peak of global demand, and request that 10% of the dry shares of mining companies be held by Congolese citizens [37].

Tanzania is one of the most radical countries in the domain of resource nationalism. In 2017, it comprehensively amended its mining law to empower the government to renegotiate terms in contracts deemed unreasonable by its parliament. The country also increased the equity share of its government in mining enterprises and augmented the royalties to be paid by mining enterprises. In 2018, Tanzania promulgated a new law, requesting the government to hold a 16% stake in mining projects and increasing the royalties for the export of mineral products including gold, copper, silver, platinum, and uranium. In May 2021, Madagascar increased the royalty rate for base metals, gold, and silver from 2% to 4% and the royalty rate for original gems to 8%, requesting that 20% of the mineral volume be surrendered to the state.

The increase of mining taxes and fees by African resource-rich countries has inspired protests among international mining companies. First, Quantum Minerals initiated an international arbitration procedure for disputes over royalties and taxes with Zambia and Mauritania. Glencore and other large mining organisations have also had serious conflicts with the Democratic Republic of Congo and Tanzania regarding the increase in royalties and the amendments to mining laws.

Big copper-producing countries such as Chile and Peru are increasing government revenues by imposing higher mining taxes. In May 2021, the Chile Chamber of Deputies passed a bill to adopt new royalty rates for copper and lithium based on a basic rate of 3%. In addition, Chile imposed windfall taxes on copper: when the copper price is between USD 2 and 2.5 per pound, the marginal tax rate on windfall is 15%; when the copper price exceeds USD 4 per pound, a 75% windfall tax is imposed on extraneous income. If the annual sales volume of copper and lithium were to reach over 12,000 tons and 50,000 tons, respectively, the tax burden on the mining industry could be as high as 82%, a significant increase of 40.3%. This may put 12 of the 15 most prominent mining companies operating in Chile in the red. Freeport-McMoRan a giant of the industry in the US, made its objections clear. Lundin Mining said that it was reconsidering the Candelaria Copper Project (Chile) valued at 600 million USD and would increase its investment in Argentina where there was less of a nationalist sentiment. Inspired by Chile, Peru's left-wing government planned to increase mining taxes in June 2021 and use the increased tax revenue for social welfare [38].

Several Pacific countries are also making new fiscal requirements for their mining industries. The federal government of Brazil is considering increasing tax rates for the mining industry, and in April 2021, Pará, a northern Brazilian state, increased the tax rates for iron ore, copper, manganese, and nickel. In June 2021, the American state of Nevada passed a bill to impose a 0.75% consumption tax on gold and silver mining enterprises with a sales revenue of USD 20–150 million and a 1.1% consumption tax when sales revenue is higher than 150 million USD. On the other side of the world, the Australian government is planning to impose a rental tax on mineral resources, including iron ore, nickel, and coal. It has also approved the imposition of a 30% tax on profits from the mining of iron ore and coal. Important resource-rich countries such as Russia and Canada are also strengthening their control of strategic resources and significantly increasing mining taxes and royalties [38].

In a related move, some countries have bolstered their tax enforcement. In 2020, Zambia's mineral officers started to collect samples from mines to prevent the tax avoidance of mining enterprises by submitting low-grade samples or underreporting output. In May 2021, the Democratic Republic of Congo announced that it would prohibit mining companies who had missed their tax payments. Ghana has cracked down on illegal mining, especially gold mining, and has required mining companies to take more responsibility for the environment. In 2021, the State Tax Service of Kyrgyzstan reinitiated its tax claim against Centerra Gold, formerly suspended between 2011 and 2017 [39].

Expropriation or nationalisation of assets

Nationalisation or expropriation of assets are extreme behaviours of new wave resource nationalism. In May 2019, the Zambian government suddenly announced that Vedanta Resources had violated licensing conditions in terms of illegal production reduction and wrongful dismissal. They thus appointed a liquidator to take over the assets of Konkola Copper Mines, which was under the control of Vedanta, and started to look for a new investor. Konkola Copper Mines was the largest copper mining and smelting company in Zambia. Vedanta Resources owned 79.4% of its equity assets, with the remaining 20.6% held by ZCCM Investments Holdings (ZCCM-IH). The Zambian government developed a long-term bitterness towards Vedanta, and this divide deepened with disputes over energy charges, salaries, taxes, and fees. Vedanta filed for arbitration with a South African court, which ruled that Zambia should cease liquidation and dismissed ZCCM-IH's appeal request. In April 2020, the Zambian government threatened to suspend the licence of the Mopani Copper Mine, operated by Glencore, underscoring the Zambian government's intent to strengthen its control over strategic mining assets [40].

In 2021, the government of Kyrgyzstan directly expropriated the Kumtor Gold Mine, a major project of Centerra Gold, a Canadian company. In September of that year, Centerra Gold filed a claim with the International Court of Arbitration against the Kyrgyzstani government and shareholders of the Kumtor Gold Mine on the grounds that the mandatory expropriation had violated the approved mining plan and had caused irreversible damages [41].

The shortage in lithium supply and the subsequent soaring prices has meant that the Latin American countries with abundant in lithium resources – including Chile, Bolivia, and Mexico – have had the opportunity to increase exports and fiscal revenue. Argentina, Bolivia, and Chile, owners of the highest lithium concentration in the world and constituting the "lithium triangle," have discussed the feasibility of establishing a lithium alliance. Chile's president is planning to found a state-owned lithium-industry company and nationalise lithium mines. In February 2022, the Constitutional Court of Chile approved a motion that could lead to the nationalisation of copper and lithium mines. Chile launched its lithium nationalisation strategy in April 2023 and is planning to establish the Chilean National Lithium Company within the year. In the future, Chile's lithium-mining development projects will only be allowed through public-private partnerships, and the Chilean National Lithium Company must hold the controlling stake in the relevant initiatives or joint ventures. However, the Chilean government will not terminate existing lithium mining contracts, among which the contract of Sociedad Química y Minera de Chile (SQM) (of which Tianqi Lithium holds 22.16% of its shares) will expire in 2030 and the contract of the American Albemarle Corporation will expire in 2043 [42]. Therefore, the nationalisation policy of lithium mines in Latin America, which has attracted much attention, is relatively modest; it basically respects existing mining contracts and the loss for multinational mining companies is mainly reflected in the loss of new investment opportunities in the future.

In September 2021, Mexico passed a motion to transfer the control of the power sector to the state, a reversal of the 2013 Energy Transform Program, which included opening the power sector to private investments. In April 2022, the Mexican Senate passed a mining bill to affirm the state's control over lithium mining and give state-owned enterprises priority status in lithium mining. Mexico's president has claimed that lithium, like oil, is a strategic national resource. The state will restrict private capital from entering the lithium mining industry and consider nationalising its lithium supply [43].

Renegotiation or suspension of existing contracts

It is a common practice under resource nationalism to review existing mining contracts. Renegotiating existing contracts is an important way for resource-rich countries to increase their share of mining profits, for example, by increasing the government's equity share or requiring the multinational mining companies to undertake more obligations in infrastructure construction. Compared with renegotiation, the suspension of existing contracts is more stringent, and multinational mining companies face greater losses. In August 2018, the Indonesian government reached an agreement with Freeport-McMoRan and Rio Tinto after more than a year of negotiations, concluding that Freeport-McMoRan would abandon their major interest in the Grasberg Mine (copper and gold), the second largest copper mine in the world, while PT Indonesia Asahan Aluminium, a state-owned enterprise of Indonesia, would receive 51% of the shares. This greatly enhanced the Indonesian government's control over the country's mineral resources. In October 2019, Sierra Leone cancelled the iron ore mining licence of Gerald, a metal trader, with the decision effective immediately. In response, Gerald requested more than USD 500 million in compensation from the government of Sierra Leone. The governments of Mali and Papua New Guinea are now also seeking to review existing mining contracts to increase mining revenues. Tanzania's Mining (Local Content) Regulations of 2018 requests that local enterprises hold at least 51% of the shares in mining companies and that international companies should cooperate with local organisations. However, in the following year, after encountering great resistance, Tanzania lowered the limitation on the stake of local enterprises in mining companies to 20% and amended the Mining (Local Content) Regulations in 2019 [37].

In April 2020, the government of Papua New Guinea (PNG) decided not to approve the 20-year renewal of the special mining right of the Porgera Gold Mine, owned by Zijin Mining Group and Barrick Gold Corporation, on the grounds that the country was to change its way of managing natural resource exploration and that the mine had produced adverse impacts on local communities and ecosystems. The Porgera Gold Mine is one of the oldest operational gold mines of the country and has been in use for the past 30 years. In 2019, its gold production reached 250,000 ounces, accounting for 10% of PNG's gold exports. While Zijin Mining Group expressed its intention to seek a legal and reasonable solution that would take into account all parties involved, Barrick said that it would not accept any negotiation with the government of PNG, whose purpose was asset nationalisation [38].

In January 2022, under the pressure of environmental protests, the Serbian government cancelled the Jadar lithium-mining project of Rio Tinto and revoked the latter's lithium exploration licence. This deal had a planned investment of USD 2.4 billion, which was envisioned as the largest lithium mine in Europe and was expected to produce 58,000 tons of lithium carbonate per year. The project aimed at providing lithium to 1 million electric vehicles and creating more than 2,000 jobs. It would also produce borate for solar panels and wind turbine production. Environmental protesters were against the cooperation between the government and Rio Tinto and threatened to block the main expressways in the country [44].

In February 2022, the Mexican government decided not to further issue lithium exploration and mining licences to private companies. Moreover, lithium mine development by foreign enterprises would likely no longer be allowed, even if granted mining concessions. President Lopez stated that foreign lithium mining enterprises could be allowed for continuous operation only with certain conditions met, but he doubted whether most companies could continuously qualify. Previous governments of Mexico have issued eight lithium exploration licences, including the Sonora Lithium Project of Bacanora Lithium, a British company acquired by Ganfeng Lithium, a Chinese group. The Sonora scheme has a lithium carbonate reserve of 8.8 million tons. Based on an annual mining limit of 35,000 tons, the project will have a mining period of 250 years, and 94% of its interests are held by Ganfeng Lithium. Lopez sharply criticised the Federal Economic Competition Commission for its approval of the acquisition offer from Ganfeng Lithium early on. He further accused Ganfeng Lithium of "endangering national lithium resources" and publicly called for an investigation into the Commission. Through this series of events, it is clear that the Sonora initiative of Ganfeng Lithium is facing great uncertainty [45].

Restriction or prohibition of exports

To develop the industry of mineral processing, attract foreign capital to the mining industry, increase opportunities for employment, and increase the proportion of products with high value-added and export revenue, Indonesia, a prominent mining country, has successively prohibited the export of multiple minerals in recent years. They have done so by requesting metal minerals to be subject to value-adding procedures before export. In 2018, for example, Indonesia required that tin ores be exported as refined products with a minimum tin content of 95%. In 2020, Indonesia prohibited the export of nickel ores, while planning to develop local nickel refining to attract foreign capital to the manufacturing of batteries for electric vehicles. In November 2021, President Joko reiterated the plan for suspending the export of all bulk raw materials, with the export of bauxite, copper, and tin possibly to be suspended in 2022, 2023, and 2024. In the winter of 2021, during global energy supply shortages, Indonesia suspended its coal export to guarantee its domestic coal supply. This move was protested by the country's coal exporters and main coal importing countries [43].

Indonesia's prohibition of raw ore exports has triggered similar policies being enacted in other countries. Tanzania announced its prohibition of the export of gold ores in 2020, requiring that gold must be exported in refined form. In November 2021, the Mines and Geosciences Bureau of the Philippines proposed to pave the way for mineral processing and value-adding within the country's mining industry by gradually restricting the export of raw ores. Myanmar may also follow the example of Indonesia in restricting the export of heavy rare earths [43].

Zimbabwe decided to ban the export of unprocessed lithium in December 2022, in the hope that lithium producers would produce battery-grade lithium products locally and that the export of lithium concentrate would be banned in the future. Namibia announced in June 2023 that it would ban the export of unprocessed lithium and other critical minerals used for clean energy technologies, such as cobalt, manganese, graphite, and rare earths, and only a small number of special minerals could be exported after approval.

4. Adjustment of strategies on critical minerals in the US and EU

In the context of the intensifying China–US rivalry, China's dominant position in the refining, processing, and manufacturing of energy transition minerals, such as rare earths, lithium, copper, and cobalt, has aroused concern and anxiety among Western countries. The United States is most worried about its high dependence on imports of critical minerals from China, which could be exploited by China in geopolitical competition. Europe, however, is more concerned about the negative impact of critical mineral supply disruptions on the competitiveness of the renewable energy and electric vehicle industries. Recently, both the United States and the European Union have re-evaluated the status of critical mineral supply chains, updated their critical mineral strategies, and promoted the localisation and diversification of critical mineral supply chains for energy transition, all in an attempt to enhance the resilience of critical mineral supply chains. The United States has actively united allies in the form of resource-rich countries as well as consumer countries in order to create a de-Sinicised critical mineral supply chain, posing a threat to China's energy transition mineral supply.

US strategies on critical minerals

In 2019, the Trump administration launched the Energy Resource Governance Initiative (ERGI), which proposed three strategic objectives: to engage resource-rich countries in responsible energy mineral governance, to support resilient supply chains, and to meet the expected demand for clean energy technologies. The United States claimed that the ERGI would benefit relevant countries in advancing governance principles, sharing best practices, encouraging fair competition, and enhancing the resilience and security of energy and mineral supply chains. Important critical mineral resource suppliers – such as the Democratic Republic of Congo, Zambia, Namibia, Botswana, Peru, Argentina, Brazil, the Philippines, Australia, and Canada – joined this initiative [46].

As the China–US strategic competition continues, reducing reliance on China has become an important goal of the critical mineral supply chain led by the United States. In June 2022, the US announced the establishment of the Minerals Security Partnership (MSP), with participating countries and organisations including Australia, Canada, Finland, France, Germany, Japan, South Korea, Sweden, the United Kingdom, the United States, and the European Union. From the perspective of participating member countries, the MSP includes both mineral producers, such as Canada and Australia, and mineral processing and consumer countries, such as the United States, Germany, Japan, and South Korea, thus forming a complete industrial chain. This is essentially a critical mineral supply–chain cooperation organisation jointly built by the United States and its allies to seek to exclude China. Some critics even call it "Metallic NATO" [47].

To encourage the localisation of energy transition mineral supply chains and enhance its competitiveness in the electric vehicle and clean energy fields, the United States enacted the Inflation Reduction Act in August 2022. According to this act, the US Federal Government will provide USD 369 billion in subsidies for the production of and investment in electric vehicles, critical minerals, clean energy, and power generation facilities. Among these, nine tax credits are based on the premise of production and sales in the United States or North America to promote the production and application of electric vehicles and other green technologies in the United States. The Inflation Reduction Act links tax breaks for purchasing electric vehicles (up to USD 7,500 per vehicle) to the source of critical raw materials and components of the battery [48]. The act has obvious unilateralist and protectionist characteristics, as it discriminates against other countries' electric vehicle industries, and it has aroused dissatisfaction from the European Union and South Korea.

Encouraging allies to impose restrictions on China's overseas investment in critical minerals is also an important way for the United States to contain China. In November 2022, the Canadian government introduced rules to protect the domestic critical minerals industry from foreign state-owned enterprises, prohibiting foreign state-owned enterprises from investing in its own critical minerals, and in January 2023, it ordered three Chinese companies to sell their equities in Canadian critical minerals companies on "national security" grounds. According to the Canadian government's directive, Sinomine (Hong Kong) Rare Metal Resources was required to divest from Canadian Power Metals, Shengze Lithium was required to divest from Chilean Lithium (headquartered in Calgary, Canada), and Zangge Mining Investment (Chengdu) was required to divest from Canadian Super Lithium. At the same time, Australia has stepped up its scrutiny of foreign, particularly Chinese, investment in sectors such as lithium and rare earths, which led to the halting of Tianyi Lithium, a joint venture between Contemporary Amperex Co. Limited (CATL) and Tianhua Super Clean, when it acquired a 12% stake in Australian mining company AVZ in 2020 [49].

EU strategies on critical minerals

The EU's critical minerals strategy focuses on the resources themselves and has not yet been generalised into a national security issue. The main strategic means include expanding diversified sources, increasing local production, building resilient supply chains, and improving resource utilisation efficiency and circularity. The EU has some technological advantages in clean energy equipment manufacturing, such as in wind turbines, photovoltaic solar energy, and electric vehicles, but there are obvious deficiencies in mineral endowments, and its critical minerals consumption is highly dependent on imports. The EU's main concern is that if the supply security of critical minerals is not addressed, the deployment of clean energy technologies will increase its import dependence on critical minerals, so that its high dependence on critical minerals in the future will replace its current heavy reliance on imported oil and gas [50].

With the rapid advancement of global low-carbon transition, the EU has adjusted its strategic framework for critical minerals supply in recent years. In September 2020, the European Union issued the documents *Critical Raw Materials for Strategic Technologies and Sectors in the EU: A Foresight Study* and *Critical Raw Materials Resilience: Charting a Path towards Greater Security and Sustainability*. The EU proposed four action plans for critical raw materials. First, to develop resilient value chains for industrial ecosystems. Secondly, to achieve product sustainability and innovation through resource recycling and reduce dependence on critical raw materials. Thirdly, to strengthen sustainable and responsible sourcing and processing of raw materials within member countries. Lastly, to diversify supply from third countries through sustainable and responsible sourcing and to strengthen rules-based open trade in raw materials.

The European Commission passed the Critical Raw Materials Act in March 2023 to enhance its refining, processing, and recycling capabilities for rare earths, lithium, cobalt, nickel, silicon, and other critical minerals. It also reduced its dependence on foreign critical minerals. According to the act's planning objectives, by 2030 the EU should be able to produce at least 10%, process at least 40%, and recycle 15% of critical raw materials. In any processing stage, the annual import volume of critical raw materials from a single third country should not exceed 65% of the EU's annual consumption. The act aims to simplify the licensing procedures for EU critical raw material projects. Strategic mining schemes will be licensed within 24 months, and strategic mineral processing projects within 12 months at the latest [51].

5. The impacts of the geopolitical competition on the Chinese critical minerals supply chain

China's position in the supply chain of energy transition minerals

As the world's factory, China has advantages in the endowment and output of a few energy transition minerals, such as rare earth and graphite, but has disadvantages in the endowment and output of most minerals, such as lithium, cobalt, nickel, and copper. China is highly dependent on a few foreign countries and has a high degree of import concentration. The high import concentration ratio makes China's supply of energy transition minerals vulnerable to political and economic policy changes and adjustments in relevant countries, thus affecting the stability of imports and the security of supply. However, China has a significant capacity advantage in the processing and refining of the vast majority of energy transition minerals, and its share of the global market is high. Under the intensification of geopolitical competition and the rise of resource nationalism, the supply security of China's energy transition minerals is facing severe challenges.

In recent years, with the rapid development of the electric vehicle and energy storage battery industries, China's demand for battery metals, such as nickel, lithium, and cobalt, has grown rapidly, with a significant increase in import demand and a high degree of external dependence. As shown in Table 2, China's net import of nickel ore and concentrate was 43.5 million tons in 2021, with a high degree of external dependence (90%) and accounting for 90.2% of global nickel ore imports. The import source of nickel ore is very concentrated, with 89.7% of its exports from the Philippines. Indonesia used to be a major source of nickel ore imports for China. Due to Indonesia's prohibition of nickel exports in 2019, China's nickel ore imports from the country fell sharply from 15 million tons in 2018 to 840 thousand tons in 2021. That same year, China imported 2.07 million tons of lithium ore, with an external dependence of 75%. Among these ores, the import volume of lithium carbonate and lithium hydroxide reached 240 thousand tons and 175 thousand tons, respectively, an increase of 40.4% and 88.6% year-on-year, mainly from Australia. In 2021, China imported 19 thousand tons of cobalt ore and concentrate, accounting for 96% of the world's total imports of cobalt ore and concentrate, and 99.5% of the imports came from the DRC. Although China is the world's third largest copper producer, accounting for 8.75% of global copper production, its domestic copper consumption is huge, accounting for more than 60% of global copper consumption. The huge gap between copper consumption and production can only be filled by a large number of imports, and in 2021, China imported 23.39 million tons of copper ore and concentrate, with an external dependence of 83%, of which 37.9% and 23.7% came from Chile and Peru, respectively.

Table 2 China's import of some energy transition minerals in 2021

	Import volume		External dependence	Import concentration (top three countries)	Major importing countries
	thousand tons	USD bn			
Copper ore	23387	568.1	83%	67.9%	Chile (37.9%), Peru (23.7%), Mexico (6.2%)
Lithium ore	2070	--	75%	99.4%	Australia, Chile, Argentina
Nickel ore	43526	44.2	90%	97.0%	Philippines (89.7%), New Caledonia (5.5%), Indonesia (1.9%)
Manganese ore	29958	49.0	96%	78.6%	South Africa (46.6%), Australia (18.1%), Gabon (14.0%)
Cobalt ore	19	0.9	97%	99.5%	DRC (99.5%)
Chrome ore	14918	26.1	99%	91.6%	South Africa (80.4%),

					Turkey (6.9%), Zimbabwe (4.3%)
Molybdenum ore	50	6.1	--	71.9%	Chile (33.5%), Armenia (19.2%), Peru (18.8%)
Zinc ore	3634	39.5	31%	61.3%	Australia (29.6%), Peru (21.7%), South Africa (10.0%)

Source: Comtrade database (2023) and author's calculation.

In stark contrast to its weaker position in resource endowments, China has a strong competitive advantage in the refining and processing of energy transition metals. At present, China is the most important refining and processing base for metal and non-metal minerals, and Western countries, such as the United States, are highly dependent on China's refined minerals. In 2019, for example, China's refining and processing capacity in various energy transition metals accounted for more than 50% of the global production capacity. China's processing production shares of rare earths, lithium, and cobalt reached 87%, 78%, and 65%, respectively, while the refining capacity shares of copper and nickel, although lower, also reached 40% and 36%. China further dominates the smelting of lithium carbonate and lithium hydroxide and has 75% of the world's battery manufacturing capacity. According to the White House's 100-day Reviews of Supply Chains, China's strong position in the metal and mineral supply chain mainly stems from processing and manufacturing, rather than raw material reserves [52]. The United States is concerned that China is restricting exports of raw materials for refined minerals, such as rare earths, cobalt, nickel, lithium, and graphite, or dumping finished materials in the global market at low prices. Obviously, the increased investment of the US and other Western countries in the refining and processing of metal minerals will increase the competitive pressure on China's related industries.

In the fields of mining and the processing and refining of energy transition minerals, China's mining industry has made great progress in its scale of production, but there is still a big gap between China's mining companies and Glencore, BHP, and Freeport-McMoRan. Moreover, Chinese companies generally have capacity advantages in one mineral at most, while international mining giants may have production advantages in multiple minerals, such as BHP in iron, copper, and nickel and Glencore in cobalt, copper, and nickel. In terms of mining and refining of copper, the scale of Chinese mining companies is generally smaller, with Zijin Mining and Jiangxi Copper producing 2.8% and 1.7%of the world supply, respectively, far below Codelo's 8% in Chile, BHP's 6%, Freeport-McMoRan's 6%, and Glencore's 5%. In terms of mining and refining of nickel, Tsingshan Holding Group, a Chinese company, accounts for 23%, significantly larger than Vale's 8% and Norilsk Nickel's 7%, while Jinchuan Group and BHP account for about 3% and 2%, respectively. In terms of the mining and refining of lithium, Chinese company Tianqi Lithium's share of production is about 11%, lower than Albemarle's 24% in the US and SQM's 12% in Chile; another Chinese company, Ganfeng Lithium, also has a relatively large share. In terms of the mining and processing of cobalt, CMOC Group, a Chinese company, has a production share of about 9%, lower than Glencore's 27% and Shalina Resources' 10%. In terms of the mining and processing of rare earths, Chinese companies have a significant competitive advantage. The capacity share of the companies, Northern rare Earths and Chinese Rare Earths is about 41% and 24%, respectively, far higher than that of Mountain Pass in the United States (15%) and Lynas in Australia (5.8%) [53].

In order to make up for the shortage of mineral resource endowment and ensure the stability of domestic mineral supply, Chinese mining enterprises have chosen to "go global". According to S&P Global Market Intelligence, there were about 425 overseas Chinese mining investment projects at the end of 2021. From 2011 to 2021, China invested USD 16.1 billion in overseas mines, of which copper was the biggest investment. Currently, there are about 68 investment plans in overseas copper mines, of which 30 are operational and 38 are under exploration, mainly in countries such as the DRC, Peru, and Afghanistan. These include Zijin Mining's Kamoa-Kakula Project on the largest copper mine in Africa, CMOC Group's Tenke Fungurume Project on the second largest copper and cobalt mine in the DRC, Minmetals' Las Bambas Project in Peru, and MCC's Aynak Project in Afghanistan [54].

In recent years, Chinese companies have also attached great importance to overseas investments in battery storage metals, such as nickel, cobalt, and lithium. China's overseas investments in lithium mines are mainly located in Oceania, South America, and Africa, where Chinese companies such as Tianqi Lithium, Ganfeng Lithium, and CATL are mainly investing in Australia, Chile, and Argentina and companies such as Huayou Cobalt and Sinomine Resource Group are investing in African countries such as the DRC, Zimbabwe, and Mali. China's overseas investments in nickel mines are concentrated in Indonesia. By the end of 2021, more than 10 Chinese enterprises had invested in nickel mines in Indonesia, including Tsingshan Holding Group, Jinchuan Group, Delong Nickel, and Huayou Cobalt, with 2.6 million tons of nickel mining capacity in production and 2.1 million tons under construction. China's overseas investments in cobalt mines are concentrated in the DRC. At present, Minmetals, Jinchuan Group, and CMOC Group are the major companies investing in cobalt mines in the DRC, with 35% of the total capacity [55].

The impacts on Chinese critical mineral supply chains

The first impact is the restrictions on resource investment and production capacity and the increasing fluctuation in prices of mineral commodities. Higher royalties and tax rates and review and renegotiation of existing contracts will increase the cost for the exploration and development of mining resources, which will in turn impact the stabilisation of investments. Moreover, the mandatory expropriation of foreign-funded mining equity assets and nationalising of operations will significantly reduce efficiency in the exploration, development, and operation of the mining industry in resource-rich countries. These resource nationalism policies will certainly worsen the short supply of mineral products, especially for critical metals that are related to clean energy. In consequence, prices of mineral products will rise, generating a positive spiral between resource nationalism and prices of metals and minerals.

The second impact is greater geopolitical risks as a result of big-power competition in the sector of critical minerals. The rise of the new wave of resource nationalism has further intensified the contention for critical metal resources. Recently, worrying about China's restrictions on the export of refined minerals, major economies mainly US and the EU reviewed and reassessed China's supply of critical minerals, strengthened their cooperation with allies and partners in trade and investment, and strengthened their development of other resources, such as rare earths, lithium, and cobalt. The global competition in occupying, extracting, refining, processing, and applying critical minerals is anticipated to intensify and aggravate geopolitical conflicts.

The third impact is the rising uncertainty in critical minerals trade and investment as a result of China's heavy dependence on overseas mineral supplies. China is the world's workshop and is also the largest importer of metal minerals, with its imports accounting for about half of the global metal trade. Minerals such as copper, aluminium, nickel, lithium, chromium, cobalt, platinum, and potash are insufficient at home and supply relies heavily on imports. In addition, minerals are unevenly distributed around the world, with some critical minerals concentrated in only a few countries. China imports minerals from only a few countries and relies heavily on imports from those with high resource nationalism, which implies high supply risks. Furthermore, Chinese enterprises that have invested hugely in overseas mining projects will be affected by higher taxes and fees, renegotiation and review of contracts, and mandatory nationalisation by host countries.

The fourth impact is on China's core position in mineral refining and processing. The shock to Chinese companies is from both the demand and supply sides. On the demand side, the United States and its allies are trying to localise, diversify, and de-Sinicise of their supply chain of critical minerals, although it is difficult to get rid of the dependence on China's supply chain in the short term due to challenges such as scale, cost, and environmental protection. On the supply side, mineral resource–rich countries are increasingly inclined to reduce raw ore exports and increase domestic mineral processing capacity to obtain more value-added benefits. It is worth noting that Indonesia's model of banning the export of raw ore has been effective, attracting a large amount of foreign investment into its mineral processing industry and promoting the rapid development of its upstream mineral refining and processing industry; some other resource-rich countries have followed Indonesia's model. This means that China's traditional model of developing and expanding its domestic refining and processing industry by importing a large amount of raw ore will encounter increasing challenges and could even become unsustainable.

Conclusion

The reliance of clean energy technologies on energy transition minerals, including lithium, nickel, cobalt, copper, and rare earth elements, is undeniable. These minerals form the backbone of the global push towards a greener, more sustainable future. As we witness an unprecedented surge in demand, driven by the widespread adoption of these technologies worldwide, it is critical to recognise the intricate supply and demand dynamics at play. This study has highlighted the stark reality of the uneven global distribution of energy transition minerals, their concentration in a few countries, and the challenges posed by prolonged mining cycles and slow supply growth. Such imbalances underscore the strategic significance of these minerals and fuel intense geopolitical competition, with nations vying for control and security over these valuable resources. Measures including increasing royalty rates, renegotiating mining contracts, nationalising resources, and banning exports are indicative of the rising wave of resource nationalism. The US and EU have worked together to build localised, diversified, and de-Sinicised supply chains through mechanisms and bills such as the Energy Resource Governance Initiative, Minerals Security Partnership, Sustainable Critical Minerals Alliance, Inflation Reduction Act, and Critical Raw Materials Act. This shift is a clear response to the strategic importance of energy transition minerals and their role in the last frontier of global geopolitical and economic competition.

China is an important supplier of clean energy products and technologies, holding half of the global market for photovoltaic solar panels, wind power equipment, and electric vehicle batteries (amongst other clean energy sources). Nonetheless, most of China's energy transition minerals have low reserves and rely heavily on imports. In the current environment of intense China–US competition as well as global competition for energy transition minerals, the question of how to ensure the supply security of critical minerals and enhance the resilience of energy transition–mineral supply chains has become a major issue that China urgently needs to solve. This necessitates making full use of domestic and foreign resources, conducting mineral resource diplomacy, expanding import channels, safeguarding overseas interests, and improving industrial competitiveness.

The outlined challenges and opportunities underscore the urgent need for strategic interventions and policy reforms. The subsequent recommendations aim to address the highlighted challenges and explore strategies for ensuring a secure, resilient, and sustainable supply chain for these crucial minerals.

Policy recommendations

1. **Enhancement of investment risk identification and warning mechanisms, as well as fostering of relations and social responsibility.** Chinese enterprises should establish internal monitoring systems to closely observe the situation and trends of resource nationalism in host countries, systematically tracking and assessing changes in mining policies and laws. Such a proactive approach will enable accurate identification and anticipation of investment risks and, if necessary, appropriate action can be taken, such as intensifying lobbying efforts in host countries to mitigate unfavourable policy shifts.

Furthermore, fostering cooperative relationships with influential local mining companies can help eliminate cultural barriers, reduce integration costs, and minimise risks associated with policy changes. Deepening cooperation with mining community leaders, local governments, and non-governmental organisations is also crucial, contributing to community development by supporting infrastructure projects, healthcare, education, and recreational facilities. Additionally, improving processes and technologies in mining, processing, and transportation is crucial to mitigating adverse environmental and community impacts, thereby adhering strictly to environmental and labour protection standards to diminish the resistance prompted by resource nationalism.

2. **Overseas mining investment and global governance participation.** Chinese embassies, consulates, and overseas industry associations, along with chambers of commerce, could establish specialised departments dedicated to overseas investment protection. These units would provide mining enterprises with critical policy advice, risk assessments, and comprehensive guidance. They should also furnish detailed information on the host country's national culture, economic and social contexts, and humanistic traditions, as well as relevant laws, regulations, international norms, and bilateral investment treaties. Promoting investments in livelihood and low-carbon projects in resource-rich countries, particularly in Africa and Latin America, can enhance China's diplomatic image, garner broader recognition, and lower barriers to investment, strengthening communication with local stakeholders and non-governmental organisations in host countries. By broadening the avenues for dialogue and exchange, and elucidating the processes behind foreign investments, these actions could significantly mitigate local resistance. Finally, Chinese enterprises are encouraged to actively engage in the global mining governance framework. This could involve leveraging international platforms including the World Trade Organization (WTO), the Regional Comprehensive Economic Partnership (RCEP), the Forum on China–Africa Cooperation, and the Belt and Road Forum for International Cooperation. Participation in these platforms should not just be passive but should also involve leading roles in the development and establishment of international mining regulations and standards.
3. **Resource conservation and innovation.** It is crucial to significantly increase investment in the exploration and development of critical minerals, accelerating the research and development (R&D) and application of cutting-edge mining technologies to augment domestic reserves of essential resources. Establishing a system for the mandatory recycling of waste critical metals and minerals should be prioritised, stimulating enterprises to pioneer technologies that can substitute rare critical minerals. Furthermore, fostering technological innovation in the refining and processing of metals is essential to bolster the competitiveness of the industrial chain. Encouraging domestic enterprises to expand their global footprint by engaging in mining investment, metal smelting, processing, and commodity trade – particularly in countries along the Belt and Road Initiative, where natural resources are plentiful – is also vital.

4. **Strategic reserves enhancement.** Maintaining both foreign exchange reserves and critical minerals reserves is essential for ensuring economic and social stability. Currently, there is a heightened risk of depreciation in the substantial assets dominated by USD within China's foreign exchange reserves, primarily due to escalating inflation in the US. Concurrently, there is an anticipated long-term scarcity of critical minerals – including cobalt, lithium, nickel, and copper – integral to clean energy technologies, which is likely to ensure elevated prices are sustained over an extended period. Strategically allocating a portion of the foreign exchange reserves to augment reserves of critical and strategic minerals, particularly those that are scarce domestically, will mitigate supply disruption risks and potentially enhance the value of the foreign exchange reserves. However, it is crucial to acknowledge that increasing critical mineral reserves is a gradual process and careful market timing and scale considerations are imperative.

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4- The Belt and Road Initiative and Africa's Green Energy Development

China's Photovoltaic Commodity Exports to Africa

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Comments

- Many thanks for your excellent changes to the paper
- Things that need to be checked are marked in yellow

To be done (TBD)

- The two tables added are excellent and incredibly informative. They are however missing the 2010-2012 % growth rates (pre-BRI treatment). Could you please add this? It would be very useful for quantifying the difference between the pre-BRI and during-BRI period. I already added two columns marked in yellow where this data can be added.

- There are some inconsistencies in the middle columns in Table 1 and Table 2 (average %/proportion). First, the proportions may not be quite right. As an example: in Table 1, China's proportion is listed at 58.38% for 2020-2022, despite China's PV exports (in Figure 1 and elsewhere in Table 1) being less than half of the total for all three years. Second, the proportions consistently add up to more than 100%. This may reflect an underlying inaccuracy

- There are some inconsistencies in the right columns (growth rate %) in table 1 and table 2. For example, in table 1, China's 2020-2022 average growth rate is listed at 69.6%. I calculated this manually, and the 2020 to 2021 growth rate is 36.82%, and the 2021 to 2022 growth rate is 35.03%. So, the average is about 36%. If one ignores 2021 and just looks at the growth between 2020 and 2022, the growth rate is 84.74%. Based on this, could you please check the results again?

- Many thanks for taking a look at the above mentioned points

Completed activities

- I changed "percentage" in the middle columns to "proportion", as that is what you used in the text.
- I rephrased the Table 1 & 2 description, and moved it below the tables (in line with how we display the Figures)
- I slightly expanded the in-text analysis of the tables.
- I removed old comments and markers
- I amended the analysis of Figure 7 on page 13 (based on the numbers provided in the chart), as the numbers written in the text were incorrect. Please check if you agree with this change (on page 13, marked yellow)

List of Abbreviations

AU:	African Union
BRI:	Belt and Road Initiative
ECOWAS:	Economic Community of West African States
EU:	European Union
GW:	Gigawatt
IEA:	International Energy Agency
IRENA:	International Renewable Energy Agency
NG-ACBP:	Next Generation Africa Climate Business Plan
MW	Megawatt
MWh	Megawatt hour
PIDA:	Programme for Infrastructure Development in Africa
PV:	Photovoltaic
TWh	Terawatt hour
UN	United Nations

The Belt and Road Initiative and Africa's Green Energy Development
China's Photovoltaic Commodity Exports to Africa

Abstract

Over the past two decades, Africa has experienced rapid economic growth and improved social conditions. Unreliable energy supplies are a problem holding back economies, with most countries regularly facing power outages and often relying on expensive and polluting solutions. Clean, homegrown, and affordable renewable energy solutions are opportunities for the continent to achieve its economic, social, environmental and climate goals. According to the International Renewable Energy Agency (IRENA) report "Expanding Renewable Energy Deployment in Africa", Africa could meet nearly a quarter of its energy needs by 2030 from homegrown and clean renewable energy. 310 Gigawatts (GW) of modern renewable energy could provide half of the continent total power generation capacity.

We found that China's exports of solar photovoltaic (PV) commodities to Africa increased significantly after the announcement of the Belt and Road Initiative (BRI). This shows that China has promoted the construction of renewable energy infrastructure in Africa. The BRI is conducive to the green development of Africa. This reflects China's positive contribution to addressing global climate change, this is shown by the rapid growth of Chinese PV commodities to all African sub-regions.

In further discussion, we found that COVID-19 has not hampered China's renewable energy exports to Africa. In the future, China and Africa should further strengthen cooperation in green development under the framework of the BRI, such as fostering cooperation in green hydrogen energy. What is more, we found that apart from China, countries such as Germany, France, Spain, Portugal, and Italy in the European Union are also important PV commodity exporters to Africa. Based on the datasets used it appears that China has significant third-party market cooperation potential in the export of PV commodities to the African continent.

Key words: China-Africa green energy, renewable energy, solar photovoltaic, trade, China, Africa, BRI

Introduction

This study aims to explore the transnationalization of Chinese green technology into Africa within the context of the Green Belt and Road Initiative (BRI). Investigating this aspect is a pivotal component of the broader research agenda on the BRI. As highlighted by Amineh [1], it is essential to comprehensively understand the BRI's origins, processes, and impacts. This paper specifically focuses on the export of photovoltaic (PV) commodities to the 54 countries comprising the African continent. Consequently, the central research question, is *How has the BRI affected China's exports of PV commodities to selected African countries?*

The methodology of this paper encompasses a dual approach. Firstly, we employ political economic theory, utilizing elements of the theory of geopolitical economy [1] to examine the origins, processes, and impacts of the Green-BRI in general, and its African component in particular. Secondly, we adopt an experimental economic approach to assess the impacts of the Green Belt and Road Initiative (BRI) on China's PV commodity exports to African countries. This analysis is facilitated by datasets sourced from United Nations (UN) Comtrade database [2] , enabling us to examine China's PV exports to Africa between 2010 and 2022. This timeframe allows us to concentrate on the period following the inception of the BRI in 2013.

Our investigation is contextualized within the framework of so-called Green-BRI. This shift commenced in May 2017, when the Chinese Ministry of Environmental Protection, Ministry of Foreign Affairs, National Development and Reform Commission, and Ministry of Commerce jointly issued the *Guiding Opinions* on Promoting the Construction of a "Green Belt and Road Initiative" [3]. This seminal document underscores the imperative of fostering a green "BRI" and promotes the "Silk Road Spirit" characterized by peaceful cooperation, openness, tolerance, mutual learning, and mutually beneficial collaboration. The *Guiding Opiniions* not only advocate for an environmental shift but also for more equitable BRI that aligns more closely with the interests of participating countries. Furthermore, the document outlines a projected 3 to 5-year timeline for establishing a greener BRI, encompassing environmental risk protection and extensive environmental cooperation (Belt and Road Portal, 2017).

Prior to delving into the operationalization of this green BRI, it is crucial to contextualize the BRI's emergence within a broader theoretical framework. Understanding the practical implementation of China's state-led BRI necessitates an understanding of its origins and the challenges it encounters [1]. The subsequent section will delve into the BRI's origin, aligning with geopolitical economy theory.

The emergence of the China-led BRI and the transnationalization of renewable energy

Key literature suggests that the BRI primarily emerged as a result of structural challenges in China's domestic economy in the early 2010s: primarily overaccumulation and scarcity of fossil fuel and mineral resources [4]. Overaccumulation, involving surplus capital and labor resulted in reduced efficiency, overproduction, and declining profitability [5, 4, 6, 7]. The 2008 financial crisis worsened these issues, leading to a steep decline in export growth and an increase in industrial overcapacity [8, 9, 10, 7, 11]. Government initiatives to reduce overcapacity on a domestic level were largely unsuccessful, even contributing to slowed economic growth [12, 6, 7]. Furthermore, China's rapid urbanization has led to labor market imbalances, escalating labor costs, and rising unemployment rates among university graduates [13, 7]. This situation has contributed to declining profits in the industrial sector [14, 15, 7].

Resource scarcity, especially in fossil fuels, poses another significant challenge to China's economy and political stability [4]. This is exacerbated by China's high levels of import dependence for fossil fuels [4]. To address these issues, China has pursued strategies like the BRI, and ordering companies to 'go out'. David Harvey describes this as a "spatial fix" [4, 5], a strategy that involves the spatial expansion of capital into new markets. This approach helps overcome domestic limits on accumulation, combats energy scarcity, and resolves overaccumulation issues through the opening up of new markets [16, 4]. Termed 'globalization', this strategy encompasses the transnationalization of economies into a global network. A historical example of this strategy can be observed in Britain's economic activities during the late 19th century, when it extended its capital across the globe, especially into Argentina [17]. The BRI is a modern iteration of this strategy. Through this initiative, China aims to relocate capital goods to the participant countries, largely developing economies. This move helps alleviate China's domestic economic problems, and opens up new corridors for Chinese investment and trade [18, 19, 20, 21, 22]. This study aims to analyze the execution of China's BRI, with a specific sectoral and spatial focus: the BRI's impact on Chinese exports of PV commodities to the 54 states that make up Africa.

World Bank Sets Ambitious Targets for Green and Resilient Economic Growth in Africa

The World Bank released the Next Generation Africa Climate Business Plan (NG-ACBP), which sets a blueprint to help Sub-Saharan African economies achieve low carbon and climate-resilient outcomes. The Plan calls for countries to seize the opportunity to scale-up climate resilience to grow their economies and reduce poverty, redouble efforts to increase energy access across the region, and take advantage of sustainable and innovative approaches to leapfrog into greener development pathways. The urgency of this plan is underscored by projections that, without rapid deployment of inclusive, climate-informed development, 43 million additional people could be pushed below the poverty line by 2030 in Sub-Saharan Africa. As the largest financier of climate action in Africa, the World Bank intends to utilize this new Climate Plan to build a strong track record under the original plan in which the Bank supported 346 projects with more than $33 billion in World Bank financing over the past six years [23].

"The climate challenge cuts across every priority – poverty reduction, agriculture, job creation, women's empowerment, fragility, and more," says Ousmane Diagana, World Bank Vice President for West and Central Africa. Countries, therefore, have to tackle it in multiple ways, including by helping cities develop in clean ways, making climate-smart agriculture practices the norm, improving clean, green, and affordable energy, and putting people and communities at the forefront in order to improve lives and protect the future. Over the next six years (2021-26), the World Bank will focus on five key areas in Africa – food security, clean energy, green and resilient cities, environmental stability, and climate shocks – emphasizing the interrelatedness of climate risks and opportunities. The Plan sets ambitious goals that push the boundaries of sustainable development in Africa, including training 10 million farmers on climate-smart agricultural approaches, expanding integrated landscape management over 60 million hectares in 20 countries, increasing renewable energy generation capacity from 28GW to 38GW to increase access to clean electricity, and outfitting at least 30 cities with low carbon and compact urban planning approaches. "Africa's main challenge is to adapt to climate change by investing in more resilient agriculture and food systems, building infrastructure that resists extreme weather events, protecting its coastal cities, and enhancing disaster preparedness systems," says Hafez Ghanem, World Bank Vice President for East and Southern Africa. At the same time, green technologies are opportunities for growth and job creation. This is especially true in the energy sector where renewables have become a source of clean and inexpensive energy, bringing the goal of universal access to electricity within reach [23].

The World Bank recommends that Sub-Saharan African countries enact policy reforms that recognize the realities of climate change to strengthen recovery and promote long-term growth. Recommendations include addressing the sizable infrastructure gap in an environmentally-friendly and resilient manner, using less carbon-intensive materials and technologies while creating more competitive job opportunities [23].

The development of the Plan was led by Kanta Kumari Rigaud, Lead Environment Specialist, who underscores that ramping up climate action on both the resilience and clean energy fronts is critical to address climate change and poverty in Sub-Saharan Africa, as the window of opportunity to counter the climate crisis is rapidly narrowing. This Plan will be rolled out amid the COVID-19 pandemic, recognizing that climate action and green recovery will be key priorities as countries work to build back better from one of the biggest setbacks in the region's development in the last 25 years [23].

Africa's vast renewable energy ready to be tapped

Africa is increasingly becoming a global hub for energy solutions, as it represents an untapped market for renewable energy resources. The shift to sustainable clean energy solutions offers a substantial investment opportunity for both domestic and international investors. Renewable energy is also an opportunity for the African continent to address climate change and attain the 2030 Agenda for Sustainable Development goals on affordable and clean energy. However, because the continent energy infrastructure was developed to support nonrenewable energy sources after the independence of African countries, fossil fuels continue to dominate the energy supply and infrastructure construction [24].

Fossil fuel energy should become outdated by 2030. As fossil fuels contribute to environmental disaster through carbon emissions, policymakers, environmentalists and climate change advocates are urging the global community to embrace renewable energy sources. These sources include wind, solar and hydro power, biomass, geothermal and tidal energy, and nuclear fission and fusion. With the world's increasing adoption of clean energy, research from various environmentalists revealed that more job opportunities based on green technology emerged for approximately 1.8 billion people, 90% of whom live in developing countries [24]. East Africa is among the largest investors of large-scale, on-grid infrastructure in geothermal, wind and solar power. For instance, Kenya is leading the deployment of renewable energy technologies in power generation, especially in the development of geothermal energy in Africa. With government efforts to train competent personnel, several geothermal plants have been set up to generate electricity in the Rift Valley. Recent additions to the grid include 158 megawatts (MW) from the Olkaria V Geothermal power plant, 310 MW from the Lake Turkana Wind Power station, and 54 MW from the Garissa Solar power plant, all renewable and environmentally friendly energy sources. One of the key reasons for the success of Kenya's renewable energy provision is the nation's policy reforms, which made it possible for the private sector to participate by using renewable energy technologies. The Kenyan government has provided fiscal incentives by removing duties on imported goods for power generation. Additionally, the enactment of the Energy Act 2019, part of which has been dedicated to renewable energy, demonstrates the government's commitment to guiding the sector. The government plans to implement the feed-in tariffs policy to facilitate electricity generation, thereby feeding the grid with renewable energy sources and ensuring better power planning that will lead to healthy energy competition [24].

Other countries are implementing similar measures to promote clean energy growth in Africa. However, despite the opportunities and significant contributions of renewable energy within the energy sector, several challenges hinder the full integration of renewable energy as the primary energy source for most African countries. These challenges include the lack of viable projects and potential financiers, market risks, inadequate and improper legislation, high-interest charges on loans to private sector investors, and energy poverty in some countries.

Nonetheless, as Africa emerges as a new frontier in renewable energy, the African Union's (AU) Agenda 2063 has introduced several initiatives to promote Africa's access to renewable energy. The first is the Africa Renewable Energy Initiative, designed to accelerate the exploration of the continent's immense renewable energy potential. Endorsed by African heads of state under the AU's mandate, it aims to generate at least 300 GW of new renewable energy by 2030. The second initiative is the Africa Power Vision, based on the Program for Infrastructure Development in Africa (PIDA), which serves as a framework for bridging Africa's vast infrastructure gap across the transportation, energy and water, and information and communication technology sectors. The third initiative, under the United Nations Development Program under the Low Emission and Climate Resilient Development project, focuses on strengthening institutions to ameliorate the coordination of climate change policies and increase resilience to climate change impacts [24].

The Share of Solar in West Africa's future energy mix

The Economic Community of West African States (ECOWAS) should prioritize the development of solar PV technology to meet surging energy demand over the next 30 years [25]. Researchers in Finland propose that solar PV become the primary energy source for West Africa as the region works towards decarbonization by 2050 [25]. ECOWAS must significantly expand its generating capacity over the next three decades to accommodate an anticipated surge in electricity demand. The study indicates that there is no necessity for member states to build new nuclear plants and coal-fired facilities, as solar PV is ideally suited to be the predominant source of the region's future energy mix through 2050. Specifically, hybrid solar PV-battery systems are projected to be the most cost-effective option for ECOWAS up to 2050 [25]. Hence, ECOWAS energy policy should centralize solar PV, particularly hybrid solar PV-battery power systems, as they appear to be the most economical solution for the region [25]. The study also notes that an efficient transmission grid infrastructure could facilitate substantial wind electricity generation from Niger and Mali, potentially further reducing the overall energy system cost of West Africa. The researchers assert that the ECOWAS region can achieve substantial renewables deployment in the coming decades without relying on state funding, as renewables offer the cost-effective option for the West African power system without subsidies [25].

Oyewo et al. advocates for a regional policy framework that minimizes investment in conventional power plants, backed by comprehensive energy market reforms and ambitious long-term renewables deployment targets. Utilizing linear optimization modeling, the researchers determined the most cost-effective generation mix to meet the region's energy demand at five-year intervals. Oyewo et al. [25] further designed six different theoretical scenarios in what they claim to be the first long-term study of its kind in West African power sector. Under their optimal policy scenario leading up to 2050, they project solar PV could satisfy 81-85% of total energy demand by 2050. Additionally, they anticipate a decrease in the cost of electricity in the region from 70 Megawatt hours (MWh) in 2015 to 36 MWh by 2050 with interconnection and to 41 MWh without interconnection under their best policy scenario. Currently, roughly half of the population in ECOWAS lacks reliable access to electricity. In some countries, such as Niger, Guinea-Bissau, Liberia, and Sierra Leone, the electrification rate was below 40% in 2016, posing a significant constraint on socio-economic development. With regional electricity demand expected to jump by roughly fivefold over the current decade to 250 Terawatt hours (TWh), the urgency for long-term energy system planning is now more pressing than ever.

The above-mentioned scholars concluded that their modeling distinctly illustrates two key aspects of the region's future electrical system: transition and expansion. They argue that this will necessitate regional policymakers to utilize all available renewable energy resources, including solar PV, wind, biomass and hydropower. This study supports a late-2018 report by IRENA, which highlighted that West Africa has the potential to deploy up to 20 GW of solar by 2030. It projects a minimum of 8 GW of PV capacity across the 15 ECOWAS countries by the end of the current decade, with Nigeria, Ghana and Côte d'Ivoire leading regional growth. Recently, Benin secured a $21.1 million loan from the ECOWAS development bank to construct solar arrays throughout the nation. Additionally, Burundi obtained a $160 million donation from the World Bank to deploy PV systems [25].

Method and Data

This paper examines whether the BRI has facilitated China's export of renewable energy products and analyses the impact of the BRI on the welfare of green trade. To achieve this, we employ an experimental-economic method of quantitative data analysis to fully comprehend these effects. This allows us to directly examine the relationship between the emergence of the BRI, and China's success in exporting solar PV commodities to the African continent.

This experimental-economic method informs the following research strategies. First, we utilize the BRI as a quasi-natural experiment. Second, we consider China's exports of PV commodities to Africa as a treatment group. Third, we use the remaining nine biggest PV exporting countries to Africa as the control group. Fourth, we analyze the three years from 2010 to 2012, which precede the implementation of the BRI. Fifth, we examine the decade from 2013 to 2022, following the BRI's implementation

Our analysis of this quasi-natural experiment includes several steps. Initially, we observe the annual export value of major PV commodity exporting countries globally during the sample period. Subsequently, we focus on Africa, starting with China's PV commodity exports to Africa from 2010 to 2012. If the export situation in these years remains relatively unchanged, it aligns with the parallel trend hypothesis of the quasi-natural experiment. Then, we observe China's exports of PV commodities to Africa from 2013 to 2022. If we note a significant increase in exports compared to previous years relative to other nine countries in the control group, it suggests that the BRI has boosted China's exports of PV commodities to Africa. Furthermore, we extend this analysis to the five main sub-regions of Africa and the 10 biggest African importers of PV commodities. Throughout our analysis, we remain cognizant of the impact of the COVID-19 pandemic on the BRI between 2020 and 2022.

Our primary data source is PV export data from UNComtrade [2]. The African continent has ample solar energy, but the distribution of wind energy is uneven. To minimize interference from differences in renewable energy endowments, this paper focuses exclusively on PV energy. UNComtrade is a widely recognized authoritative database in international trade research, known for its rapid updates. This facilitates the use of internationally recognized commodity codes to examine the export situation of different countries to a specific region for PV commodities. The data selected for this paper encompass global country-commodity-annual trade data, specifically global exports of various countries to the African continent, using PV cells as the commodity code and covering the period 2010 to 2022.

We selected global exports of PV products to African countries for cross-country comparison. Given that only two African countries have not joined the BRI as of now, this paper does not need to select African countries that have not joined the BRI as a control group. Instead, we select other countries that export PV commodities to Africa as the control group for China. The commodity code used is HS code 8541, which includes diodes, transistors, similar semiconductor devices, including PV cells whether assembled in modules, or panels, and light emitting or mounted piezo-electric crystals, commonly recognized in the industry as the export code for PV commodities. The time range from 2010 to 2022 was selected because China proposed the BRI in 2012, allowing for an observation of changes before and after its implementation, to further observe the impact of the COVID-19 pandemic on PV exports.

Due to varying degrees of missing data in the research sample for the export quantity of PV commodities, and given that the export value data is complete, we focused on the export value data and did not include export quantity data.

Literature Review

Ascensão et al. [26] noted that the BRI will have a significant influence on the future of global trade. This is in line with what De Soyres et al. [27] observed: that the BRI will significantly reduce shipment times and trade costs. Positive effects have also been noted by Boffa [28], who found that trade integration has increased among Belt and Road Economies. Furthermore, Liu et al. [29] found that the BRI had a strong policy effect on the greening of Chinese OFDI in the related countries and areas, especially in developing countries. Because Chinese firms chose to invest in clean energy projects as a result of the new BRI policy framework, Liu et al. [30] found that the announcement of BRI reduced the trade-inhibiting effect of cultural distance on China's trade with the Belt and Road countries, while increasing China's exports sensitivity to institutional distance. Jiang et al. [31] also assess the BRI positively, noting that the initiative contributes to energy savings, lowered pollution, and increased trade. Rojas-Mora et al. [32] provide a more critical note, noting that the BRI has not yet succeeded in elevating China's centrality in global trade networks, as it still lags behind its East Asian neighbours, as well as the EU and the US. Dumor et al. [33] echo this more critical assessment, noting that BRI trade with Africa is hampered by regional trade agreements, which encourage intra-African trade rather than trade with China.

Apart from works about the BRI's broader impacts on trade, there is also a body of literature that specifically focuses on the relationship between green energy and China-Africa trade. Zakari et al. [34] utilize a sample of forty Sub-Saharan African countries, finding that Chinese investment and trade have a positive impact on environmental quality. This is possibly related to the findings of Berhe et al. [35], who also examine a sample of forty African states, noting that Chinese exports increase renewable energy consumption across the continent. Chen et al. [36] present similar findings, noting that Chinese exports positively affect green growth in their sample of twenty-seven African states.

While the existing body of literature provides information about the effects of the BRI on trade, as well as the green energy-related implications of China-Africa trade, our research aims to innovate in three key ways.

First, we contribute to the active debate around the BRI's effects on trade. Authors disagree on the BRI's success in promoting trade integration among participating countries. Our aim is to present findings about a BRI-led transnational green trade network in the specific spatial context of Africa.

Second, comparative research on green BRI trade with Africa is currently rather sparse. The few articles discussed above use limited samples of African states, and examine the environmental impacts of China-Africa trade as a whole, rather than specifically examining green trade. Our contribution is to link the BRI to green trade in the African context, while using an exhaustive sample of all fifty-four recognized African states.

Finally, we make the concept of 'green trade' concrete by examining a specific, crucial, type of renewable energy commodity: solar PV. This is especially relevant in the African context, where natural endowments make this the most effective and broadly applicable form of renewable energy generation.

Analysis

Global export situation of PV commodities.

As depicted in Figure 1, from 2010 to 2022, the top ten PV commodity exporting countries in the world are China, Germany, Malaysia, Japan, Singapore, the United States, South Korea, the Philippines, Thailand, and the Netherlands. China's PV commodity exports to the global market fluctuated between US$20 billion and US$40 billion from 2010 to 2020, showing no clear increasing trend. However, in 2021 and 2022, these values significantly rose, exceeding US$40 billion and US$60 billion, respectively. This suggests that the BRI was not clearly linked to an increase in global Chinese PV commodity exports before the COVID-19 pandemic. Notably, the second and third years of the pandemic, 2021 and 2022, witnessed sharp increases in Chinese PV commodity exports. We can also get the same conclusion from the proportion and growth rate shown in Table 1, neither of which showed major increases in the BRI period. These findings contrast with the situation in Africa, which will be further discussed in the following analysis.

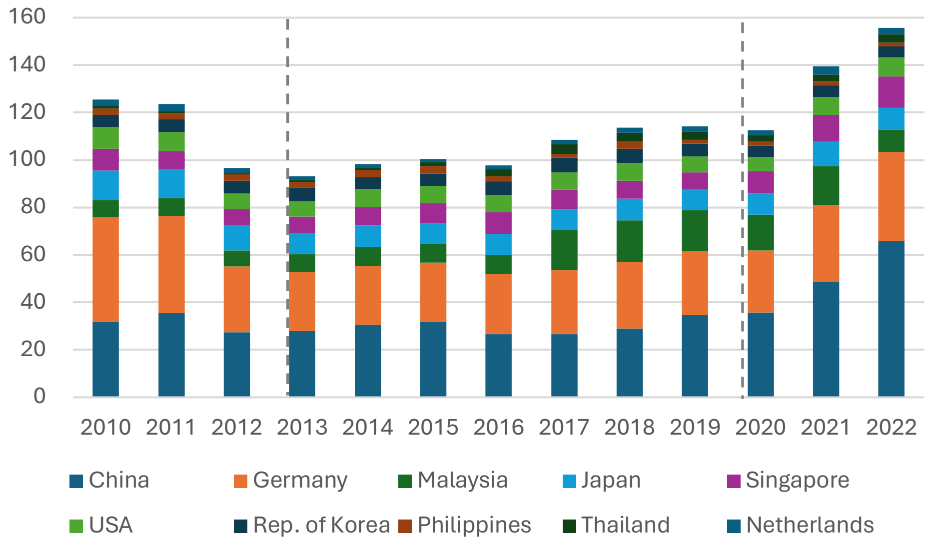

Figure 1: Exports of the top ten PV commodity exporters in the world from 2010 to 2022 (USD, billions). Source: UNcomtrade [2] and the author's calculation.

		Average from 2010 to 2012 (pre-BRI treatment)	Average from 2013 to 2019 (during BRI, pre-covid)	Average from 2020 to 2022 (the most recent year)	2010-2012 average proportion (pre-BRI treatment)	2013-2019 average proportion (during BRI, pre-covid)	2020-2022 average proportion (the most recent year)	Average growth rate from 2010 to 2012 (pre-BRI treatment)	Average growth rate from 2013 to 2019 (during BRI, pre-covid)	Average growth rate from 2020 to 2022 (the most recent year)
1	China	31.59	29.55	50.11	37.74%	39.88%	58.38%		-6.4%	69.6%
2	Germany	37.62	25.97	32.00	44.95%	31.04%	38.24%		-31.0%	23.2%
3	Malaysia	7.14	11.96	13.67	8.53%	14.29%	16.34%		67.6%	14.3%
4	Japan	11.85	8.86	9.47	14.16%	10.58%	11.32%		-25.3%	6.9%
5	Singapore	7.71	7.90	11.21	9.22%	9.44%	13.39%		2.4%	41.9%
6	USA	7.97	7.20	7.27	9.52%	8.61%	8.68%		-9.6%	0.9%
7	Rep. of Korea	5.30	5.57	4.83	6.34%	6.66%	5.77%		5.1%	-13.4%
8	Philippines	2.60	2.47	1.64	3.11%	2.95%	1.96%		-5.1%	-33.5%
9	Thailand	0.94	2.44	2.87	1.13%	2.92%	3.43%		158.8%	17.6%
10	Netherlands	2.56	1.74	2.87	3.06%	2.08%	3.43%		-32.1%	65.1%

Table 1: Average global exports of the top ten PV commodity exporters from 2010 to 2022: in USD, billions; as proportion, percent; as growth rate, percent. Source: UNcomtrade [2] and the author's calculation.

Top 10 countries' exports of PV commodities to the African continent.

As indicated in Figure 2, between 2010 and 2022, the leading countries exporting PV commodities to Africa are China, Germany, Spain, France, South Africa, Italy, the United States, Singapore, India and Türkiye. Before the BRI's proposal, Germany ranked first in terms of PV commodity exports to Africa for three consecutive years from 2010 to 2012. However, post-2013, China's exports to Africa substantially exceeded Germany, surpassing the annual exports of less than US$200 million recorded from 2010 to 2012. Notably, from 2013 to 2019, China's exports ranged between US$200 million and US$1 billion annually. Following the COVID-19 pandemic, these values rose above US$1 billion. We can also draw the same conclusion from the proportion and growth rate shown in Table 2, which both rose more rapidly in the 2013-2019 BRI period than in 2010-2012.

An alternative explanation for the observed patterns would be that China's growing PV commodity exports are the result of the country's rapid advances in renewable energy technology, rather than the BRI [37]. Additionally, over the last decade, a series of environmental regulation policies have been implemented in China. The above policies have promoted China's green technology innovation from the Policy-Push side and Demand-Pull side [38, 39]. This may be beneficial to the production and export of photovoltaic commodities in China.

However, through the above analysis, we find that the increase in these exports is also directional. China's growth in PV commodity exports was disproportionally concentrated in Africa, a continent with high levels of BRI involvement, rather than an even increase in exports to the whole world. This indicates that the BRI does indeed promote China's PV commodity exports.

In summary, several conclusions can be drawn: First, China's PV exports to Africa saw a higher growth rate during the 2013-2022 BRI period compared to the period from 2010-2012. Second, the rate of increase in these exports was faster than that of the competing countries mentioned above. This indicates that the BRI significantly contributed to the growth of China's PV exports to Africa. Third, the COVID-19 pandemic had little adverse effect on the growth of Chinese PV exports, apart from a brief dip in 2020. The next section will examine Chinese PV exports to the five main African subregions.

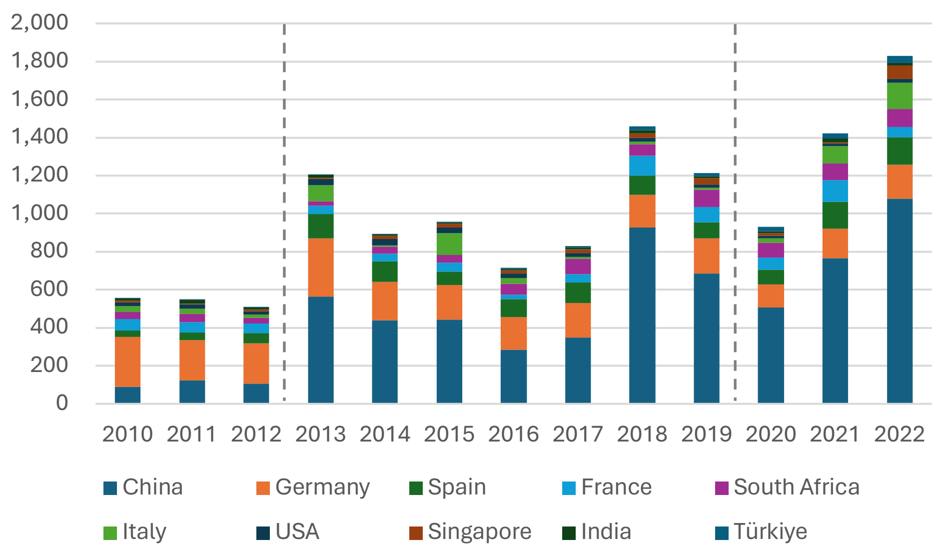

Figure 2: Top 10 countries' exports of PV commodities to the African continent from 2010 to 2022 (USD, millions). Source: UNcomtrade [2] and the author's calculation.

		Average from 2010 to 2012 (pre-BRI treatment)	Average from 2013 to 2019 (during BRI, pre-covid)	Average from 2020 to 2022 (the most recent year)	2010-2012 average proportion (pre-BRI treatment)	2013-2019 average proportion (during BRI, pre-covid)	2020-2022 average proportion (the most recent year)	Average growth rate from 2010 to 2012 (pre-BRI treatment)	Average growth rate from 2013 to 2019 (during BRI, pre-covid)	Average growth rate from 2020 to 2022 (the most recent year)
1	China	105.82	527.20	783.63	19.74%	50.77%	56.16%		398.2%	48.6%
2	Germany	228.01	200.08	151.79	42.52%	37.32%	28.31%		-12.2%	-24.1%
3	Spain	43.32	99.12	120.79	8.08%	18.49%	22.53%		128.8%	21.9%
4	France	54.97	54.93	78.40	10.25%	10.25%	14.62%		-0.1%	42.7%
5	South Africa	37.92	55.51	85.35	7.07%	10.35%	15.92%		46.4%	53.7%
6	Italy	23.70	38.52	83.52	4.42%	7.18%	15.58%		62.5%	116.8%
7	USA	20.76	25.52	16.17	3.87%	4.76%	3.02%		22.9%	-36.7%
8	Singapore	8.28	20.18	31.98	1.54%	3.76%	5.96%		143.8%	58.5%
9	India	13.14	9.42	14.09	2.45%	1.76%	2.63%		-28.3%	49.6%
10	Türkiye	0.26	8.00	29.62	0.05%	1.49%	5.52%		2936.9%	270.4%

Table 2: Average exports to the African continent of the top ten PV commodity exporters from 2010 to 2022: in USD, millions; as proportion, percent; as growth rate, percent. Source: UNcomtrade [2] and the author's calculation.

The trend of global major countries' export of PV commodities to African sub-regions.

Northern Africa, comprising Algeria, Egypt, Libya, Morocco, Sudan, and Tunisia, represents a significant market in Africa's northern region. As illustrated in Figure 3, from 2010 to 2022, the top 9 countries exporting PV bulk commodities to Northern Africa were Germany, China, Spain, France, Italy, Singapore, the United States, Turkey, and the Netherlands. Notably, the export value of China's PV commodities to Northern Africa saw a significant increase to US$130 million in 2014. Though there was a slight decreased in 2016, the export value has been on a steady rise since, exceeding US$180 million in 2022.

Based on this finding, it can be concluded that China's PV commodities exports to Northern Africa have notably increased following the proposal of the BRI. Moreover, these exports were not adversely affected by the COVID-19 epidemic.

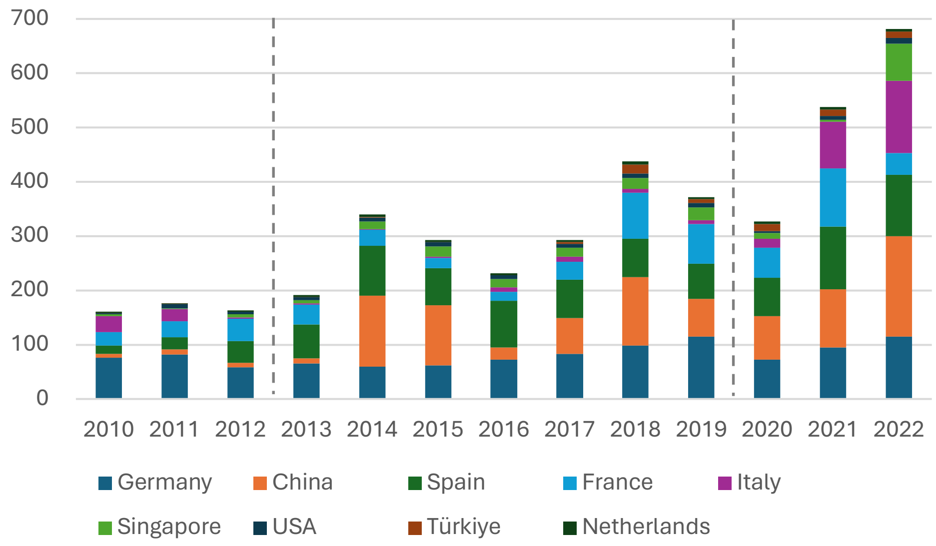

Figure 3: Exports of PV commodities to Northern Africa by major countries from 2010 to 2022 (USD, millions). Source: UNcomtrade (2023) and the author's calculation.

Eastern Africa encompasses Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, South Sudan, Tanzania, Uganda, Zambia, Zimbabwe. According to Figure 4, between 2010 and 2022, the top nine countries exporting PV commodities to Eastern Africa were China, South Africa, Germany, Spain, India, Malaysia, the United States, Kenya, and France. Notably, after 2014, China's exports of PV commodities to Eastern Africa have experienced a significant yearly increase, with only minor decrease observed in 2019 and 2020. The export value then continued to rise, from US$50 million in 2014 to over US$200 million in 2022.

Based on this data, it is evident that the BRI has been instrumental in boosting China's exports of PV commodities to Eastern Africa. Moreover, the COVID-19 epidemic appears to have had a minimal impact on these exports.

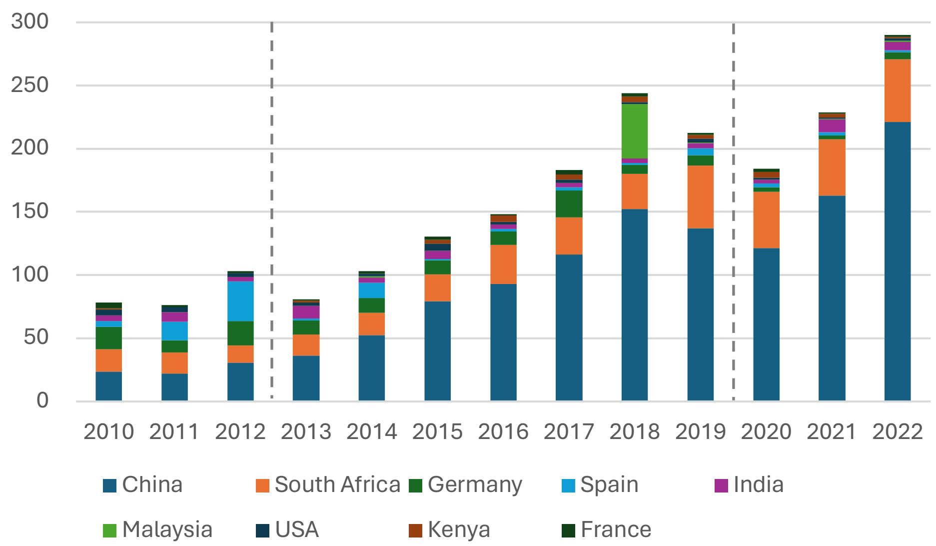

Figure 4: Exports of PV commodities to Eastern Africa by major countries from 2010 to 2022 (USD, millions). Source: UNcomtrade [2] and the author's calculation.

West Africa encompasses 16 countries: Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Guinea, Guinea-Bissau, Ghana, Liberia, Niger, Nigeria. Mauritania, Mali, Senegal, Sierra Leone, and Togo. As demonstrated in Figure 5, between 2010 and 2022, the top nine countries exporting PV commodities to West Africa were China, Germany, France, Spain, South Africa, Portugal, India, the United States, and Italy. Mirroring the trend in East Africa, since 2014, China's exports of PV commodities to West Africa have consistently risen each year, with the export value increasing from US$50 million in 2014 to nearly US$300 million US in 2022.

From this data, it is clear that the BRI has significantly boosted China’s exports of PV commodities to West Africa. Furthermore, the COVID-19 pandemic appears to have had no adverse effect on these exports.

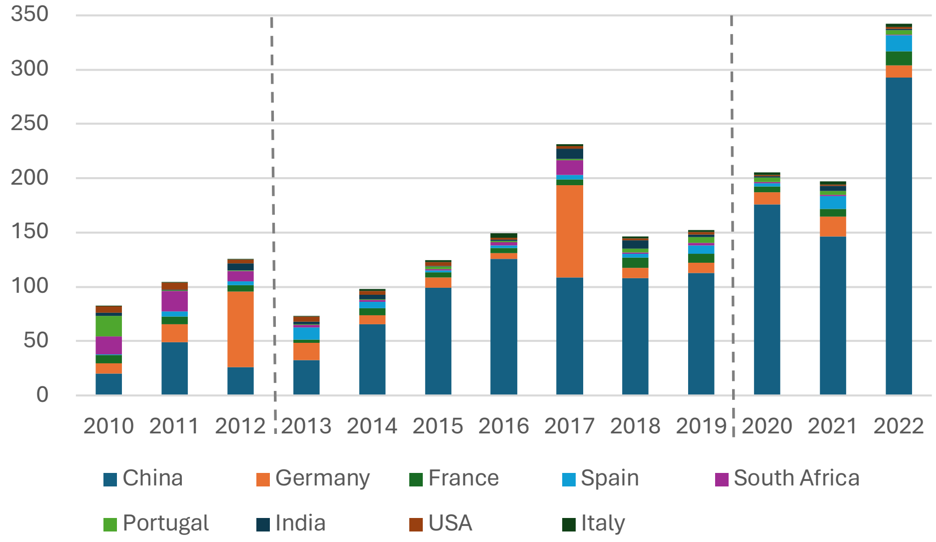

Figure 5: Exports of PV commodities to West Africa by major countries from 2010 to 2022 (USD, millions). Source: UNcomtrade [2] and the author's calculation.

Central Africa typically comprises Angola, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, and São Tomé and Príncipe. As shown in Figure 6, between 2010 and 2022, the top nine countries exporting PV commodities to Central Africa were China, South Korea, Spain, South Africa, Portugal, Germany, France, the United States, and Switzerland. Notably, in 2012, China's exports of PV commodities to Central Africa began to rise significantly. Subsequently, the export value remained stable within the range of US$10 million to US$20 million. After the COVID-19 epidemic, the value gradually broke through US$20 million and US$40 million in 2021 and 2022. Based on this data, it can be inferred that the BRI has likely played a role in facilitating China’s export of PV commodities to Central Africa.

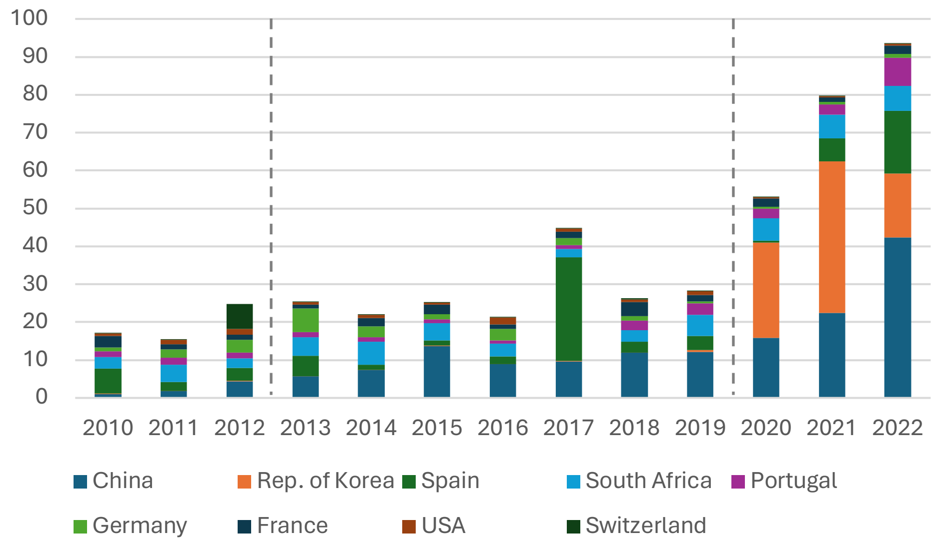

Figure 6: Exports of PV commodities to Central Africa by major countries from 2010 to 2022 (USD, millions). Source: UNcomtrade [2].

Southern Africa includes: Botswana, Eswatini, Lesotho, Namibia, and South Africa. As shown in Figure 7, between 2010 and 2022, the top nine countries exporting PV commodities to Southern Africa were China, Germany, South Africa, Italy, the United States, France, Spain, the United Kingdom, and India. In 2013, China's exports of PV commodities to Southern Africa saw a significant increase to US$493 million, well above the three preceding years, when exports did not exceed $51 million. Despite a decline between 2014 and 2017, PV exports remained well above their pre-BRI levels, and saw a notable increase in 2019, exceeding $300 million. From this analysis, it can be concluded that the BRI has been effective in boosting China's exports of PV commodities to Southern Africa. The adverse impact of COVID-19 appears to be limited to 2020, as the 2019 export figure was matched in 2021, and exceeded in 2022.

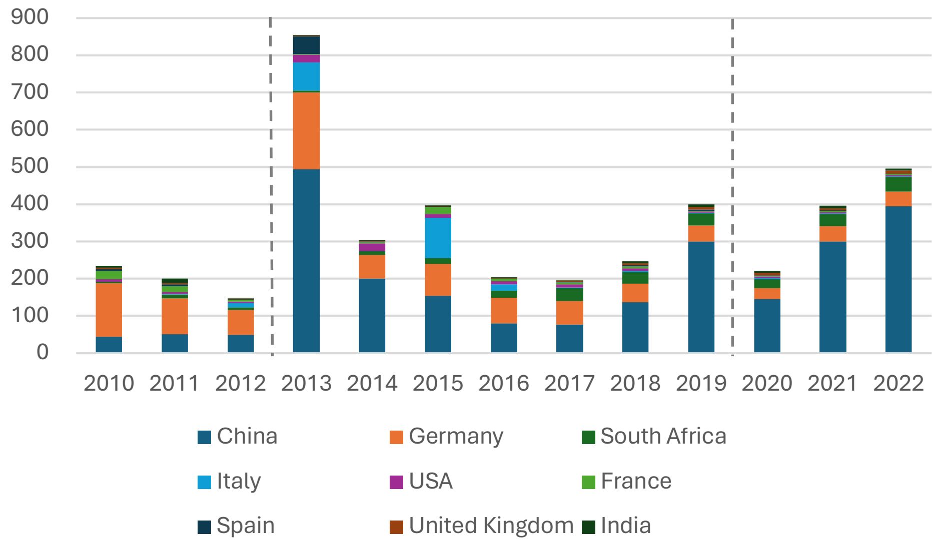

Figure 7: Exports of PV commodities to Southern Africa by major countries from 2010 to 2022 (USD, millions). Source: UNcomtrade [2] and the author's calculation.

Based on the analysis of the export trends of PV bulk commodities to the African continent by various countries, it has been found that, in addition to China, European countries such as Germany, France, Spain, Portugal, and Italy are also important exporters to Africa. This indicates that both China and the EU have significant potential for third-party market cooperation in exporting PV commodities to the African continent.

In addition, as an African country, South Africa is actively exporting PV commodities within the continent. This highlights the substantial potential for cooperation in the PV commodities industry among China, the EU, and South Africa.

Top 10 African countries in terms of China's exports of PV commodities

After conducting empirical analysis at the global, continental, and sub-regional level, we now shift our focus to examining the export trends of China's PV commodities to individual African countries.

As depicted in Figure 8, between 2010 and 2022, the top ten African countries that imported the most PV bulk commodities from China are South Africa, Egypt, Nigeria, Morocco, Algeria, Tanzania, Ghana, Tunisia, Namibia, and Mozambique. Notably, in 2013, China's exports of PV commodities to these top ten African countries surged to over US$500 million. Since then, the total has consistently remained at least US$200 million, with values exceeding US$800 million in both 2018 and 2022.

Consequently, these countries exhibit considerable potential for further cooperation with China in the trade of PV commodities, particularly within the framework of the BRI.

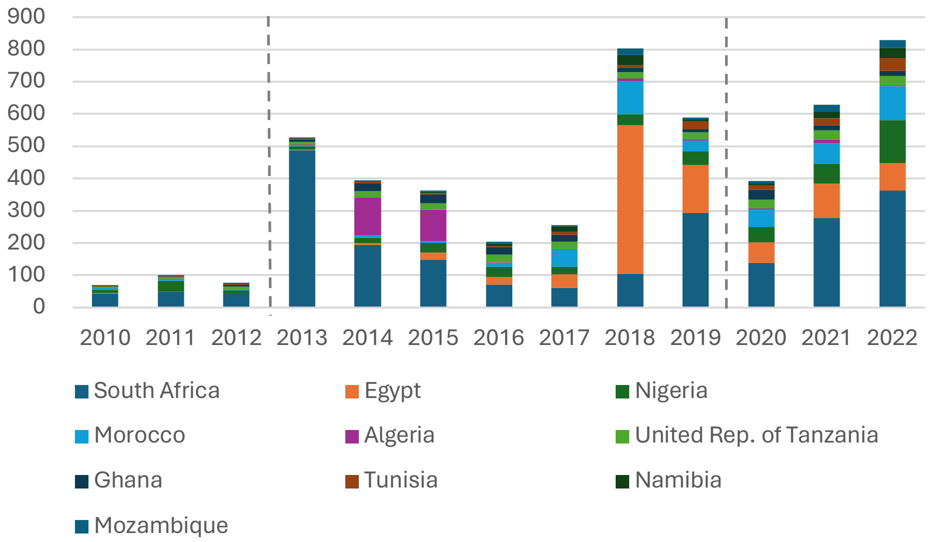

Figure 8: Top 10 African countries in terms of China's exports of PV commodities from 2010 to 2022 (USD, millions). Source: UNcomtrade [2] and the author's calculation.

Conclusion

This study examines the impact of the Green Belt and Road Initiative on the expansion of Chinese PV commodity exports to Africa. The emergence of the BRI is attributed to China's domestic economic challenges, notably resource scarcity and overaccumulation. These developments prompted Chinese policymakers to adopt their "go globe" strategy, marking a significant step in the transnationalition of China's economy in general and green economy in particular, to secure profits and ensure access to critical resourses.

Our main findings are twofold. First, the BRI's engagement in the African green energy sector has proven relatively successful, aligning with China's efforts to establish a "Green BRI" [3, 4]. This policy initiative has resulted in a substantial increase in PV exports to the African continent, positioning China ahead of competitors such as Germany, Spain, and Italy. The top importers of Chinese PV commodities have been identified as South Africa, Egypt, Nigeria, Morocco, Algeria, Tanzania, Ghana, Tunisia, Namibia, and Mozambique. Second, our analysis indicate that the COVID-19 pandemic did not hamper the growth of Chinese PV exports, which notably increased during 2021 and 2022. This suggests that Chinese policymakers effectively managed the supply chain challenges presented by the COVID-19 period.

Additionally, our findings suggest that both China and the EU have significant potential for third-party market cooperation in exporting PV goods to the African continent, being major exporters to the region.

Looking forward, four areas warrant further research. First, our focus exclusively on PV overlooks the role of other renewable energy commodities, such as wind and geothermal energy products. We suggest that future research explores China's exports of non-PV commodities to Africa.

Second, and more critically, this study did not examine the role of specialized energy-related corporations, both private and state-owned, which are pivotal in cross-border green technology investment (i.e.,transnationalization). This includes Chinese state-owned energy corporations and financial institutions engaged in the transnationalization of renewable energy technology, as well as private corporations from the Western world. Further research should delve into how the investment of private and state-owned corporations gradually produces transnational networks of capital, information, and technology.

Third, we suggest that further research provides a more substantive comparison between China's PV commodity exports, and those of key EU member states. This would allow us to gauge how unique China's rapid PV export growth is in a comparative context, and the potential for EU-China third-party market cooperation can be explored further.

Finally, this paper has examined China-Africa green trade at the international level, but we encourage the examination of African perspectives within the countries impacted. Future research could focus on how Chinese green commodity exports are received in African countries: what the political ramifications are, and whether Chinese exports can promote sustainable cooperation with African countries in the framework of the BRI.

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5- Comparing the Dynamics of the Energy Transition in the European Union and China

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List of Abbreviations

BRI:	Belt and Road Initiative
B.U GDP	Boston University Global Development Policy
CCS	Carbon Capture and Storage
CCICED	China Council for International Cooperation on Environment and Development
CL:	Capital Logic
DG:	Directorate-General
DIB:	Development Investment Bank
EEA:	European Economic Area
EED	Energy Efficiency Directive
EJ	ExaJoule
EMSR:	Energy Market Structure of Renewables
ETC	Economic and Trade Commission
ETS:	Emission Trading Scheme
EU:	European Union
FYP:	Five-Year-Plan
GDP:	Gross Domestic Product
GEC:	Green Electricity Certificate
GIER:	Geo-Infrastructural Ensemble of Renewables
GJ/tonne coal	GigaJoule to tonne of coal equivalent
GW	GigaWatt
IEA:	International Energy Agency
IRENA:	International Renewable Energy Agency
MEE	Ministry of Ecology and Environment
MOST	Ministry of Science and Technology
Mtoe	Million Tonnes of Oil Equivalent
Mwe	MegaWatt electric
NBSC	National Bureau of Statistics
NDRC	National Development and Reform Commission
NEA	National Energy Administration
OCI	Oil Change International

OECD	Organization for Economic Cooperation and Development
PJ	PetaJoule
PRC	People's Republic of China
PSC:	Politburo Standing Committee
PV	Photovoltaic
RE	Renewable Energy
RES:	Renewable Energy Source
SET:	Strategic Energy Technology
SOE:	State-Owned Enterprise
SS:	Strategic Scenario
SSMC:	State-Society-Market Complex
TJ/tonne crude oil	TeraJoule to tonne of oil equivalent
TWh	Terawatt hour
UN	United Nations
UNDP	United Nations Development Programme
USD	US Dollar

Comparing the Dynamics of the Energy Transition in the European Union and China

Abstract

This study provides a comparative analysis of the European Union (EU) and China's energy governance models, scrutinizing their impacts on energy transition strategies from 2000 to 2022. It aims to answer the research question: How have the EU's liberal and China's centralized energy governance models shaped their energy transnition strategies in terms of efficiency, effectiveness, and adaptation to environmental and socio-politial factors sicne 2000, and what are the specific challenges and advancements encountered by each? This analysis delves into the shift from fossil fuels to renewable energy admist global climate change, highlighting the efficiency, effectiveness, and adaptability of each model. It examines energy policies, clean energy investments, and distinct challenges stemming from their energy resource endowments and consumption patterns. Additionally, the study explores their progress in combating climate change, including the adoption of renewable energy and improvements in energy efficiency. This is done by a mixed methods approach, which includes e.g. quantitiave data from energy statistics and qualitative information from policy documents. A pivotal aspect of this analysis is the juxtaposition of the EU's liberal energy governance with China's centralized energy governance, analyzed through the lens of Geopolitical Economy theory, with a focus on "Liberal state-society-market complexes" versus "Centralized state-society-market complex." The findings reveal that China's centralized approach facilitates a more rapid and aefficient transition to renewable energy, whereas the EU's liberal model encounters delays due to the diverse and contradictory interests of its stakeholders. This paper offers insights into the broader socio-economic and environmental implications of these shifts, enriching our -understanding of how governance models impact energy transition strategies.

Keywords
Energy transition policy, Energy governance, Renewable energy technology, Energy transition challenges, China, the EU, Centralized energy governance, Liberal energy governance.

1. Introduction

Political and social stability are deeply intertwined with a country's ability to manage and accumulate capital, at the core of which lies the pivotal role of energy. In the face of the scarcity of traditional energy sources and their adverse environmental impacts, the transition to sustainable and renewable alternatives becomes imperative for maintaining economic, political, and social stability.

This research examines the energy transition experiences of the European Union (EU) and China from 2000 to 2022, especially focusing on the influence of their distinct energy governance models – the liberal model in the EU and the centralized model in China – on their respective strategies for energy transition. It scrutinizes the efficiency, effectiveness, and adaptability of these models in response to environmental imperatives and socio-political contexts. The EU's journey towards renewable energy and energy efficiency is marked by an increasing reliance on energy imports, posing risk of supply disruptions (see Amineh and Crijns-Graus, 2018). ~~Conversely,~~ China, as the world's largest energy producer and consumer, faces challenges in balancing its rapid economic development with environmental sustainability and energy supply security, due to heavy reliance on fossil fuels.

By understanding the paths taken by the EU and China in their energy transition, this study offers insights into the broader socio-economic and environmental implications of such shifts. Consequently, this study poses the research question: How have the EU's liberal and China's centralized energy governance models shaped their energy transition strategies in terms of efficiency, effectiveness, and adaptation to environmental and socio-political factors since 2000, and what are the specific challenges and advancements encountered by each?

The structure of this paper unfolds as follows: first, we introduce (1) the EU and China's energy governance models, utilizing state-society-market complex from geopolitical economy theory to understand the behaviour Amineh, 2022/23). After outlining (3) the methodology and data, we first present (4) the results of the EU policy analysis and the trends observed, followed by (5) the analysis of China's experience. Finally, (6) we provide a discussion and conclusions.

2. Method and Data

This research employs a mixed-methods approach, integrating both qualitative and quantitative analyses, to conduct a comparative study of the energy transition dynamics in the EU and China from 2000 to 2022. This approach is tailored to provide a holistic understanding of the multifaceted energy transition processes in these regions, encompassing policy analysis, descriptive statistics, and qualitative trend evaluation of their respective energy strategies.

The qualitative component of this study involves an examination of official documents, policy directives, and communications from pivotal institutions. For China, the analysis involves a thorough examination of official documents from the NDRC, NEA, MOST, among others, to gain insights into the country's energy transition strategies[2]. Similarly, for the EU, the study assesses official communications and documents from the European Commission[3], coupled with scholarly literature and reports from energy agency (e.g. IEA), to understand its energy transition approaches.

Complementing the qualitative analysis, this study employs descriptive statistics to evaluate the effectiveness of the energy transition strategies and targets in the EU and China, This approach enables a detailed evaluation of various energy supply security trends, complemented by an analysis of more qualitative, recent developments in the energy sector. Key variables have been carefully selected to gauge

[2] (IEA, 2007; 2018; 2021a; 2021b; 2021c; 2022d; 2023b; IRENA, 2013; 2019; MEE, 2017; NDRC, 2001; 2006; 2011; 2016; 2019; 2021a; 2021b; NEA & MOST, 2021; Standing Committee, 2002a; 2002b; 2005; State Council, 2002; UNDP, 2016; Wallace, 2004).
[3] (European Commission, 2000; 2006; 2008; 2013; 2023b).

the progress and experiences of both regions in their energy transition journey: the evolution of energy use, energy mix, and import dependency.

Specifically, the EU data encompasses the EU27, including Croatia (which joined in 2013) and excluding the United Kingdom (which left in 2020). The primary energy use data is based on the physical energy content method and lower heating value. The European Environment Agency (EEA, 2022) provides data on final and primary energy use, excluding non-energy uses (e.g. feedstocks in industries) and international shipping and aviation. Eurostat's Statistics Database (Eurostat, 2023b) informs on EU import dependence, calculating net imports as the difference between total imports and exports from outside the EU, adjusted for gross inland consumption. In the case of China, the study observes trends in the import of crucial resources including minerals, metals, and fossil fuels, as well as the exports of energy-related manufactured goods, using data from various editions of the China Statistical Yearbook.

Conversion rates applied include 41.868 Terajoules (TJ)/tonne of crude oil and 29.3 Gigajoules (GJ)/tonne of coal. Natural gas use, given in TJ-higher heating value, is converted into a lower heating value with a factor of 0.9. The principal indicators and sources are detailed in Table 1.

Table 1. Indicators and Sources

Energy Demand, Energy Supply, Renewable Energy Capacity	- IEA Energy Balances (2023) - China Statistical Yearbooks - Chinese Five-Year-Plans - Irena
Final & Primary Energy Use	- European Environment Agency (EEA, 2022)
Import & Export of energy, minerals & metals, and energy-related manufactured goods.	- Eurostat Statistics Database (Eurostat, 2023b) - UN Comtrade database (UN, 2023)
Primary Energy Production in China 1.Number of total primary energy production (2000-2022) 2.Energy production mix (2000-2022)	- China Statistical Yearbook 2023
Energy Consumption in China 1.Number of total energy consumption (2000-2022) 2.Energy consumption mix (2000-2022)	- China Statistical Yearbook 2023
Renewable Energy Capacity 1. Renewable energy generation targets and achievements in Series Five-year Plans 2. Installed capacity of main renewable energy from 2000 to 2020	- Chinese Five-Year-Plans (10th,11th,12th 13th) - China Statistical Yearbook 2022 - International Renewable Energy Agency

While the study covers an extensive period and employs a comprehensive methodological framework it is important to acknowledge certain limitations. These include potential data inconsistenceis due to differing report standards and methodologies between the EU and China, and the dynamic nature of energy policies which may affect the analysis of more recent data.

3. The Energy Governance Models in the EU and China

Energy governance is a critical factor in the success of energy transitions, influenced by various forces and institutions within specific geopolitical contexts. The forces directly shaping energy transition policies are political authorities. However, their strength depends on their inherent 'internal and external environments' (Amineh, 2023, p18).

In the realm of social sciences and International Relations (IR) approaches, the chosen unit of analysis is pivotal, as it critically defines the scope of social reality under study. This analytical dimension, informed by the researcher's theoretical perspective, ranges from state entities to individual actors and profoundly influences research outcomes ((see, Cox 1986, 1987; Amineh 2022a). The state-society-market complex emerges as a vital analytical construct in critical geopolitics and international political economy, offering insights into the interactions among governmental, societal, and market and related forces and their collective impact on global political-economic dynamics (see, Amineh 2022: 18; see also Cox 1986, 1987; Jessop 2016).

In the study (i.e., political science and IR) we suggest two *idea types* of state, society and market forms (i) the Liberal state-society-market complex (LSMC) and the centralized state-society-market complex (CSMC).

The liberal state-society-market complex (LSMC) marked by a delineation between a governing political class and a capitalist ruling class (Amineh 2022a: 18-19). This system develops gradually after a successful capitalist industrialization development. It supports a robust civil society with influential groups (civil society organization) namely the middle, capitalist, and working classes, and their institutions (Moore 1966; Giddens 1973; Wright et al. 1998). The LMSC fosters economic pluralism through interactions among these classes, enriching political discourse and reflecting diverse economic interests. The state's role is to intergrade these interests into comprehensive policies. Civil societies, mainly self-regulating, has evolved alongside class-divided structures from capitalist economic growth, forming a hegemonic social structure (Van der Pijl 1998; Amineh and Yang 2018; Amineh 2022b). The LSMC's origin traces back to Britain Industrial Revolution in mid-18th century, particularly during the early phases of the Industrial Revolution, with the state initially playing a significant role in establishing institutional frameworks before transitioning towards a liberal state society and market complex (Van der Pijl, 1998; Amineh, 2022a).

Conversely, the centralized state-society-market complex (CSMC), exemplified by China, diverges from the LSMC by eschewing the liberal, pluralist foundation (Amineh 2022). This complex emerges in some countries with limited size of socio-economic development and a fragmented civil society with related modern social classes and institutions (Amineh 1999, 2010).

The CSMC features centralized political authority with a 'state class' controlling governmental, societal, and market dynamics, reflecting ruling class in authoritarian states (Elsenhas 1984; Amineh 2022: 19). In this model, societal forces like capitalist classes and labor unions have limited autonomy, leading to state-dominated capital and labor amalgamation (Cox, 1987: 69-70). China's state-class, comprising high-ranking officials, exercises significant control, indicating the state's pervasive influence (Lieberthal and Oksenberg, 1988; Nolan, 2001: 199-200; McNally, 2007; Breslin, 2012; Amineh, 2022: 20). Strategies like the 'Going Out' policy and the Belt and Road Initiative (BRI) demonstrates China's efforts to globalize its economic activities (Jiang and Sinton, 2011; Cheng, 2012; Jiang and Ding, 2014; Zhang and Xu, 2019;

Amineh 2022a,b: 20). State-owned enterprises (SOEs) play a crucial role in this, aligning with the sstate class's directives since 1949 and contrasting sharply with pluralist, liberal systems (Amineh, 2022: 27).

As previously discussed, a centralized state features a strong ruling class with associated market, and society; whereas a Liberal state's governance significantly influenced and shaped by society and the market forces, with these forces being the principal drivers of their energy transitions. We will begin by examining the EU's liberal energy governance, followed by an analysis of China's centralized energy governance.

The European Union Energy Governance

The EU's energy transition has been tainted by disparate and uneven support from powerful interest groups (i.e. civil society and market-based interest-groups and organizations) as well as from the member states. The Geopolitical Economy theory clarifies that inherent systemic differences among countries result in diverse capacities and strategies in handling the political economy of energy and related policy processes (Amineh, 2022). In a liberal state-society-market complex like the EU, state intervention in society and the market is generally restrained, except when market and gains must be secured institutionally. Therefore, fathoming the EU's energy governance and key societal and market players is crucial to comprehending its energy transition.

Driven by economic growth objectives, the EU's energy transition policy process aimed at sustainable energy supply security. This goal is influenced by the Union's reliance on foreign energy resources, shaped by demand-, supply- and structural scarcities[4], often exacerbated by unreliable geopolitical

[4] In the context of energy security, it is essential to examine the multifaceted nature of resource scarcity, ~~in the global and domestic energy sectors. This scarcity, particularly pertinent in major energy consumers including China, India, Japan, and the EU,~~ which emerges from a confluence of increased consumption, depleting reserves, and intricate geopolitical dynamics. This scarcity manifests in three distinct forms: demand-induced, supply-induced, and structural.

The simplistic view of finite, exhaustible mineral stocks being depleted through extraction overlooks crucial complexities. The actual quantity of underground minerals is uncertain, and the size of known reserves is influenced by extraction technology and cost relative to market value, leading to 'supply-induced scarcity.' This scarcity arises from dwindling reserves viable with current technology and market conditions. ~~It interplays with consumer demand, influencing market prices via extraction and refining costs, and often leads to increased price volatility as depletion becomes apparent.~~ Geopolitically, it drives actions from energy-dependent states for resource security, exemplified by the 2003 Iraq war, highlighting the significance of national power in energy security.

Demand-induced scarcity stems from three primary factors: increasing populations in high-consumption regions like South and East Asia, rising per-capita income driving greater energy use, ~~particularly in advanced and developing economies~~, and the fluctuating costs of energy substitutes influencing fossil fuel reliance. This form of scarcity disproportionately affects lower-income groups~~, while wealthier, first-industrialized societies are less immediately impacted~~. Furthermore, the sequential waves of industrialization amplify this reliance on fossil fuels, integral to economic growth and technological development, making demand-induced scarcity a complex issue tied to demographic and economic dynamics.

Lastly, structural scarcity, driven by strategic actions of entities like OPEC or major powers, significantly impacts global supply (Yergin, 1991; Bromley, 1991; Kalre, 2004). Exemplified by the Russia-Ukraine war of 2022, which disrupted EU's maritime oil and gas supplies, it underscores the geopolitical dimensions of energy access (Amineh, situation and uncertain market gains for powerful interest groups backed by the Member States (See Amineh and Houweling 2007; Amineh & Yang, 2012: 507-509). Consequently, in times of economic crises, market forces' interests tend to be prioritized in EU energy policy. Energy corporations, as major lobbyists within the Union, wield significant influence over the EU's decision-making (Dür et al., 2015; Lindberg et al., 2019). Furthermore, various types of crises — economic, financial, and external relations — shape EU decision-making by bolstering the positions of particular groups capable of mitigating the crises, particularly market actors. Falkner (2016) notes that in response to the 2008 economic crisis, EU institutions acted swiftly to ensure energy supply security, prioritizing gas infrastructure security, and limiting the influence of 'pro-climate stakeholders such as DG Environment within the Commission' (Slominski, 2016, p347; see also von Homeyer et al., 2021).

Secondly, the relationship between the EU Member States presents a challenge to the Union's energy transition. Member States, in their quest for energy sovereignty, often obstruct the EU's interconnection goals and resist the strict enforcement of its policies and ambitions. Despite the EU's efforts to reinforce coordination through the establishment of the Energy Union in 2015, the pursuit of supply security has led Member States to assert greater autonomy in their energy policies (Szulecki et al., 2016; Kovacic and Di Felice, 2019). Key factors in this dynamic include uneven and the level of of socio-economic and political development and support, which pose a significant challenge to the EU's energy transition. For instance, uneven Research and Development funding has exacerbated technological disparities among Member States, leading to divergent development in renewable energy markets and competitiveness. This asymmetry has resulted in varied support from market forces and, consequently, from Member States for the energy transition. As such, the development among Member States is heterogeneous, and their responses to EU energy and climate actions are heavily influenced by the nature of their specific market conditions and actors (Charquet, 2023; Slominski, 2016; Fischer and Geden, 2015).

Finally, geopolitical situations compel the EU to continuously adapt its energy policies. Being a substantial importer of fossil fuel, the EU is faces structural-induced scarcities and high political risks associated with its energy partners. A poignant example is Russia's invasion of Ukraine in 2022, which severely impacted the EU's economy by constraining oil and gas supplies, resulting in high inflation, and subsequently necessitating internal solutions (Kuzemko et al., 2022; Eurostat, 2023a).

1999; Amineh & Houweling, 2003, 2005; Klare, 2004). In response, nations such as India and China are expanding maritime capabilities and, notably, China is creating overload routes to Russia and the Caspian to mitigate such risks (Amineh and Yan, 2014: 507-8).

In essence, market forces are the primary drivers of the EU's energy policy process. Therefore, the EU's energy transition process must focus on strengthening policy interconnections among Member States. This will help mitigate structurally induced scarcity (Amineh and Houweling 2007; Amineh and Yang 2012) and the impacts of heterogeneity, while also promoting internal market gains through the adoption of renewable energy production technologies.

China's Energy Governance

As previously discussed, China exemplifies a variant of the Centralized State, Society, and Market Complex (CSMC). Its centralized decision-making has predominantly facilitated rapid economic development from above, allowing the country to catch up with the core industrialized nations in North America, West Europe, several late-industrialised Asian powers[5]. However, the continuation of China's economic growth, along with challenges such as overaccumulation, resource scarcity, and regional inequities, has necessitated the transnational expansion of its economy through the geographical expansion of capital. This initiative aimed, among others, to improve the domestic economic conditions by enabling green economic development and energy transition (IEA, 2021a, p37; Jain-Chandra et al., 2018; Amineh 2022a,b).

Amineh (2023) posits that China operates under a CSMC, where the ruling class predominantly influences political and economic decisions. Consequently, the leadership, along with related institutions and forces, plays a pivotal role in socio-economic development and transformation. The impetus for China's national energy transition primarily stems from the policy strategy of the leadership. Since the 1970s, initiated by Deng Xiaoping, former leader of the People's Republic of China, China embarked on a path of economic openness, development, and technological progress, striving to catch up with the core states of the global political economy (Amineh, 2022b; Bachman, 1986; PRC Embassy, 2012). This state-guided policy initiative constitutes the foundation of China's capacity to undergo a remarkable energy transition and integrate into the global economy with related institutions (Amineh 2002b).

Despite embracing trade openness with liberal principles, the Chinese state class retains considerable, giving the government a decisive advantage in domestic and foreign affairs. Through State-Owned Enterprises (SOEs) and specialized financial institutions, the state class maintains control over planning, the market, and technological progress (OECD, 2009; Brødsgaard, 2012; Amineh & Guang, 2014 and 2018). For instance, in 2000, recognizing its limited technological progress, China's 10th Five-Year Plan (FYP) called for greater technological progress. As primary energy companies are state-owned, actions taken to improve technology were immediate and effective, with SOE investments in technological development surging by 324% (NBSC, 2001).

Consequently, China's state-led development approach ensures a structural and rapid transition, facilitating access to designed multilateral institutions such as the Asian Infrastructure and Investment Bank

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[5] The centralisation of power depends on the nature of society and the market, as well as the levels of development and autonomous institutions. If market forces and societal interest groups are weak or passive, then state power will be centralised and take the initiative. It is important to note that not all centralised states are progressive and able to lead social and economic change and development. For colleges of Centralized states see, Amineh 1999 and Amineh 2010).

(AIIB), the Shanghai Cooperation Organization (SCO) and the Belt and Road Initiative (BRI). Throughout its development, China has faced various challenges, which will be discussed in subsequent sections. However, the strength and transnational reach of China's centralized energy governance have been sufficient to ensure the country's progress, aspiring to achieve a leading position in energy transition and renewable energy capacity. Hence, the primary factors influencing China's energy governance are its development prospects, such as heterogeneous economic development, and energy security, including critical minerals.

4. The European Union: Energy policies and trends

In this section we dive into the EU's energy transition through (i) an overview of the EU' energy policy from 2000 to 2022 and (ii) an examination of policy implementation by looking at trends revolving around energy efficiency, renewable energy development, and fossil fuel import dependency.

EU Energy policies

Energy supply security in the EU was mainly addressed in the Green Papers "Towards a European strategy for the security of energy supply" (European Commission, 2000) and "A European Strategy for Sustainable, Competitive and Secure Energy" (European Commission, 2006). These policy documents emphasize on the opening markets to create a stable, competitive environment and to develop an integrated approach towards tackling climate change, including energy efficiency improvements and renewable energy use as well as the fossil fuel import. These Green Papers formed the basis for energy policy in the EU. Electricity and gas markets were liberalized between 1998 and 2004, and a Market Observatory for Energy was established in 2008. Strategic Energy Reviews in 2007 (COM 2007/1) and 2008 (COM 2008/0781) led to European Council agreements on European energy policy targets.

In December 2008, the energy and climate change 'package' was adopted to reduce greenhouse-gas emissions (GHGE) and increase energy efficiency and renewable energy use by 2020 (COM 2008/30). The overall target was to reduce GHGE by 20% by 2020, compared to 1990 levels. For renewable energy, the target was to generate 20% of final energy use by renewables[A1] by 2020, implemented through the Renewable Energy Directive (COM 2008/19). The Directive on energy efficiency (COM 2012/27) established a framework to achieve 20% energy efficiency improvement by 2020. In support of the goals set for 2020, the European Strategic Energy Technology (SET) Plan was developed. This plan aims to accelerate the development of low carbon technologies (e.g., around renewable energy, energy conservation, nuclear reactors and Carbon Capture and Storage. It set targets for 2050 of 80-95% GHGE reductions compared to 1990 levels (European Commission, 2010).

In 2008, the Green Paper "Towards a Secure, Sustainable and Competitive European Energy Network" (COM 2008/782) discussed the aging European energy networks and poor east-west and south-north connections. Such complexities in intra-EU energy transport complicate and threaten some regions with supply disruptions. The third internal energy market package (IP 2007/1361), adopted in 2009, was meant to stimulate investments, synergies, efficiencies, and innovation in energy networks. The Second Strategic Energy Review of November 2008 identified several infrastructure developments as energy security priorities. These included enhanced connectivity between the Baltic region and the EU, the establishment of a Southern Gas Corridor for Central Asian and Middle Eastern supplies, and the creation of a North Sea offshore grid. Despite the EU's leading position in energy transitions, in 2013, their ambitions diminished due to the intervention of business lobbies and Member States (European Commission, 2013). Both groups found that the EU's actions were misplaced compared to low international climate efforts (Lindberg et al., 2019; Fischer and Geden, 2015). Hence, market actors found weak incentives and short-term gains in shifting their economy towards sustainability, diminishing the first 2030 framework's ambitions compared to the 2020 climate package.

More recently, in 2020, the European Green Deal was approved. This set of policy initiatives has the overarching aim of making the EU climate-neutral in 2050. Part of the Green Deal is the Fit for 55 packages, which includes policy targets for 2030, among which a 40% share of renewable energy in final energy use and a 39% improvement in energy efficiency compared to the baseline primary energy demand by 2030. Compared to the earlier target in the Energy Efficiency Directive, this is an increase of 32.5% in energy efficiency. As a response to the Russian invasion of Ukraine, the REPowerEU proposal, launched in 2022, aims to reduce import dependency on Russian gas and oil, further sharpening the climate targets (see Table 2). In March 2023, a provisional agreement was made on a binding renewable energy target of 42.5% in 2030 (European Commission, 2023b).

Table 2 Summary of energy and climate targets (European Commission (2023) and European Council (2023)

	2020 (Climate Package 2008)	2030 (FIT for 55 package)	2030 (REPowerEU, proposal)
Renewable energy	20% of final energy	40% of final energy	45% of final energy
Energy efficiency	20% compared to baseline	39% for primary and 36% for final energy use, compared to baseline	42% for primary and 39% for final energy use, compared to baseline
Greenhouse gas emissions	20% reduction compared to 1990 (14% compared to 2005)	55% reduction compared to 1990 (40% compared to 2005)	

Note: The baseline refers to the PRIMES 2007 Reference Scenario (European Commission, 2008)

Table 3 shows the absolute amount of final and primary energy use in 2030 (in mega tonnes of oil equivalent (Mtoe) and Exajoule (EJ)) under the different energy efficiency targets. The last two columns show the needed reduction (in %) in comparison to the 2030 energy use in two reference scenarios: (1) the PRIMES 2007 Reference Scenario (European Commission, 2008) and (2) the PRIMES 2020 Reference scenario (European Commission, 2021), and (3) in comparison to 2005 levels.

Table 3 Overview of energy efficiency targets (European Commission (2023) and EEA (2022)

	Targets for energy use in EU (Mtoe / EJ)		Reduction (%) compared to (1) 2007 Reference scenario in 2030 (2) 2020 Reference scenario in 2030 and (3) 2005 level	
	Final energy	Primary energy	Final energy	Primary energy
2005	1041 / 44	1498 / 63		
2030 Energy efficiency directive	846 / 35	1128 / 47	32.5%, 2.1%, 19%	32.5%, -0.3%, 25%
2030 Recast Energy efficiency directive (Fit for 55 package)	787 / 33	1023 / 43	36%, 9%, 24%	39%, 9%, 32%
2030 REPowerEU	750 / 31	980 / 41	39%, 13%, 28%	42%, 13%, 35%

Notes: (1) The values are excluding the UK and excluding feedstocks. (2) The original target in the Energy efficiency directive for 2030 was 956 Mtoe final energy and 1273 Mtoe primary energy (these values include the UK and exclude Croatia).

The most ambitious target is proposed in REPowerEU and aims to reduce primary energy use by 35% in 2030, compared to 2005 levels. This is a 10% increase from the original target in the Energy Efficiency Directive, which stood at 25%. Table 3 shows less ambitious targets in the Energy Efficiency Directive compared to the 2020 Reference scenario, which projects that the primary energy target will be achieved in 2030 without new policies.

To conclude, EU policies that impact energy security can be categorized into: (1) redusing energy use by energy-efficiency improvement, (2) more indigenous renewable energy use, and (3) better (inter)connections to diversify imported (fossil) fuels. Market actors exert significant influence on policymaking, and infrastructure decisions are made at a national level. This scenario poses difficulties in ensuring a coordinated EU approach to energy policy across multiple, potentially conflicting objectives (e.g., energy security, environmental concerns, and competitiveness). In the next section, we look at the progress made in energy efficiency, renewable energy, and import dependence.

Trends

Energy Efficiency Progress

Figure 1 shows the evolution of final and primary energy use in the EU since 2005. Note that these values do not include "non-energy use", such as feedstocks in the petrochemical industry and international aviation and shipping (see section 5.2), since these are excluded from the targets. The figure shows a slight decreasing trend for both primary and final energy use. The impact of the economic crisis in 2009 is visible in the graph. The 2020 targets were achieved, partly due to the COVID-19 pandemic, which impacted energy consumption especially in 2020 and 2021. Final energy use was 38 EJ in 2020, and primary energy was 52 EJ. However, in 2021, these values increased to 40 EJ and 55 EJ, respectively, despite the impact of the pandemic on energy use. For 2022, a strong impact is expected due to the Russian invasion of Ukraine, resulting in a reduction in energy supply to the EU and a subsequent rise in energy prices. This situation has especially lowered natural gas consumption in the EU.

Figure 1 Development of final and primary energy in the EU (based on EEA, 2022)

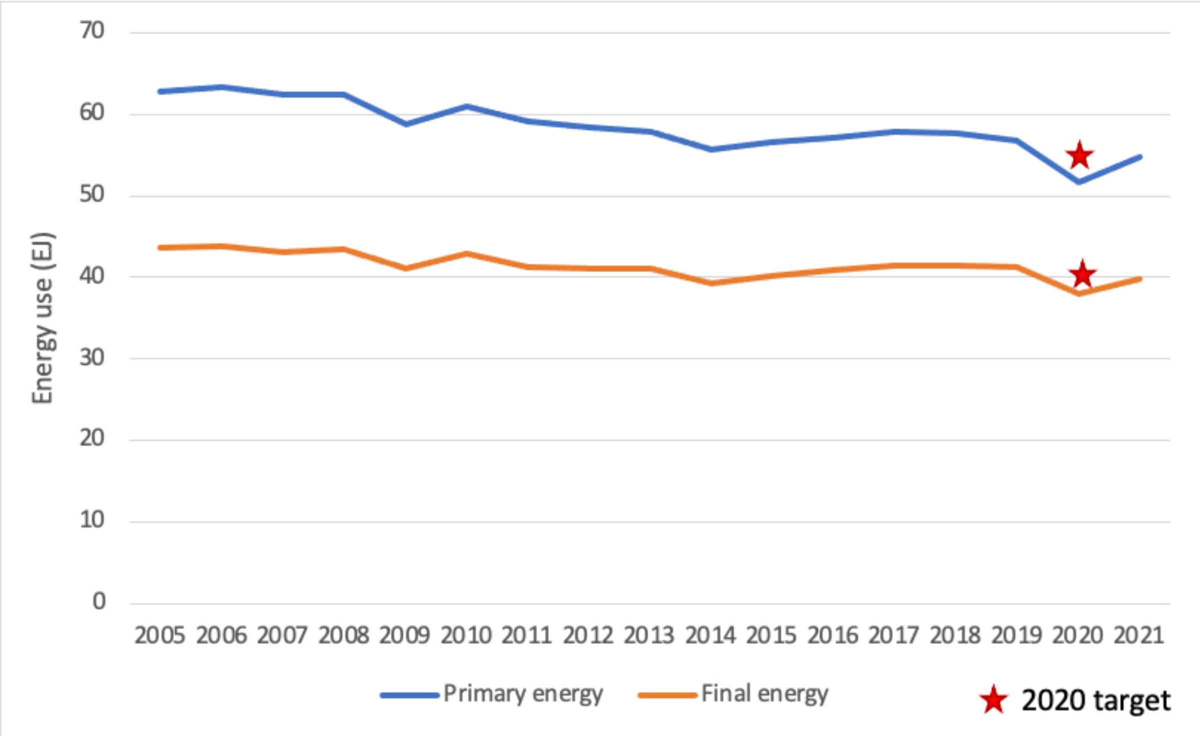
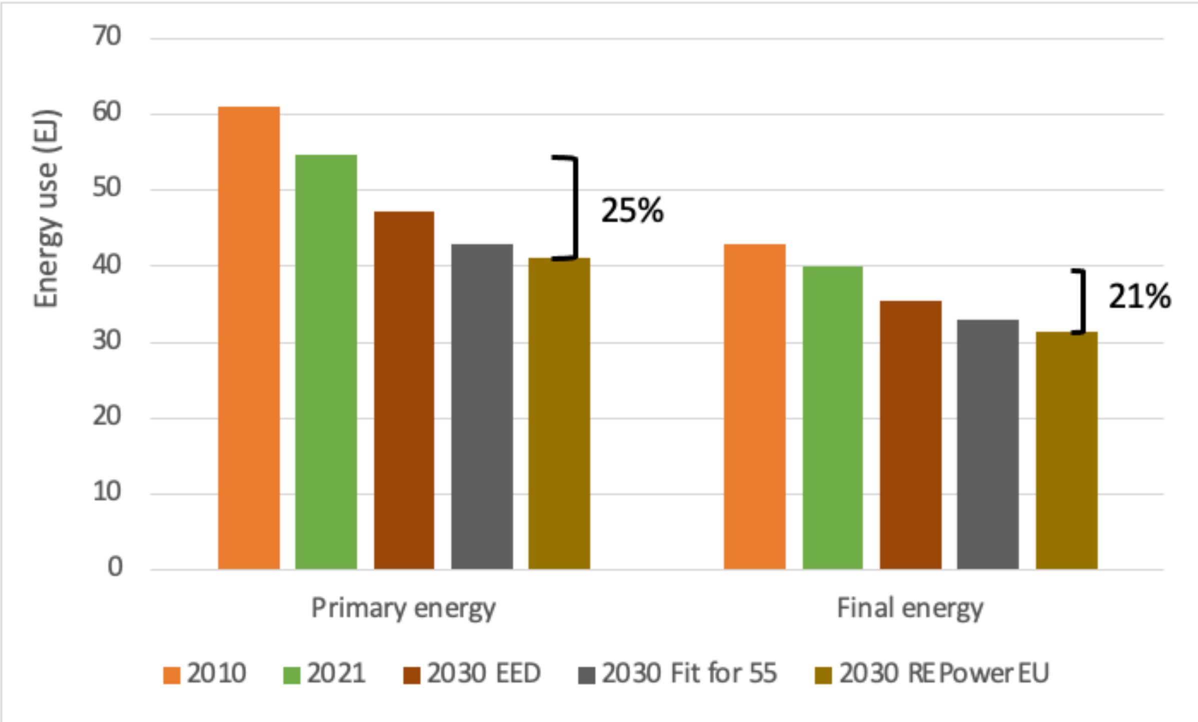


Table 4 shows the necessary reduction by 2030 for achieving the targets compared to the year 2021 and to the year 2030 in the Reference 2020 scenario (European Commission, 2021). Figure 2 visualizes the primary and final energy use in 2010, 2021, and 2030 under the different targets. The most ambitious target, proposed in REPowerEU, aims at a 25% reduction of primary energy in 2030, compared to 2021, and 21% for final energy. These reductions are higher than those achieved in the period 2010-2021, where primary energy use decreased by 10% and final energy use by 7%. Compared to the Reference 2020 scenario, by 2030, a reduction of 13% for both is needed. This indicates that additional policies are required than the ones included in the Reference 2020 scenario.

Table 4 Reduction needed in 2030 compared to baseline and 2021, based on European Commission 2023 and EEA 2022

	Reduction (%) compared to (1) 2030 value in 2020 Reference scenario and (2) 2021 value		Mtoe / EJ	
	Final energy	Primary energy	Final energy	Primary energy
2021			952 / 40	1306 / 55
2030 Energy efficiency directive (EED)	2.1%, 11%	-0.3%, 14%	846 / 35	1128 / 47
2030 Recast Energy Efficiency directive (Fit for 55 package)	9%, 17%	9%, 22%	787 / 33	1023 / 43
2030 REPowerEU	13%, 21%	13%, 25%	750 / 31	980 / 41

Figure 2 Final and primary energy in the EU in 2000, 2021, and targets for 2030, based on European Commission 2023 and EEA 2022



Fuel mix energy use and share renewable energy

Figure 3 shows the development of primary energy use in the EU. In contrast to the data in section 4.1, these values include non-energy use (e.g., oil products used as feedstocks in the petrochemical industry) and international aviation and bunker fuels.

Non-energy use contributes to around 4 EJ and covers 6-6.5% of total primary energy use. Around 75% of this (around 3 EJ) corresponds to the input of feedstocks in the (petro)chemical industry, such as naphtha for the production of plastics (based on IEA, 2023).

In the pre-pandemic period, international aviation and bunker fuels typically covered 7-8% of primary energy use in the EU, with about 70% being international marine bunker fuels and 30% international aviation fuels. In 2019, marine bunker fuels amounted to 3.5 EJ, and international aviation fuels to 1.9 EJ. Post-pandemic, in 2021, these values were 2.6 EJ and only 0.29 EJ, respectively (based on IEA, 2023). This reduction shows the strong impact of the COVID-19 pandemic on international aviation in 2021.

Overall, the share of fossil fuels decreased from 78% in 2000 to 69% in 2021 but still covers the largest share of energy use. At the same time, the share of renewable energy in primary energy has increased from 6% in 2000 to 16% in 2021. Biomass accounts for about 65% of renewable energy, followed by hydropower with 21%.

Figure 3 Development of primary energy use in the EU (based on IEA, 2023)

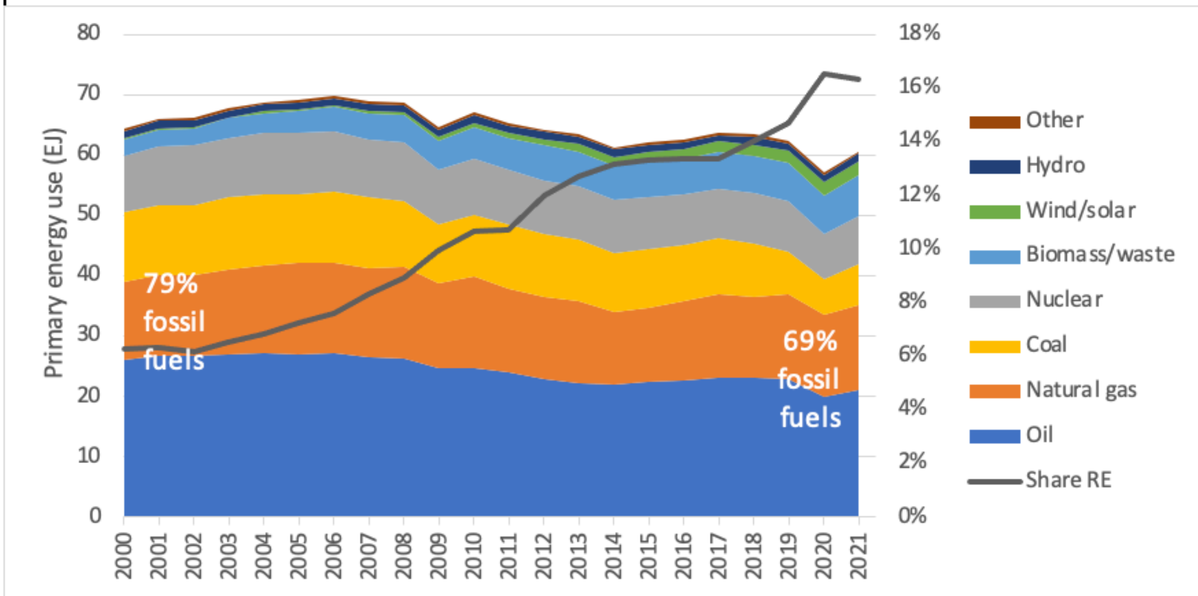


Table 5 shows the development of the renewable energy share in primary energy use, final energy use, and electricity generation. Final energy consumption includes the use of energy (e.g. fuels, electricity, heat) by end-use sectors (e.g. industry, households, services, agriculture, and transport) and excludes non-energy use and losses in energy conversion (e.g., for electricity). The targets for renewable energy have been defined for final energy use and were 20% in 2020 (Climate Package 2008) and 40% in 2030 (Fit for 55). The REPowerEU plan (May 2022) proposes a 45% target in 2030, and in March 2023, a provisional agreement was made on a binding renewable energy target of 42.5% by 2030. Although the 2020 target was met, the 2030 target sets a substantial increase compared to the 22% share in final energy in 2021.

Table 5 Share of renewable energy (RE) in the EU primary, final energy use and electricity generation

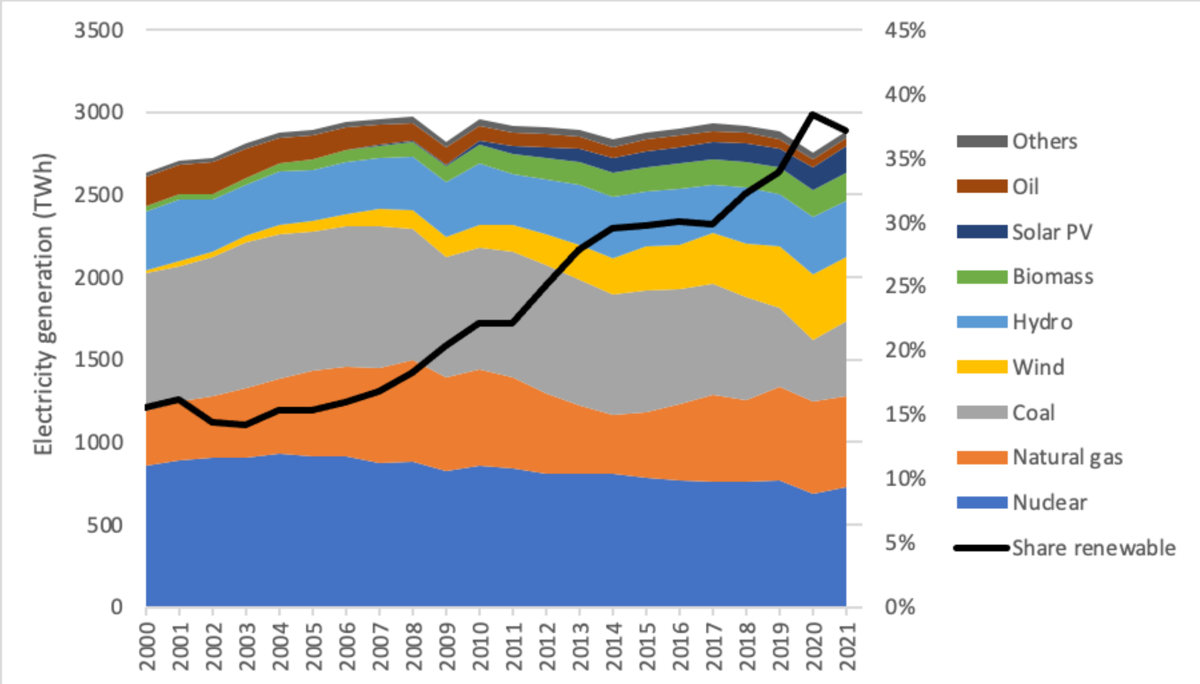
	2005	2010	2015	2020	2021	Based on
Share RE in primary energy use	7%	11%	13%	17%	16%	IEA (2023)
Share RE in final energy consumption	10%	14%	18%	22%	22%	EEA (2023)
Share RE in electricity generation	15%	22%	30%	38%	37%	IEA (2023)

As can be seen in Table 5, the share of renewable energy is especially high in electricity generation, with 37% in 2021, as opposed to 15% in 2005. For other sectors the share is substantially lower, with 9% for transport (EEA, 2023), 14% for industry (IEA, 2023) and 23% for heating and cooling (EEA, 2023) in 2021.

Figure 4 shows the development of the fuel mix for electricity generation in the EU and the share of renewable energy. Hydropower maintained a stable share in the fuel mix of around 12-13%. Conversely, the shares of solar photovoltaic, biomass, and wind increased strongly from 0.0%, 1.1%, and 0.8% in 2000 to

5.5%, 5.9%, and 13% of total power output, respectively, in 2021. At the same time, the share of nuclear decreased from 33% in 2000 to 25% in 2021, while natural gas-fired power generation fluctuated between 13 and 19%, correlating with changes in natural gas prices. Coal-fired power generation decreased from 31% to 16% and oil-fired from 6.9% to 1.8%. In 2020, the effect of the pandemic was evident, with a peak in the share of renewable energy. A reduction in economic activity and a decrease in electricity consumption notably impacted coal-fired power generation, leading to a slightly higher share of renewable energy in 2020.

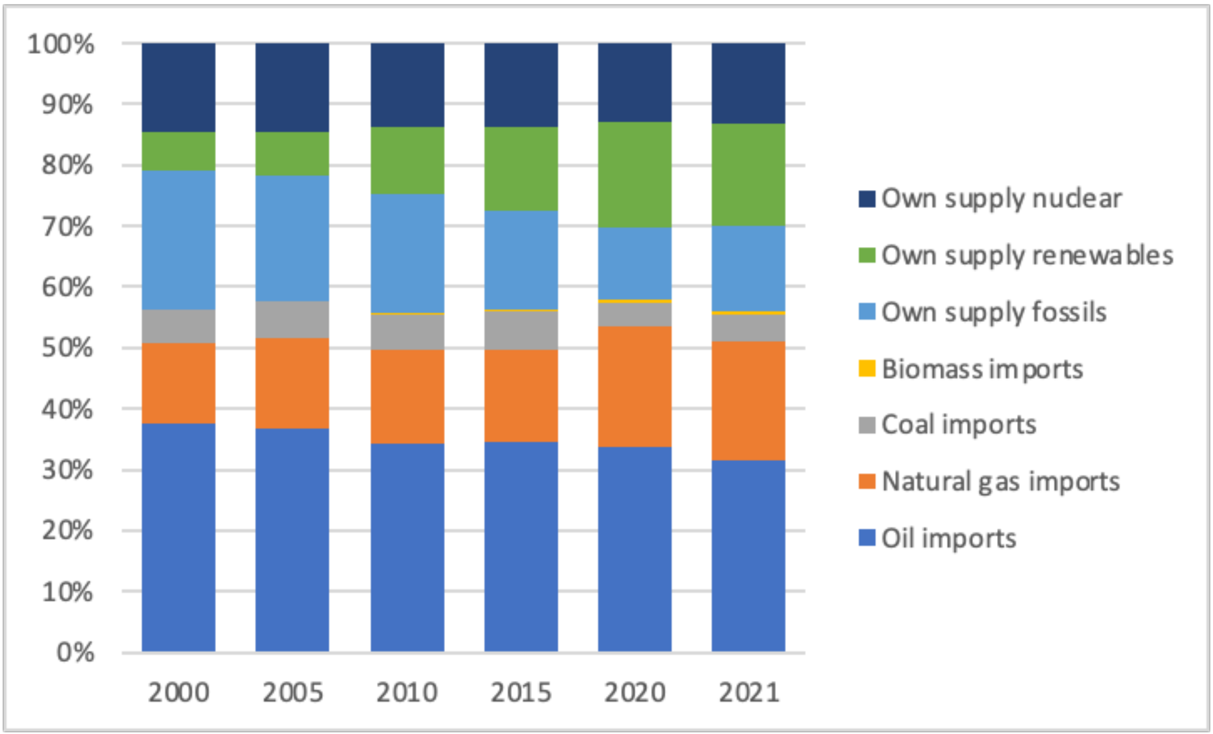
Figure 4 Electricity generation in EU (based on IEA, 2023)



Import dependence

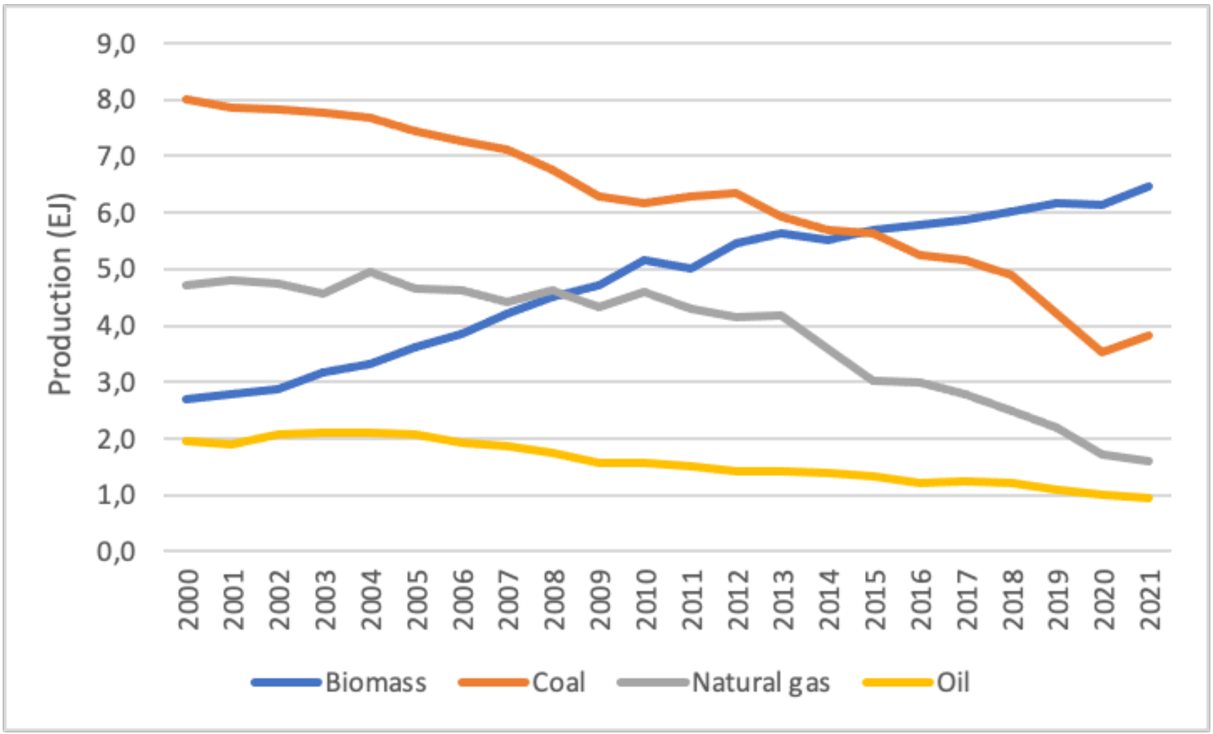
Figure 5 shows the share of imports in total primary energy use in the EU. In 2021, around 56% of primary energy use was imported, with 32% being oil, 20% natural gas, 4%, coal and 1% biomass (0.3 EJ in 2021). There is a noticeable shift from reliance on oil and coal towards natural gas imports. Own supply consists of produced fossil fuels and stock changes, nuclear energy use, and renewable energy use (excluding imported biomass). Here, a clear shift is visible from fossil fuel production (because of decreased production) to renewable energy supply.

Figure 5 Breakdown of primary energy use in the EU by source (based on IEA, 2023)



The decrease in the own supply of fossil fuels is directly related to a decrease in fossil fuel production (mining and exploration) (see Figure 6). All three fossil fuels show a decreasing trend where the production of coal and oil reduced by 50% in the period 2000-2021, and natural gas production fell by approximately 65%.

Figure 6 Fossil fuel production in the EU by source (based on IEA, 2023)



The decreasing fossil fuel production has an impact on the import dependency rates per fossil fuel and total primary energy use. These are defined as the share of net imports in total energy use (per fuel). Table 6 shows the evolution in the period 2000-2021 per fossil fuel and overall.

Table 6 Import dependence (based on IEA, 2023)

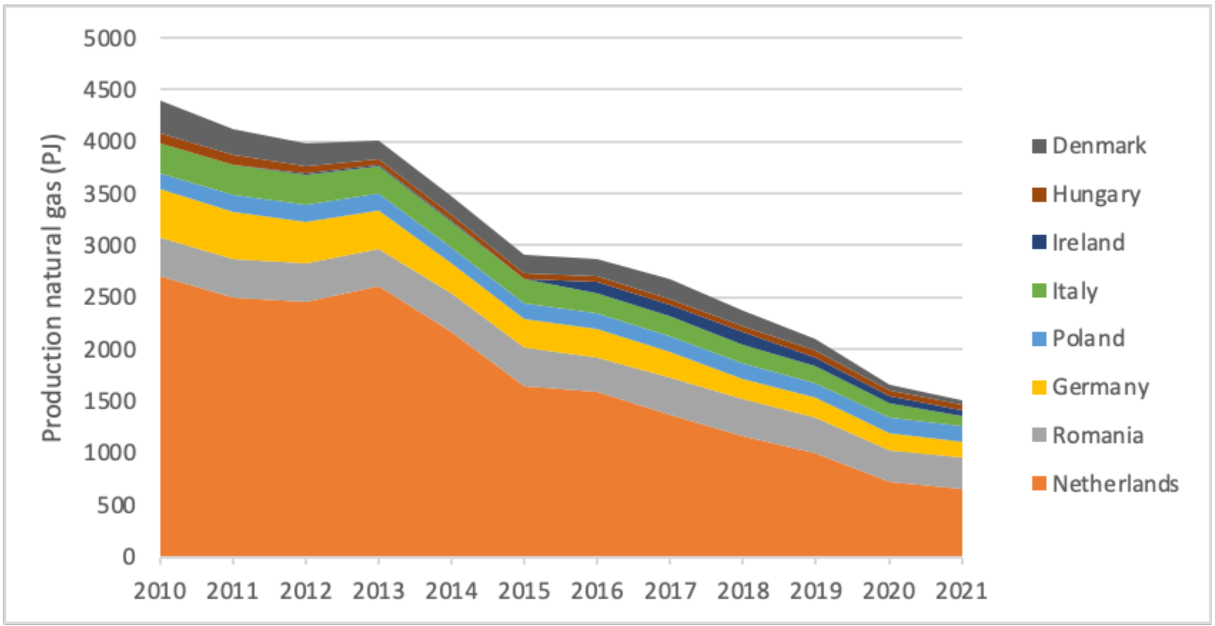
	Import dependence						
	2000	2005	2010	2015	2019	2020	2021
Coal	30%	36%	38%	41%	43%	36%	38%
Oil	93%	93%	93%	96%	96%	96%	91%
Natural gas	66%	69%	68%	74%	90%	84%	83%
Total	56%	58%	56%	56%	61%	58%	56%

The import dependency for coal had increased from 30% in 2000 to 43% in 2019. In the years 2020 and 2021, the import dependency experienced a slight decrease, attributed to lower coal consumption stemming from the pandemic. At the same time, coal production has decreased in the key coal-producing countries in the EU (Poland -40% since 2000, Germany -55% and Czech Republic -58%). These three countries were responsible for almost 90% of the EU coal production in 2021 (based on IEA, 2023).

Oil import dependency was high during the whole period. Oil production in the EU occurs in several countries, such as Italy, Denmark, and Romania. However, the absolute output is low, with the highest being only 0.2 EJ in 2021 in Italy.

Most notably, the import dependency on natural gas increased. This situation was related to a decrease in natural gas production in EU27, especially in the Netherlands (see Figure 7), which has been the principal European natural gas producer in the last 20 years. Due to earthquakes close to the main reservoir, the natural gas production from this reservoir has been reduced in recent years and stopped in 2023.

Figure 7 Natural gas production in the EU27 by country (based on IEA, 2023)

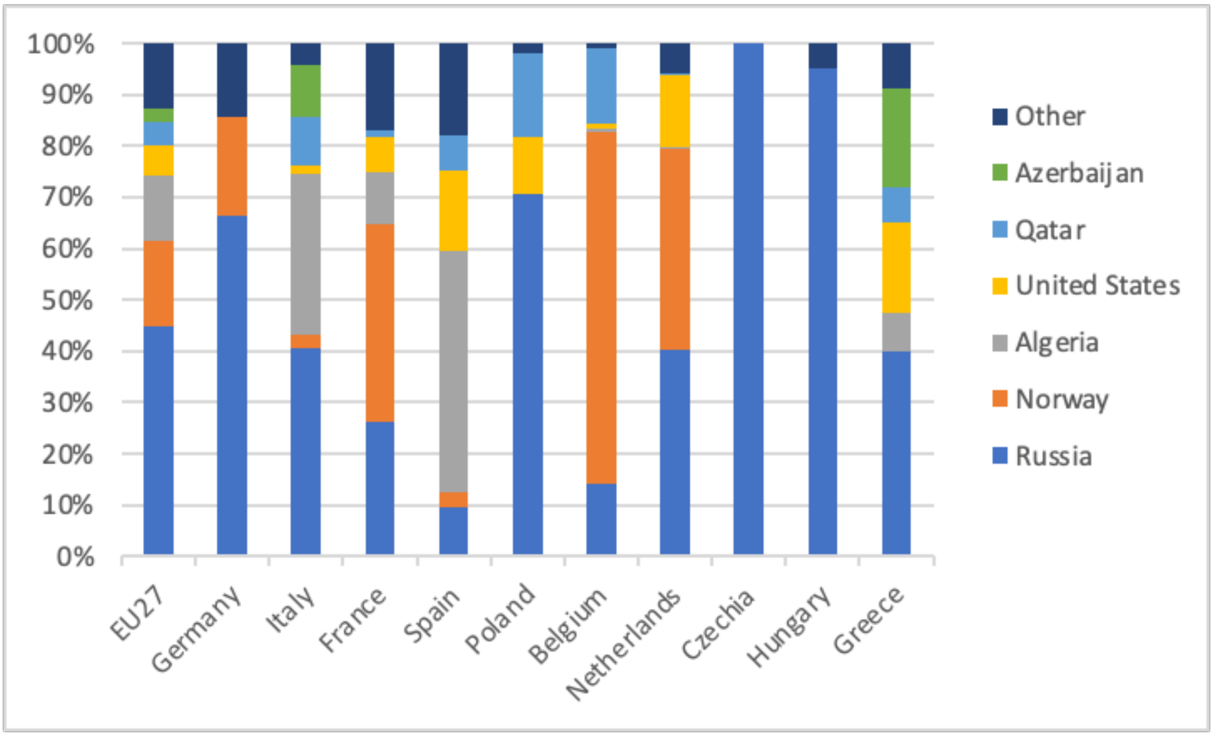


Among the three fossil fuels, historically, natural gas had the highest dependency on Russia. Figure 8 shows the origin of natural gas imports for the ten biggest natural gas importing countries in the EU in 2021. About 45% of imports originated from Russia, but the share per country shows significant variations (e.g., 70% for Poland and 10% for Spain). The three principal natural gas importing countries, have a high import dependency rate; Germany imports 89% of its natural gas use, Italy 94%, and France 95% (including intra-EU net imports) (based on Eurostat, 2023b).

For coal and oil, Russia also delivered a substantial portion of imports in 2020, contributing to around 27% of each (based on Eurostat, 2022). The supply of oil showed, however, quite a large and diverse number of countries supplying substantial shares (following Russia: Norway, Kazakhstan, the United States, Saudi Arabia, Nigeria, Iraq, Azerbaijan, Algeria, Libya, Mexico, and others). For coal, the main imports are coming from fewer countries (following Russia: the United States, Australia, and Columbia, in 2020) (based on Eurostat, 2022). The indigenous production of coal is, however, the most substantial of the three fossil fuels and covers roughly 60% of the consumption.

In the course of 2022, Russia's fossil fuel supply was largely replaced with other suppliers. However, the sudden halt in supplies led to a significant increase in energy end-use prices, especially for natural gas and electricity in the EU.

Figure 8 Net natural gas imports, by country of origin, for the 10 largest net natural gas importers (in order of size, from left to right) (based on Eurostat, 2023b)



To conclude, this section showed that although the EU has had remarkable success in incorporating more renewable energy into its primary energy uses, achieving the EU energy targets requires the implementation of extra policies beyond~~, compared to~~ baseline projections. Sufficient attentions also need to be given to feedstocks in industries and international aviation and shipping, which are excluded from the targets, but account together for a substantial share of primary energy use (13-14%). Furthermore, the high level of import dependence has not improved since 2000. Although the share of renewable energy increased, the production of fossil fuels decreased, leading to a roughly equal share of imports. The reduction in Russian energy supply therefore had a high impact on energy prices.

5. China: Energy policies and trends

Following the EU energy security, we here examine China's energy transition by providing a policy analysis from 2000 to 2022 and presenting the results of these plans on renewable energy development, energy production, energy consumption, and import dependency.

China's Energy policies

Chinese policies analyzed from 2000 to 2022 commonly converge towards three energy transition categories: energy supply security, energy markets, and the development of technologies and renewables. In China's policy system, national plans, especially the FYP, are the most important public policies. After their release, the regional government and industry management department develop their own plans under the national plans' guidance.

In 2001, China released the 10th FYP, concentrating on energy mix diversification to secure energy supply and meet demand, decreasing the pressure on fading domestic coal reserves. Being the first to include renewable energy, this national plan establishes the need for technological progress to cultivate the industrialization of a new renewable energy market (ETC, 2001). In 2006, the 11th FYP sustained China's ambitions to improve energy efficiency, attempting to cut its energy consumption per unit of GDP by 20% from 2005 levels by 2010 (National Energy Administration, 2007). Preferential policies were put in place to support energy-conserving industries, and the Renewable Energy Law was issued in 2006 to ensure renewable energy progressed steadily (CCICED, 2010). Further, the "Medium and Long-term Development Plan for Renewable Energy" was released in 2007, providing a fifteen-year roadmap for China focusing on increasing the use of renewables, electrification, and the national grid, energy supply security, and stimulating the renewable energy market. Through this plan, China recognized the heterogeneity between provinces (National Energy Administration, 2011). In 2009, fiscal support and tax incentives for the transition were solidified, with the National Development and Reform Commission introducing fixed feed-in tariffs for onshore wind power (Auffhammer, 2021). Therefore, green development was encouraged. In 2011, the 12th FYP was designed to control the growing energy consumption and limit energy intensity (Xin Hua 2011). The focus on developing a competitive domestic energy market was reinforced, with support towards wind, solar, and biomass equipment manufacturing, energy conversion, and generation technologies strengthened. In 2016, the 13th FYP was issued alongside the "Energy Technology Innovation Action Plan 2016-2030". Long-term groundbreaking objectives were set to stimulate China's technological progress and renewable energy supply projects towards self-sufficiency (NDRC, 2016; National Development and Reform Commission, 2017). With the central government exercising robust control on energy transition plans, provincial governments were given compulsory targets to increase the consumption and generation of renewable energy. In a similar vein, the China Renewable Energy Engineering Institute designed and launched a pilot Green Electricity Certificates (GECs) system, allowing businesses and individuals to buy renewable energy voluntarily. China's GECs are compliant with RE100, the global initiative requiring its signatories to commit to 100% renewable electricity (Tina Zhang, 2023). Consequently, China's renewable energy market legitimacy and development were both reinforced. In 2021, the 14th FYP was released and stated that China would pursue a non-fossil fuel-dominated paradigm for its energy system in the long term. However, widespread power shortages urged Chinese leaders to ensure energy security homogeneously whilst pushing for even economic and social development between provinces. Hence, technological progress, international cooperation, and a new grid system to accommodate renewable energy sources, limit power shortages, and enhance provincial development were proposed (NEA & MOST, 2021; Beijing Review, 2022). Finally, since 2011, a carbon trading market has been developed, with pilot operations implemented in seven provinces in 2013. In 2021, the national carbon-emission trading scheme (ETS) came into operation, and the carbon cap-and-trade system was put into practice (Fu et al., 2022). Carbon emissions from two thousand power companies were encompassed by this scheme, strongly supporting China's goal of carbon neutrality by 2060. More importantly, it marked the increase in China's use of market-based mechanisms (Xinhua, 2021).

China's energy transition policy development grew quickly towards establishing a strong domestic energy market, technological progress, international presence and renewable energy industry, consumption, and generation developments. Its strategy lies in (1) improving energy efficiency through technological progress, (2) increasing the use of renewable energy whilst decreasing fossil fuel reliance, and (3) ensuring economic development and market leadership.

Trends

The research results regarding China's energy transition are discussed hereafter. Following the policy analysis, we demonstrate the energy transition's impact on (5.1) renewable energy development, (5.2) energy production, (5.3) energy consumption, and (5.4) import dependency.

5.1 Energy Targets and Renewable Energy Development

In China, FYPs for renewable energy play a key role in prompting renewable energy development. Every FYP sets up goals and guidelines depending on the period's context. As Table 7 shows, all goals of every plan were achieved and even exceeded the original goals. With the series of plans completed, renewable energy is growing steadily and rapidly.

Table 7. Renewable Energy Generation in Series Five-year Plan (in Gigawatts)

Content	10th Five-year plan		11th Five-year plan		12th Five-year plan		13th Five-year plan	
	Targets	Actual	Targets	Actual	Targets	Actual	Targets	Actual
Hydropower	100	110	190	216.06	290	319.54	340	340
Wind power	1.2	1.26	10	31	100	129	210	280
Photovoltaic	0.053	0.07	0.3	0.8	21	43.18	105	250
Biomass	NA	2	5.5	5.5	13	10.3	15	30

Data Source: Compiled from reports of the Five-year Plan

As shown in Table ~~2~~8, from 2000 to 2022, the installed capacity of wind power and hydropower has grown year by year. The installed capacity of photovoltaic began to increase exponentially in 2009.

Table ~~2~~8. 2000-2022 Installed Capacity of Main Renewable Energy（MW）

Year	Wind power	Photovoltaic	Hydropower	Other
2000	340	0	79350	0
2001	380	0	83010	0
2002	470	0	86070	0
2003	550	0	94900	0
2004	820	0	105240	0
2005	1060	0	117390	0
2006	2070	0	130290	0

2007	4200	0	148230	0
2008	8390	0	172600	0
2009	17600	30	196290	30
2010	29580	260	216060	30
2011	46230	2120	232980	190
2012	61420	3410	249470	200
2013	76520	15890	280440	80
2014	96570	24860	304860	190
2015	130750	42180	319540	90
2016	147470	76310	332070	70
2017	163250	129420	343590	70
2018	184270	174330	352590	190
2019	209150	204180	358040	370
2020	281650	253560	370280	410
2021	328710	306540	39094	940
2022	365640	392680	41406	6750

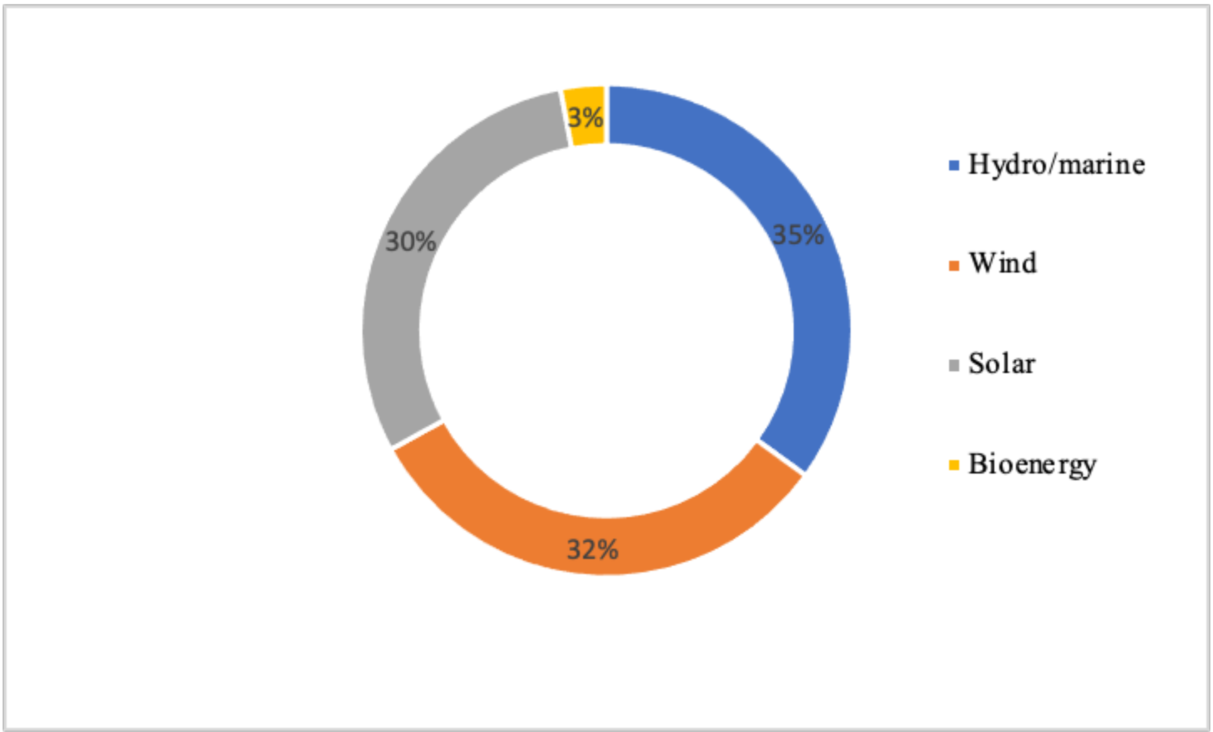
Data source: China Statistical Yearbook 2023

https://www.stats.gov.cn/sj/ndsj/2023/indexch.htm

The newly installed renewable energy power capacity in 2021 accounted for 76.1 % of the country's total newly installed power capacity, according to a new study by the China Energy Media Group (Xinhua, 2022). In 2022, the cumulative installed power generation capacity of renewable energy reached 1,060 gigawatts, accounting for 44.8% of China's total installed power capacity (ibid.).

Concerning the renewable energy capacity, as shown in Figure 9, hydro/marine energy was the highest share, accounting for 35% of total renewable energy generation. Wind and solar power accounted for 32% and 30%, respectively, whilst bioenergy remained at an early development stage.

Figure 9. China's Renewable Energy Capacity in 2021



Data Source: International Renewable Energy Agency. Energy profile China, 24th August 2022

5.2. Energy production

Table ~~3~~ 9 highlights that with its rich endowment and low cost, coal consistently occupied the largest share of China's primary energy production from 2000 to 2022. For decades, coal has contributed to China's extraordinary economic growth. Before 2006, with fast economic development plans, China solved the contradiction between energy production and consumption by expanding coal energy production. However, the ensuing pollution shifted China's strategy towards a non-fossil energy development focus. Hence, the proportion of coal decreased particularly after 2011 with the non-fossil energies increase.

Table 39. Total Primary Energy Production and the Proportion (2000-2022)

Year	Total primary energy production (Million tonnes of standard coal)	Proportion (%)			
		Raw coal	Crude oil	Natural gas	Non-fossil
2000	1385.70	72.9	16.8	2.6	7.7
2001	1474.25	72.6	15.9	2.7	8.8
2002	1562.77	73.1	15.3	2.8	8.8
2003	1782.99	75.7	13.6	2.6	8.1
2004	2061.08	76.7	12.2	2.7	8.4
2005	2290.37	77.4	11.3	2.9	8.4
2006	2447.63	77.5	10.8	3.2	8.5
2007	2641.73	77.8	10.1	3.5	8.6
2008	2774.19	76.8	9.8	3.9	9.5
2009	2860.92	76.8	9.4	4	9.8
2010	3121.25	76.2	9.3	4.1	10.4
2011	3401.78	77.8	8.5	4.1	9.6
2012	3510.41	76.2	8.5	4.1	11.2
2013	3587.84	75.4	8.4	4.4	11.8
2014	3622.12	73.5	8.3	4.7	13.5
2015	3621.93	72.2	8.5	4.8	14.5
2016	3459.54	69.8	8.3	5.2	16.7
2017	3588.67	69.6	7.6	5.4	17.4
2018	3788.59	69.2	7.2	5.4	18.2
2019	3973.17	68.5	6.9	5.6	19
2020	4072.95	67.5	6.8	6	19.7
2021	4272.15	66.7	6.7	6.0	20.6
2022	4660.00	67.4	6.3	5.9	20.4

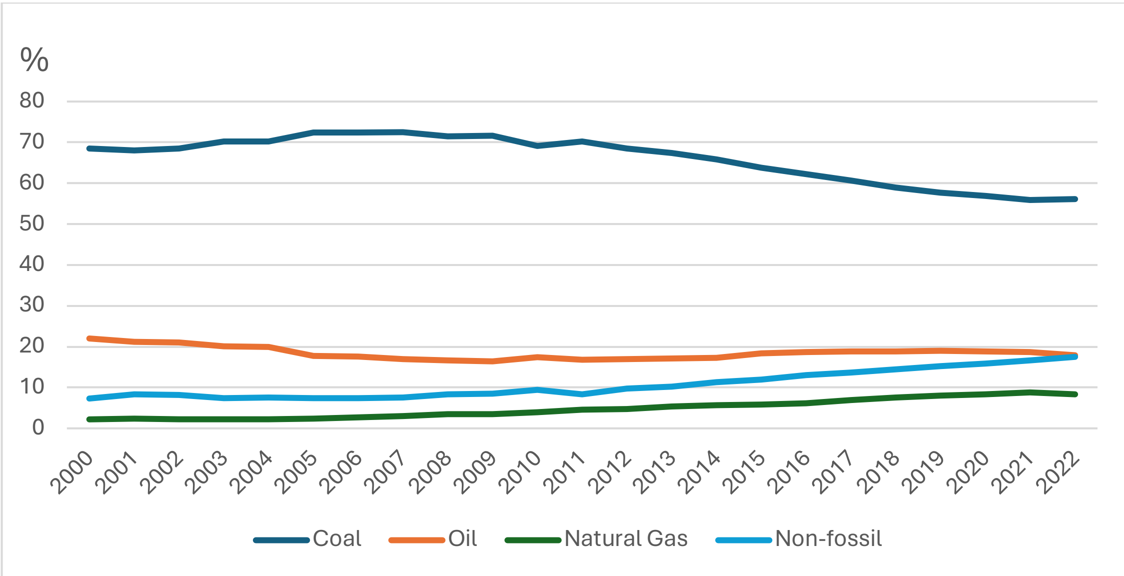
Data source: China National Bureau of Statistics. China Statistical Yearbook 2023, https://www.stats.gov.cn/sj/ndsj/2023/indexch.htm

Energy consumption

The development of the Energy Consumption Structure is similar to the energy production. China's energy consumption increased dramatically since 2000 and will keep rising in the next several decades due to continuous economic growth. Although optimizing energy structure has been put forward in the 10th FYP, a pattern of economic growth based on high investments, consumption, and pollution remains. Coal was the most consumed energy in 2000, retaining a gradually increasing trend from 2000 to 2009. However, since the 12th FYP, coal consumption declined despite still accounting for more than half of total energy consumption. Further, natural gas consumption increased thanks to governmental support. Regardless, financial supports for conversions from coal to natural gas were implemented, as well as directives to state-owned companies.

In 2009, China committed to 15 % of non-fossil energy consumption. Non-fossil energy increased gradually and consistently after the 12th FYP, reaching the 15% goal in 2019, as shown in Figure 410.

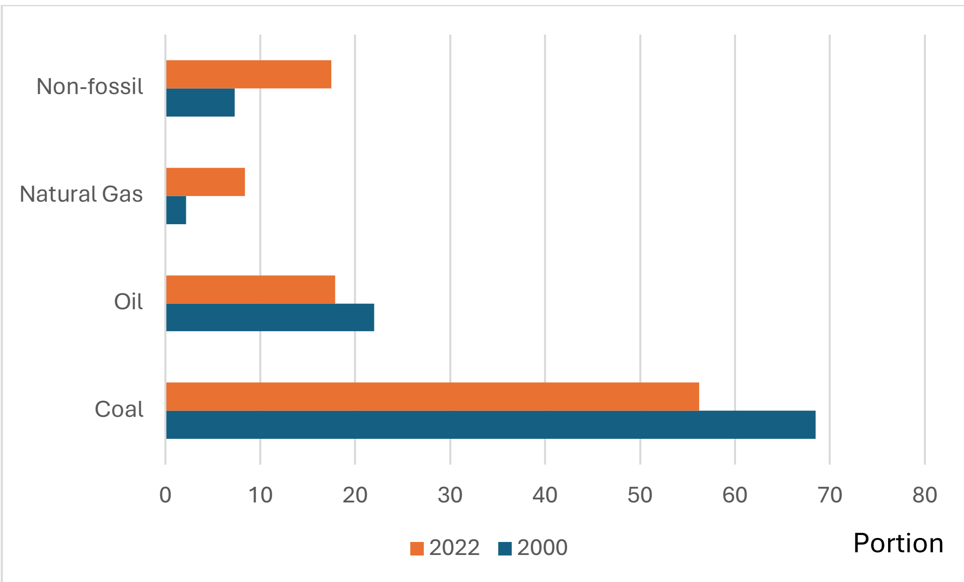
Figure 410 Energy Consumption Mix in China (2000-2022)



Data Source: China National Bureau of Statistics. China Statistical Yearbook 2023, https://www.stats.gov.cn/sj/ndsj/2023/indexch.htm

Figure ~~2~~ 11_demonstrates how coal and oil consumption declined between 2000 and 2022, whilst natural gas and non-fossil energy increased. Hence, FYPs managed to develop energy alternatives quickly despite heavy coal reliance.

Figure ~~2~~11. Energy Consumption Mix in 2000 and 2022

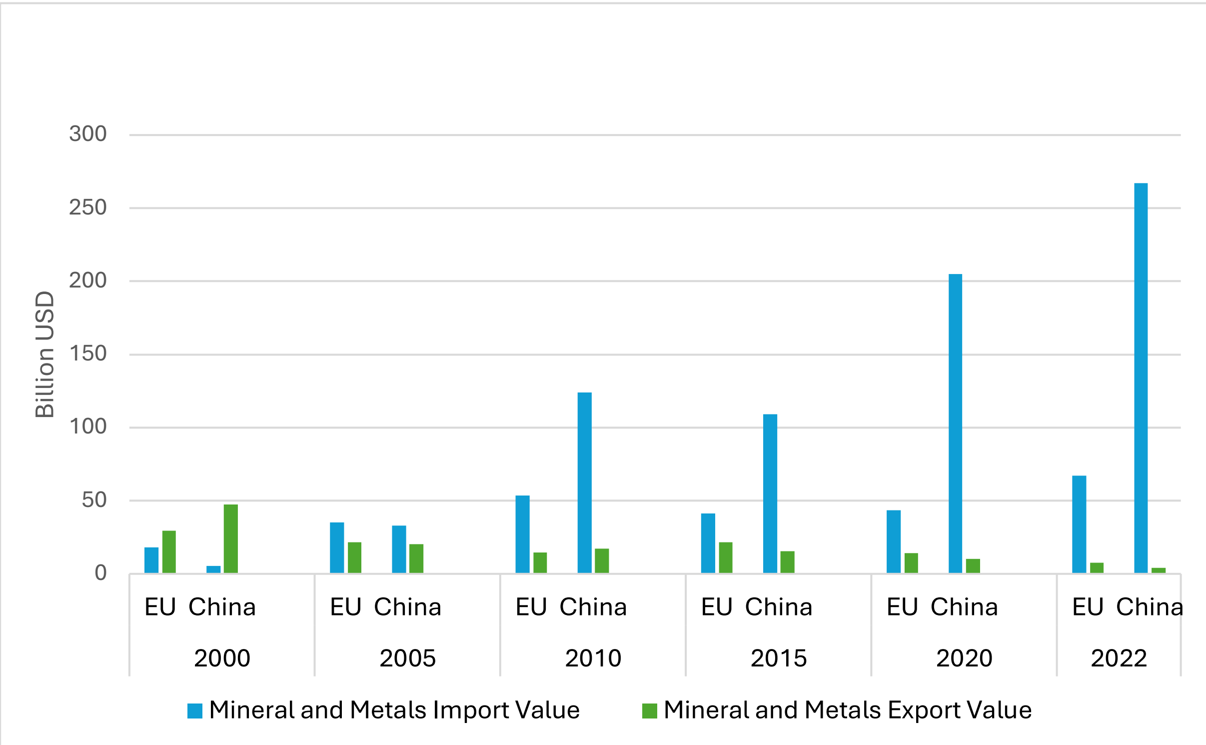


Source: China National Bureau of Statistics. China Statistical Yearbook 2023, https://www.stats.gov.cn/sj/ndsj/2023/indexch.htm

Import dependence

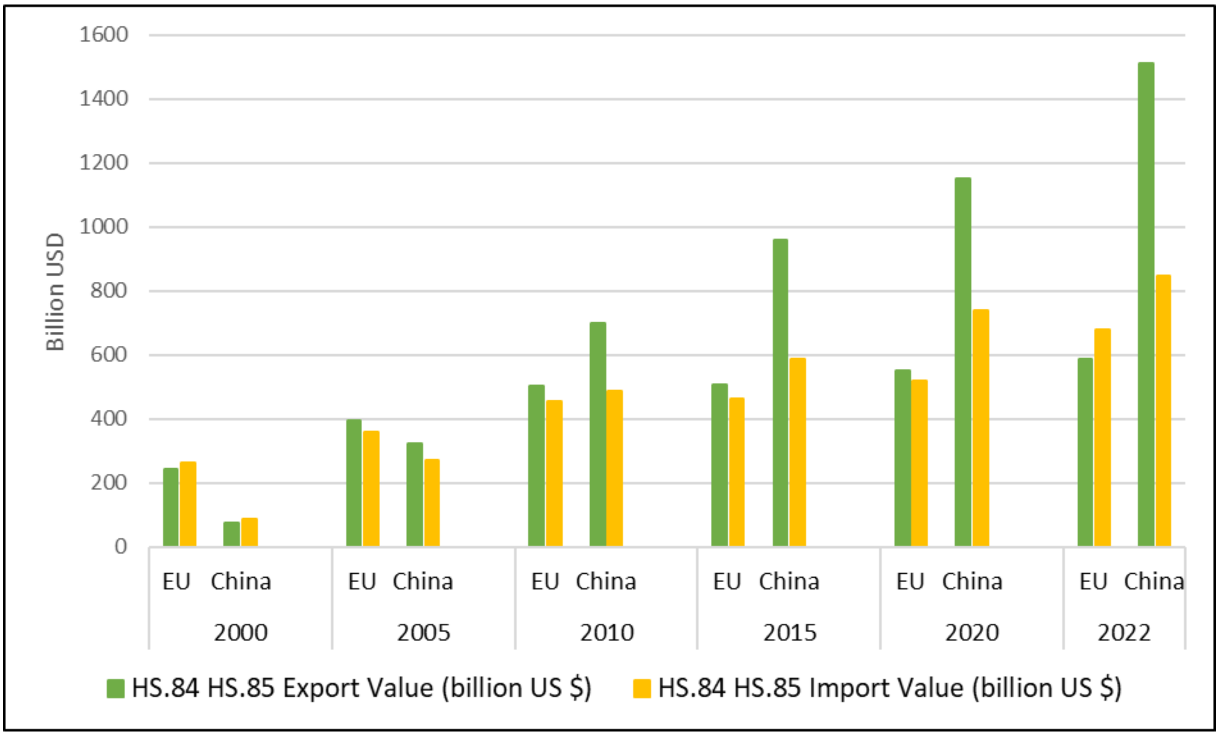
Energy transitions' competitiveness and economic growth prospects led Chinese Development Investment Banks (DIBs) to increase financial flows outside borders. This strategy aimed to expand capital, secure its accumulation, ensure economic growth, and achieve self-sufficiency in the long term. In the short term, imports increased despite China's self-sufficiency goal. However, in the long term, China built reliable resource access through the transnationalization of capital and multi-lateral agreements such as the BRI (B.U GDP, 2022a; Gulley et al., 2019; IEA, 2022a). Consequently, it enabled mass production and competitiveness in energy markets, thus reaching competitiveness and economic growth aims. For instance, as shown in Figures 12 ,13 and 14, we find that China's fossil fuel and metals and minerals imports correlate with an increase in exports of electrical and energy-related machinery.

Figure 12. Evolution of Minerals & Metals Trade in China and the EU



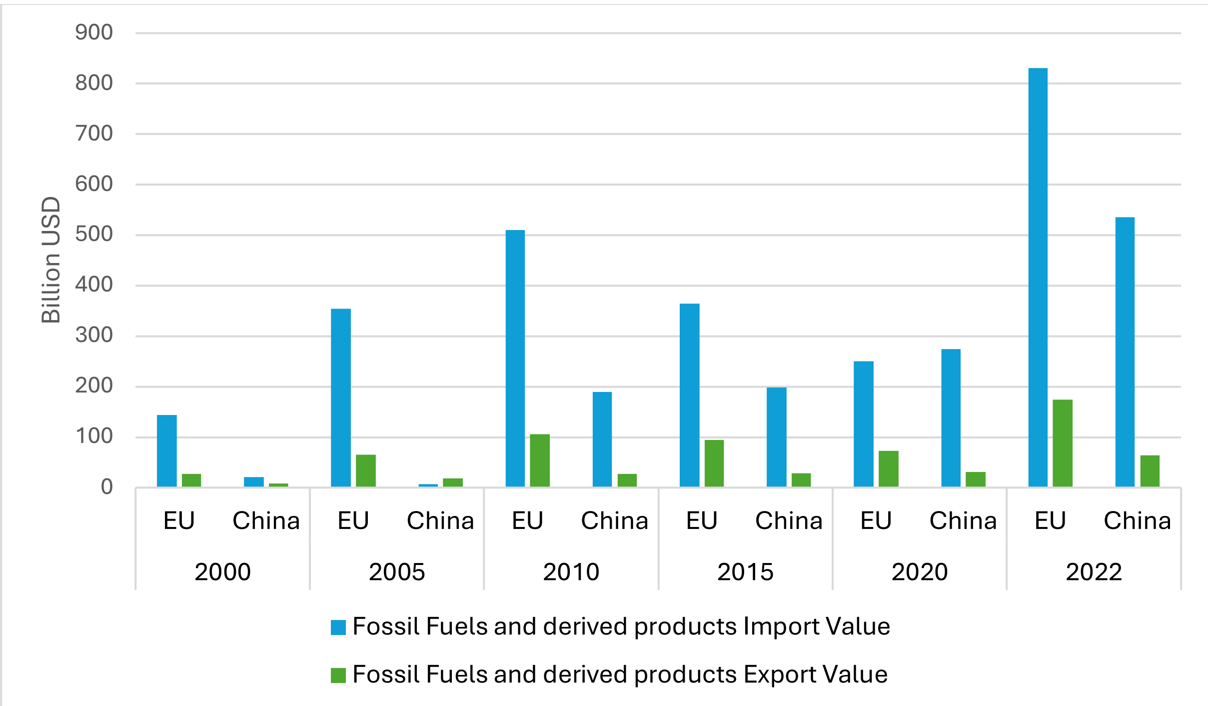
Source : Data retrieved from UN (2023). UN Comtrade. [online] comtradeplus.un.org. Available at: https://comtradeplus.un.org/

Figure 13. Evolution of Exports and Imports Value for HS.84 and HS.85 manufactured goods in China and the EU



Source : Data retrieved from UN (2023). *UN Comtrade*. [online] comtradeplus.un.org. Available at: https://comtradeplus.un.org/.

Figure 14. Evolution of Fossil Fuels and Derived Products Trade in China and the EU



Source : Data retrieved from UN (2023). *UN Comtrade*. [online] comtradeplus.un.org. Available at: https://comtradeplus.un.org/.

Consequently, China's fossil fuel reliance and import dependency increased but enabled their competitiveness in the renewable energy market, technological progress, and long-term self-sufficiency and sustainability prospects.

To conclude, the rapid progression of China's energy transition, in comparison to EU, is a critical observation. China's reliance on fossil fuels and import dependency has paradoxically fostered its competitiveness and long-term sustainability. In contrast, both the EU and China face the challenge of balancing economic growth and energy security with their net-zero ambitions. This research highlights three principal findings: first, both regions need policy revisions to achieve their targets. Second, the EU can benefit from China's competitive approach, while China should consider the EU's market dynamics to mitigate potential challenges related to structural scarcity in energy, minerals, and metals. Third, addressing the challenges of geographically heterogenous development is crucial for both, as it underpins the success of geo-infrastructural changes essential for sustainable transition.

Carbon neutrality, a complex goal involving numerous aspects of the energy system, necessitates a multifaceted approach. It requires reducing greenhouse gas emissions by curbing the growth of energy-intensive industries and adjusting product and industrial structures, all while sustaining economic growth. To balance development goals and emissions reduction, China and the EU must accelerate the pace of the energy transition and ensure efficient use of renewables. Further studies should concentrate on applying this research to the policy process by proposing ways to overcome the challenges mentioned.

6. Discussion and Conclusion

Discussion

Our analysis of energy transition in the EU and China from 2000 to 2022 stands as a pivotal contribution to the existing body of research, offering a novel comparative perspective that bridges gaps in the understanding of energy governance models. By contrasting the EU's LSMC with China's CSMC. Unlike traditional analyses that focus predominantly on state-centric or market-centric models, the state-society-market complex framework provides a holistic view by integrating state, society, and market components.
This divergence provides a unique lens through which to assess the impact of these models on the efficiency, effectiveness, and adaptability of their energy transition strategies in the context of environmental urgency and socio-political values.

In the EU, the liberal energy governance model, driven by the market forces and civil society organizations, results in a diverse, consensus-driven approach, as seen in initiatives including the European Green Deal. This model, though democratic and inclusive, often leads to slower policy implementation and potential compromises in effectiveness, reflecting the complexity of harmonizing various interests and achieving energy supply security, market competitiveness, and environmental sustainability. The EU's experience thus presents both the strengths and limitations of a liberal model in managing a multifaceted energy transition. Contrastingly, China's centralized energy governance model, characterized by significant state-led, state-intervention and strategic planning, demonstrates a capacity for rapid and efficient policy shifts, notably in renewable energy development and reducing fossil fuel reliance. However, this approach also reveals challenges in balancing economic growth with environmental and social considerations, as well as managing the regional disparities in policy impact.

Our empirical findings highlight China's centralized model as more efficient and rapid compared to the EU's decentralized approach. This observation raises critical considerations about the effectiveness of differing governance models, particularly in the face of limited resources and the urgent need to transition from fossil fuels. While the EU's approach, shaped by diverse interests and democratic processes, results in a slower transition, it upholds fundamental democratic values integral to its sound governance framework.

This research does not endorse the Chinese model as superior but acknowledges the effectiveness of certain aspects of centralized governance in expediting the energy transition. It is important to clarify that this endorsement of a more centralized approach is not a long-term solution but a strategic response to the immediate challenges of energy transition, aiming to temporarily accelerate the shift towards sustainable energy before returning to a more inclusive and democratic process.

In conclusion, this research enriches the ongoing debate about optimal governance models for energy transition. It underscores the necessity of a balanced approach that addresses the urgency of the transition while respecting the intricate values of various socio-political contexts. The insights from this study could guide future policy decisions, advocating for a strategic and adaptable approach to energy governance in times environmental urgency.

Conclusion

From 2000 to 2022, both the EU and China have made significant strides in their energy transition towards net-zero emissions, albeit facing distinct challenges shaped by their respective energy governance models. This conclusion draws together key findings, contrasting how the liberal model in the EU and the centralized model in China have influenced their energy transition strategies in terms of efficiency, effectiveness, and adaptation to environmental urgency and socio-political values.

The EU's efforts towards carbon neutrality faced policy gaps in sectors including industrial feedstocks and international transport, accounting for 13-14% of primary energy use. These gaps, combined with high energy import dependency, have increased the EU's vulnerability in moving away from fossil fuels. This policy shortfall, in conjunction with stagnant progress in reducing energy import dependency, has heightened the EU's vulnerability in transitioning from traditional fossil fuel sources. This shift has inadvertently increased reliance on external energy imports, further strained by reduced energy imports from Russia, impacting energy prices and the broader economic landscape. Resistance from key stakeholders including CEFIC and Business Europe towards costlier renewables and disparities in technological funding among member states have hindered the EU's energy market evolution, emphasizing the need for consistent infrastructural change and renewable electrification policies.

In contrast, China's centralized energy governance has enabled a more aggressive shift towards renewable energy and reduction in coal usage, positioning it as a leader in renewable equipment production. However, its challenges lie in continued fossil fuel dependency and regional development disparities. China's strategy needs to address these issues to maintain its momentum in energy transition, focusing on reducing reliance on fossil fuels and promoting balanced regional development.

One significant limitation of this study is the limited exploration of the policy-making process within the CSMC framework. While our study effectively contrasts the LSMC and CSMC models in terms of outcomes and overarching strategies, it falls short in delving into the intricacies of policy formulation and execution within the CSMC model. This aspect is critical, given the differences in policy-making transparency and stakeholder involvement between the LSMC and CSMC models. This gap highlights the need for future research to focus on the inner workings of policy development within CSMC framework, crucial for understanding energy transition and energy security. Such studies would not only enhance the academic discourse on energy governance models but also provide valuable insights for policymakers in crafting.

To encapsulate, the research reveals that while China's model has facilitated a rapid and competitive energy transition, it must now prioritize equitable development across provinces to sustain its progress. On the other hand, the EU, with its liberal energy governance, must navigate the complexities of harmonizing policies among diverse member states and interests. It needs to foster novel policies, corporate engagement, and equitable development to reduce import dependency and strengthen its internal energy market. Both the EU and China's experience in energy transition, reflecting their distinct governance models, highlight the need for tailored policy strategies that address specific regional challenges and priorities. By focusing on these nuanced aspects, both regions can optimize their approaches for sustainable, long-term growth in the energy sector, contributing to their respective and collective goals in the global energy landscape.

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6- Energy cooperation under the Polar Silk Road

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Energy cooperation under the Polar Silk Road

Abstract：

With global warming and the rapid ice-melting, energy exploration and development in the Arctic region, which has huge fossil and renewable energy resources, have gradually become a hot issue. However, considering the high exploration cost, fragile environment, and intense geopolitics, it is difficult to exploit and develop energy resources in the Arctic region. The Polar Silk Road is an integral part of the Belt and Road Initiative, and an important mechanism for China to participate in energy cooperation in the region. The United States and Russia are both aiming to dominate the development of Arctic energy, and have adopted new policies and measures recently, which will cause geopolitical tension to escalate in the Arctic region. Based on the approach of SWOT, this paper will discuss China' s strengths, weaknesses, opportunities, and threats when it participates in Arctic energy affairs and cooperates with the US, Russia, and other Arctic states, and put forward some suggestions.

Key Words: Arctic; Energy Development; Energy cooperation; Polar Silk Road

Since the beginning of the 21st century, the Arctic ice cap has been melting continuously, and the thickness of the ice layer has reached the lowest point in history. The rate of the temperature rises is twice the global average. The increase in temperature has brought increasing attention to the development of energy resources in the Arctic. At the same time, Arctic countries are also undergoing energy transition to promote the sustainable development of the Arctic region. The "Polar Silk Road" is part of the "Belt and Road" initiative, participating in energy development cooperation in the Arctic is an important content of China's oil and gas import diversification. At the same time, due to the increasing geopolitical importance of the Arctic region, the Arctic energy issues related to the "Polar Silk Road" are also becoming more complicated.

1.Is the era of oil and gas development in the Arctic region coming?

According to data of the U.S. Energy Information Administration (EIA), the proven onshore and offshore oil and gas reserves in the Arctic region are 410 million tons of oil equivalent, accounting for 13% of global proven oil reserves, 30% of natural gas reserves, and 20% natural gas liquids reserves. In terms of geographical distribution, the oil and gas resources in the Arctic are mainly distributed in Russia and the United States. Russia accounts for about 50% of the Arctic oil and gas reserves, the United States accounts for about 20%, and the rest are distributed in several Arctic countries such as Norway, Denmark, and Canada. Russia's reserves are dominated by natural gas, and the United States' reserves are dominated by oil (see Table 1 for details). Abundant reserves and continuous improvement of development technologies have gradually highlighted the importance of the Arctic in the global energy landscape.

TABLE **1** Arctic Mean Estimated Undiscovered

Technically Recoverable, Conventional Oil and Natural Gas Resources
By Arctic Province, Ranked by Total Oil Equivalent Resources

USGS Petroleum Province Name	Crude Oil (Billion barrels)	Natural Gas (Trillion cubic feet)	Natural Gas[1] Liquids (Billion barrels)	Total Resources, Oil Equivalent[2] (Billion barrels)
West Siberian Basin	3.66	651.50	20.33	132.57
Arctic Alaska	29.96	221.40	5.90	72.77
East Barents Basin	7.41	317.56	1.42	61.76
East Greenland Rift Basins	8.90	86.18	8.12	31.39
Yenisey-Khatanga Basin	5.58	99.96	2.68	24.92
Amerasia Basin	9.72	56.89	0.54	19.75
West Greenland-East Canada	7.27	51.82	1.15	17.06
Laptev Sea Shelf	3.12	32.56	0.87	9.41
Norwegian Margin	1.44	32.28	0.50	7.32
Barents Platform	2.06	26.22	0.28	6.70
Eurasia Basin	1.34	19.48	0.52	5.11
North Kara Basins and Platforms	1.81	14.97	0.39	4.69
Timan-Pechora Basin	1.67	9.06	0.20	3.38
North Greenland Sheared Margin	1.35	10.21	0.27	3.32
Lomonosov-Makarov	1.11	7.16	0.19	2.49
Sverdrup Basin	0.85	8.60	0.19	2.48
Lena-Anabar Basin	1.91	2.11	0.06	2.32
North Chukchi-Wrangel Foreland Basin	0.09	6.07	0.11	1.20
Vilkitskii Basin	0.10	5.74	0.10	1.16
Northwest Laptev Sea Shelf	0.17	4.49	0.12	1.04
Lena-Vilyui Basin	0.38	1.34	0.04	0.64
Zyryanka Basin	0.05	1.51	0.04	0.34
East Siberian Sea Basin	0.02	0.62	0.01	0.13
Hope Basin	0.002	0.65	0.01	0.12
Northwest Canadian Interior Basins	0.02	0.31	0.02	0.09
Total	89.98	1,668.66	44.06	412.16

Source: U.S. Geological Survey, "Circum-Arctic Resource Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle," USGS Fact Sheet 2008-3049 Washington, DC (2008), Table 1, page 4. Note: The column totals do not equal the sum of the rows due to rounding. USGS website URL is: http://pubs.usgs.gov/fs/2008/3049/. The relative location of these provinces is identified in Appendix B. 1/ Natural gas liquids are composed of ethane, propane, and butane. 2/ The USGS uses a natural gas to oil conversion factor in which 6 thousand cubic feet of natural gas equals 1 barrel of crude oil.

Large oil and gas companies such as Exxon Mobil, ConocoPhillips, Shell, BP, Rosneft, Gazprom, Total, Eni and Equinor have formed strategic alliances, and carried out Oil and gas exploration in Arctic's coastal and offshore areas such as Barents Sea, the Chukchi Sea, and the Beaufort Sea. Although the cost of developing oil in the Arctic region is high and it is difficult to make profits under low oil prices, but with the advancement of technology and the continuous reduction of costs, the development of oil and gas resources in the Arctic still has good prospects in the future. The Johan Castberg offshore oil project in Norway and the Pikka Unit onshore oil project in Alaska have lowered the breakeven price of oil extraction from $100 to $35 per barrel, the start-up of the Yamal LNG and Alaska LNG projects has brought oil and gas development in the Arctic gradually With competitiveness, Greenland also plans to start bidding for oil and gas in 2021, and the pace of future Arctic energy development and utilization seems to be getting closer.

But the development of Arctic oil and gas resources is not easy. First, Arctic oil and gas development costs are high. The harsh climate environment will significantly increase the cost of oil and gas extraction, and the fragile natural environment will also increase the investment of oil and gas companies related environmental safety. Second, once the oil price is low, it will make Arctic oil and gas oil exploration unattractive. The recognized data on Arctic oil and gas reserves was released by the US Geological Survey in 2008, when oil prices were at a high point, which was conducive to the development of Arctic oil and gas. With the sharp drop in international oil prices for several years, although oil prices soaring during 2022, it is still questionable whether countries can increase oil and gas demand and whether high oil prices can continue in the face of global commitments to climate change. Once oil prices drop, Arctic oil and gas extraction becomes less attractive. Third, oil companies need to bear the financial and reputational risks of oil spills in addition to the cost of deep drilling. In cooler temperatures, water and oil are likely to freeze and become part of the ice and permafrost, remaining in the environment for much longer than oil spills in the tropic areas. BP's oil spill in the Gulf of Mexico alone cost $18.7 billion, and the damage in the Arctic is not only economic, but reputational[6]. The long time required for Arctic oil and gas development also carries risks. The business environment may change dramatically between project start and completion dates, coupled with the different oil and gas exploration license systems and lack of infrastructure in Arctic countries, resulting in the risk of development oil and gas in the Arctic region delays and cost overruns are high. In the past decade, although people have generally placed high hopes on the exploration of oil resources in the Arctic offshore, the actual exploration and production progress has been slow. So far, only two oil fields and one natural gas field are in production[7].

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[6] Michael John Laiho, Four Myths About the Arctic Oil and Gas Bonanza. https://www.highnorthnews.com/en/analysis-busting-myth-arctic-oil,Oct 24, 2018.

[7] Daria Shapovalova, Kathrin Stephen.No race for the Arctic? Examination of interconnections between legal regimes for offshore petroleum licensing and level of industry activity.*Energy Policy*,129(2019) ,pp.907-917.

2. Renewable energy transition in the Arctic region is hopeful

The development of oil and gas resources in the Arctic can promote local economic development and benefit indigenous peoples and development companies. But this development is unsustainable and has made many Arctic communities' reliance on fossil fuels for power, heating, and transportation, resulted in increasing greenhouse gas emissions. In fact, the Arctic region is not only rich in oil and gas, but also rich in renewable energy such as rare earth elements, hydropower, wind power, and geothermal energy, and its development potential should not be underestimated. At present, hydropower and geothermal energy in the Arctic region are the main renewable energy sources, and the installed hydropower capacity has exceeded 80 GW. The annual theoretical power generation and technically exploitable capacity of wind power account for 18.5% and 17.2% of the global wind energy resources respectively, and the technologically exploitable capacity is 110.6×10^8 kW, including 73.1×10^8 kW on shore and 37.5×10^8 kW offshore. The priority of the Arctic Council's Working Group on Sustainable Development (SDWG) is to provide comprehensive solutions for the development of Arctic communities in terms of infrastructure, energy, agriculture, and environmental management, maximizing the use of affordable and clean energy to provide reliable electricity and Heating, reducing reliance on fossil fuels. Many Arctic countries also regard renewable energy and energy efficiency as the core of sustainable development, through the effective integration of clean energy resources, to achieve a balanced development between energy security, environmental protection, public safety, and economic viability.

The Arctic Renewable Energy Project, established by the Sustainability Working Group, is co-organized by the United States, Canada, and the Geviche International Council (GCI). It is mainly committed to compiling an online atlas of renewable energy sources in the Arctic region, including wind power, hydropower, solar energy, geothermal energy, biomass energy, tidal energy, etc., while providing the community with energy production, consumption, efficiency databases and best practice guidelines. The project has raised $275,000 for related researches. The U.S. Department of Energy established the Indian Energy Office, which is responsible for developing the Arctic region's renewable energy development strategy and renewable energy and energy efficiency development plans. The main work of the Arctic Renewable Energy Working Group (ARWG) of the Arctic Research Council of the United States is to promote research on renewable energy and efficient energy systems in remote Arctic communities, and integrate renewable resources and supporting technologies into community power generation systems, aiming to increase local employment and reduce air pollution and carbon footprint, lower costs for local consumers. The Government of Canada is working with experts and community leaders to create a replicable, scalable, and self-sustaining development model for renewable energy investments to reduce the reliance on diesel in Arctic communities, and the low-impact, community-wide environmentally-friendly renewable energy technologies were planned to be deployed in three candidate communities by 2020.

Renewable energy is also seen as an opportunity in the European Arctic[8]. The Faroe Islands has wind energy and Greenland is rich in water resources and has the potential for hydroelectric power generation. Norway and Iceland have invested in hydropower and exported excess electricity to Denmark. The North Atlantic Energy Project is looking at connecting the region's isolated energy systems, such as a renewable energy network between Norway and Greenland, or the UK and Iceland through a renewable energy network. It is worth mentioning that, as an Arctic country, Iceland's politicians realized the importance of energy transition from the oil crisis in the 1970s, and the climate change debate in the 1990s prompted Iceland to embark on a renewable energy transition dominated by hydropower and geothermal energy. By 2018, hydropower and geothermal energy consumption accounted for 55.6% and 24.2% of Iceland's primary energy consumption, respectively. Iceland plans to completely get rid of its dependence on fossil energy till 2050.

The role of the Arctic region in the energy transition is gradually emerging. First, the natural gas resources of the Arctic are expected to boost the global energy transition. The proven natural gas reserves in the Arctic Circle that can be developed using existing technologies are estimated at 1,669 trillion cubic meters, or about 30% of the world's proven reserves. According to the Report of the International Energy Agency, natural gas will play a key "bridge" role in the future energy transition and is the most realistic choice for the global energy transition. The increase in natural gas supply in the Arctic region will play an important role in the clean transformation of global energy consumption. Second, the arctic's rare earth resources are key players in the energy transition, the Arctic is rich in rare earth resources. It is estimated that the rare earth oxide resources in the Arctic region are about 127 million tons, of which the rare earth reserves in the Russian Arctic region are 72.26 million

[8] Doris Friedrich, Renewable Energy Seen as an Opportunity for the European Arctic. https://www.newsdeeply.com/arctic/articles/2016/11/21/renewable-energy-seen-as-an-opportunity-for-the-european-arctic,21/11/2016.

tons, ranking second in the world, the rare earth reserves in Greenland and the Canadian Arctic region are 41.69 million tons and 14.13 million tons, ranking 5th and 6th in the world, in addition, the rare earth reserves of Swedish Lapland have also entered the top ten in the world[9]. Rare earth is a strategic resource, which can often be used in the field of defense and the production of high-tech equipment and auto parts, and can also be applied to the field of renewable energy. If the world to meet the "Paris Accord" required greenhouse gas emission targets, the future demand for rare earth metals will further increase[10], the Arctic region's rich rare earth resources can provide huge support for the transition to renewable energy. The third is to form a renewable energy hydrogen production supply chain. Hydrogen energy is considered to be the ultimate goal of energy transformation, and the production of green hydrogen energy without carbon emissions is the key to the utilization of it. Developed countries such as the United States, Japan, Germany, the United Kingdom, and France have successively released hydrogen energy strategies and goals to promote the rapid development of the hydrogen energy industry. The abundant renewable energy in the Arctic can also be used to produce green hydrogen energy and transport it around the world, which is an effective path for the global energy transition.

On the whole, the development of renewable energy and fossil energy in the Arctic region has great potential. There are not only the successful exploitation of the Ob Bay and Predhoe Bay oil fields and the Yamal gas field, but also the examples of Iceland's successful energy transition. Once the development of oil and gas resources in the Arctic and the transition of renewable energy are combined together closely, in the case of limited use of fossil fuels, the two complement each other, which can not only significantly reduce system costs and increase power system reliability, but still reduce greenhouse gas emissions. The Arctic region is expected to become a model for global energy development, application, and transformation.

3. New trends in Arctic energy development in the United States and Russia

The United States and Russia have the largest reserves of resources and the greatest influence among the eight Arctic countries. The two have been trying to become the leader in the development of the Arctic and have a significant impact on the development of Arctic energy.

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[9] Mikaa MERED ,The Arctic: Critical Metals, Hydrogen and Wind power for the Energy Transition, IFRI Working Paper,23 JANUARY 2019.https://www.ifri.org/sites/default/files/atoms/files/mered_arctic_metals_2019.pdf

[10] Pieter van Exter, etal., METAL DEMAND FOR RENEWABLE ELECTRICITY GENERATION IN THE NETHERLANDS Navigating a complex supply chain, https://www.metabolic.nl/publications/metal-demand-for-renewable-electricity-generation-in-the-netherlands/

The United States and Russia also have a gradual understanding of Arctic energy development, and in the context of Russia's deepening development of the Arctic, the United States is also paying more and more attention to Arctic energy development.

3.1 Changes of the U.S. Arctic Energy Development Policy

Alaska, located in the Arctic region, used to be one of the main oil producing areas in the United States. In 1988, when the output was the highest, it accounted for nearly 1/4 of the total oil production in the United States. However, with the rise of the shale oil and gas revolution in the United States, which has attracted a lot of investment, Oil and gas production in Alaska is declining due to lack of capital, and energy development is slow.

3. 1. 1 U.S. primary concerns for the Arctic are national security and environmental protection

The successive U.S. administrations from Nixon to George W. Bush have paid more attention to national security, environmental protection, scientific exploration, climate change, and international cooperation in the Arctic region. The U.S. Arctic strategy has only been planned and designed from a macro and conceptual level, and has not raised the Arctic issue to the priority agenda and national strategy[11],and Arctic energy development is not the core of U.S. Arctic policy. It was not until 2013 that the Obama administration promulgated the United States' first formal " National Strategy for the Arctic Region", and “National Strategy for the Arctic Region Implementation Report” documents. Its strategic direction includes three aspects: Advance United States Security Interests, Pursue Responsible Arctic Region Stewardship and Strengthen International Cooperation. In advancing the National Security Interests strategy, the Arctic's important role in securing future U.S. energy security is emphasized, while proposing that Arctic oil, gas resources and renewable energy can be actively developed within the context of economic, environmental and climate policy objectives, and actively working with stakeholders, industry and other Arctic countries, but the overall keynote is still to protect the Arctic natural environment. Although the United States has also approved oil and gas drilling bidding permits in the Arctic's National Petroleum Reserve during this period, but the overall effect was not good.

3.1.2The game of oil and gas development on federal land in Alaska

Although Alaska has abundant energy resources, but the US government still pays more attention to the environmental protection of Alaska to maintain its original appearance. The Alaska National Interest Lands Conservation Act, passed in 1980, protected 104 million acres

[11] SUN Kai, YANG Songlin, Changes and Implications of Arctic Policy during Obama Administration's Second Term, *Pacific Journal*, Vol.24, No.12, 2016, pp.31--41.

of federal land and established the Arctic National Wildlife Refuge (ANWR). The Arctic National Wildlife Refuge (ANWR) is located in northern Alaska, east of the Prudhoe Bay oil field and the Alaska National Petroleum Reserve (NPRA). Surveys conducted by the U.S. Geological Survey indicate that there are 5.7--16 billion barrels of technically recoverable oil in the Arctic National Wildlife Refuge (ANWR) coastal plain areas, with an average of 10 billion barrels. For a long time, successive Republican administrations and oil tycoons in the United States have always wanted to develop the oil and gas resources in this area, but each time, it has been opposed by the Democratic Party and environmental groups, and it has not been successful.

During the Obama presidency, the government was slightly negative on the development of Arctic energy due to more emphasis on environmental protection and climate change. Still, the Obama administration granted ConocoPhillips a license to drill on Alaska's North Slope National Petroleum Reserve. However, oil and gas extraction is prohibited in the Arctic National Wildlife Refuge (ANWR) and in most of the Chukchi and Beaufort Seas. Former President Obama even tried to get Congress to make the policy permanent, but ultimately failed. It also provides an opportunity for the Trump administration to change this policy.

In December 2017, the United States passed Public Law 115-971, which requires the Secretary of the Interior to develop and manage competitive oil and gas program by authorizing leases within the Arctic National Wildlife Refuge's (ANWR) Coastal Plain (Area 1002) , to develop, produce and transport oil and gas[12]. This means that the Trump administration has lifted policy barriers to energy development in the U.S. Arctic, promoting energy exploration and production on federally-owned lands and offshore areas. Meanwhile, the Department of the Interior also offered the largest-ever oil and gas lease deal in the National Petroleum Reserve in northwest Alaska, included 900 plots of land with an area of more than 16,000 square miles. But the oil industry reacted lukewarmly, with only 7 bids and a total of $1.16 million in revenue.

In January 2018, the Trump administration released a draft five-year plan for offshore oil and gas leases for 2019-2024, which includes more than 1 billion acres of federal offshore oil and gas development. The plan includes 19 Alaska oil and gas development leases, six of which are in the Beaufort and Chukchi Seas in the Arctic. Federal waters offshore Alaska hold an estimated 27 billion barrels of oil and 12 trillion cubic feet of natural gas development potential. The Chukchi Sea holds more oil and gas resources than any other untapped U.S.

[12] Public Law 115-97， December 10,2017,https://congress.gov/115/bills/hr1/BILLS-15hr1enr.pdf.

energy reserve and may be one of the largest untapped oil and gas resources in the world. In November 2017, the Bureau of Safety and Environmental Enforcement, under the Department of the Interior, issued a license for the U.S. branch of the Italian Eni Group to explore for oil on an artificial island in the Beaufort Sea, becoming the first company to be approved to explore for oil in Alaska's federal waters since 2015. In October 2018, the Trump administration approved the development of oil by Texas-based company Hilcorp in the Beaufort Sea, east of Prudhoe Bay. Under Trump's strong supportive policies, new opportunities have emerged for the development of oil and gas in the U.S. Arctic region[13].However, with Biden officially taking office in January 2021, the momentum of Alaska gas development that has just begun is facing a new situation of slowing down or even stopping.

3.1.3 U.S. Arctic energy policy faces changes after Biden takes office

Biden won the 2020 U.S. election, and U.S. Arctic energy development is once again facing variables. In his campaign energy plan, "Clean Energy Innovation and Environmental Justice," Biden said he would re-establish climate change as a priority for the Arctic Council as extreme warming in the Arctic poses a challenge to U.S. national security, focused on reducing Arctic black carbon and methane pollution, and will also work with Arctic Council member states to suspend drilling in the Arctic offshore oil and gas seas globally. The development of Arctic energy in the United States has always faced problems such as high cost, insufficient investment, and opposition from environmental protection organizations. After Biden takes office, he is expected to ban the leasing of fossil energy such as oil and natural gas in Arctic waters, and promote this concept to a global scale, his policy May turn to support the development of renewable energy in the Arctic. In the future, the United States' Arctic energy policy may once again turn to the policies of Obama's administration, focusing on climate change and international cooperation, and the development of Arctic oil and gas energy may face a situation of shelving.

3.2 Russia’s Arctic energy development

Russia attaches great importance to the development of the Arctic and is involved in all aspects of oil and gas resource development, port infrastructure construction, transport equipment such as icebreakers, and power reserves.

3.2.1 Comprehensively formulate an Arctic development strategy

After the collapse of the Soviet Union, the severe economic difficulties caused Russia to lack sufficient funds for Arctic energy development and infrastructure maintenance. In recent

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[13] Guo Peiqing, Zou Q, Adjustments of the Trump Administration’s Arctic Policy, *International Forum*, No.4,2019

years, Russia's Arctic development has gradually resumed. In 2001, President Putin signed the first policy document involving the Arctic development strategy, "The Russian Federation's Maritime Policy for the Period up to 2020", and in 2008 issued the first Arctic Development Outline ,"Principles of State Policy of the Russian Federation in the Arctic to 2020 and Beyond", which emphasizes that natural resources are the first national interest, the second is to maintain peace and international cooperation in the Arctic, the third is to protect the unique ecosystem of the Arctic, and the fourth is to promote the Northern Sea Route as an international waterway under Russian jurisdiction. Two years later, the "State Program for the Economic and Social Development of the Arctic Region of the Russian Federation for 2011-2020" was promulgated. In 2011, the Russian Arctic Scientific Research Center was established, In March 2020, Russia issued the "National Arctic Policy Basis until 2035", In this file, the Arctic region still remains a priority for oil and gas development, supporting investment in energy, transportation and infrastructure, as well as oil and gas technologies, further developing the Northern Sea Route, and accelerating economic development in this area, and Protect the Arctic environment and the original habitat and traditional way of life of ethnic minorities, strengthen international cooperation, peacefully resolve various Arctic disputes, and maintain Russia's national interests in the Arctic.

3.2.2 Actively develop Arctic natural gas projects

Russia's Arctic region is rich in natural gas reserves. In 2019, the Arctic Yamal LNG project with a total output of 16.5 million tons ran at full capacity ahead of schedule, which not only increased sales profits of US$2.5 billion, but also boosted Russia's confidence in developing Arctic oil and gas resources, large-scale LNG development projects are gradually increasing. The Arctic Liquefied Natural Gas 2 (Arctic LNG2) project consists of three liquefaction production lines with an annual output of 6.6 million tons respectively, and it is planned that the first production line will be put into use in 2023, the second and third production lines will be put into use in 2024 and 2025, and Full-load operation will be achieved in 2026, with a total output of 19.8 million tons. Exploration of the Ob LNG (ob LNG) project is also scheduled to be completed around 2023[14].In addition, Novatek also announced that the gas development capacity of the North Ob Bay gas field could reach 900 billion cubic meters, and named the project Arctic LNG 3 (Arctic LNG3). In order to cope with the huge transportation of liquefied natural gas as well as coal, oil and various ores, Russia has high hopes for the

[14] Marlène LARUELLE.Russia's Arctic Policy : A Power Strategy and Its Limits. https://www.ifri.org/en/publications/notes-de-lifri/russieneivisions/russias-arctic-policy-power-strategy-and-its-limits,March,2020

Northern Sea Route in the Arctic, and plans to increase the transportation volume from 18 million tons in 2018 to 80 million tons in 2024. The opening of the Northern Sea Route will greatly shorten the Arctic summer voyage to the Asia-Pacific region, cutting the time by nearly half, will have a huge impact on global trade, and bring trillions of dollars of wealth to Russia.

Table 2. Traffic along the Northern Sea Route, in millions of tons

2013	2014	2015	2016	2017	2018	Official Forecasts for 2024
2.8	3.7	5.15	7.5	9.7	18	80

Source: Marlène LARUELLE.Russia's Arctic Policy：A Power Strategy and Its Limits. https://www.ifri.org/en/publications/notes-de-lifri/russieneivisions/russias-arctic-policy-power-strategy-and-its-limits,March,2020

3.3.3 Problems faced by Russia's Arctic energy development

First, it faces financial and technical constraints. Russia is under international sanctions, the United States restricts the entry of a number of Russian companies, including Rosneft, Novartec and other Russian companies and banks into the U.S. bond market, the European Union and the United States also prohibit the export of high-tech oil equipment for arctic deep-sea and shale exploration projects to Russia, and the financing channels and technical sources of Russian Arctic oil and gas development are restricted. Under pressure from sanctions, In February 2018, ExxonMobil withdrew from a partnership with Rosneft in the Arctic Kara Sea. In addition, most of the Russian companies that have obtained oil and gas exploration in the Russian Arctic are currently Russian companies, but these state-owned companies have onshore oil and gas development experiences and have no technical experiences in offshore exploration and exploitation in the Arctic, while most small companies with technical experiences in offshore exploration and development in Russia are restricted by the fact that companies with more than 50% of Russian state-owned shares can only be issued access permits, so cannot carry out oil and gas exploration in the Arctic.

Second, environmental protection and migration problems in the Arctic. The Siberian region of Russia is the second largest "lung" of the world after the Amazon Basin, which is very important in maintaining global biodiversity and the ecological vulnerability of the Arctic region. However, it is also strongly affected by climate change, the 27 Arctic regions of Russia have caused environmental damage and increased population mortality due to oil and gas extraction. At the same time, it has also affected the normal life of indigenous people, such as reindeer herding. Russia has invested the most in industries in the Arctic region, and its population has also flowed with the rise and fall of the industries. Now that nearly a third of the Arctic population has migrated to its European part, it is expected that, Russia's polar regions will continue to experience significant population decline in the coming decades, with the exception of the Yamal-Nenets autonomous region, which is attracting new inhabitants due to the growth of oil and gas development, which in turn will affect the overall development of its Arctic.

4. China's experiments and cooperation in developing Arctic energy resources

Energy development in the Arctic has attracted global attention. As a near-Arctic country, China attaches great importance to and actively participates in the development of energy resources in the Arctic, and plays an active role in the development of energy resources in the Arctic. China became an official observer state of the Arctic Council on May 15, 2013, indicating the international community's recognition of China's status as an "Arctic stakeholder". The white paper "China's Arctic Policy" released in January 2018 stated that China's participation in Arctic affairs is based on the basic principles of "respect, cooperation, win-win and sustainable". China will actively promote scientific expeditions and research in the Arctic, actively participate in the development and cooperation of Arctic oil and gas, minerals, fishery resources, and tourism resources, explore new Arctic waterways, build a "Polar Silk Road" with all partners. China will actively participate in Arctic governance and play a constructive role in formulating, interpreting, applying, and formulating international rules for the Arctic.

4. 1 LNG cooperation with Russia continues to deepen

Actively participating in the Russian Arctic LNG project is an inevitable choice for China’s energy import diversification. The success of the Arctic Yamal LNG project has been becoming a template for China to deeply participate in Russia's Arctic energy development. In this $27 billion worth project, the major shareholder Russia Novatek holds 50.1%, Total and CNPC each hold 20%, and Silk Road Fund holds 9.9%. According to the contract, 4 million tons of LNG will be sold to the Chinese market after reaching production capacity, accounting for 10%-15% of China's LNG imports. In the Arctic LNG 2 (Arctic LNG 2), which is dominated by Novatek, with a larger output, CNPC and CNOOC each hold 10% of the shares, and China will also actively participate in projects such as Arctic LNG 3 (LNG3) in the future. The in-depth cooperation between China and Russia in the Yamal project, Chinese elements are also reflected in the project construction, including Chinese companies contracting 85% of the module construction, providing polar low-temperature drilling rigs, constructing engineering ships and ordinary carriers, operating LNG carriers, etc., the contract is more than $15 billion. Chinese enterprises provide a variety of products for the project, which promotes the technological innovation and transformation of domestic steel, cable, and other industries[15], and provides technology and talent reserves for China's participation in Arctic energy development.

4.2 Extensive participation in energy resource projects in Arctic regions

In addition to cooperation with Russia in Arctic energy projects, China has also signed energy resource development agreements with many Arctic countries to strengthen cooperation in this region. Greenland has a large amount of oil and gas, iron, zinc, rare earth elements and even uranium and other resources. The Greenland Autonomous Government also wants to develop its economy through energy and resource development, increase public income, local employment, training, and education opportunities, and change the situation in which 90 per cent of its exports depend on fish. In 2014, the Chinese company General Nice wholly acquired the Isua Project of the London Mining Company and obtained the exploration license in Greenland. It is the first Arctic project completely owned by a Chinese company[16]. In 2016, Chinese company Shenghe Resources Holding Co.Ltd. acquired a 12.5% stake in Greenland Mining Company and obtained the right to develop the rare earth mine kvanefjeld, In the future, Shenghe Resources Holding Co.Ltd. can hold up to 60% of the shares.

The state of Alaska in USA, has abundant oil and gas reserves and is eager to revitalize the economy through energy exports. In November 2017, the Alaska State Government, Alaska Natural Gas Development Corporation (AGDC) signed a non-binding joint development agreement with Sinopec, China Investment Corporation, and Bank of China. China will invest US$43 billion to develop LNG in Alaska and purchase 75 % of the project's mining volume, in exchange for equal shares, and the provision of necessary financing, which was one of the major orders signed by former President Trump during his visit to China that year. But, with the outbreak of the "trade war" between China and the United States, both countries involved oil, natural gas, and chemical products in the second round of tariff lists, and energy cooperation between China and Alaska was also affected. In July 2019, the president of the Alaska Gas Development Corporation confirmed that the project was no longer in progress. However, in view of the good complementarity between the two countries

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[15] Chen Fu: How to ship the products of the Sino-Russian Yamal natural gas project back to China, https://new.qq.com/omn/20180129/20180129A05 2BK.html, JAN.,29,2018

[16] Marco Volpe.The tortuous path of China's win-win strategy in Greenland. https://www.thearcticinstitute.org/tortuous-path-china-win-win-strategy-greenland/, March 24, 2020.

in the energy field and the strong willingness to cooperate between enterprises, the future direction of the project is still worthy of attention.

4.3 SWOT analysis of China's Arctic energy development

Judging from China's investment in the Arctic energy sector in recent years, the advantages and disadvantages are obvious, and opportunities and challenges coexist. Through SWOT analysis, we can see that China's huge energy consumption market and capital strength, as well as the experience and technical reserves accumulated by energy companies in the "going out" strategy, are China's advantages in developing Arctic energy. The original intention of Arctic countries to develop energy resources to promote economic development and increase national well-being is highly consistent with China's huge demand for energy in economic development and the urgent need to find overseas energy markets, providing a good opportunity for China to participate in Arctic energy development. Opportunities, the continuous deepening of the "The Belt and Road" initiative and "Polar Silk Road" have accelerated China's pace of developing Arctic energy.

Since China is a latecomer to the development of the Arctic, many projects have long been laid out in Western developed countries, and it remains to be seen whether China's M&A projects will be profitable in the future. Chinese companies' unfamiliarity with the local situation, their lack of understanding of the rules and government policies, and the existence of cultural differences will put China at a disadvantage in Arctic investment negotiations. In recent years, some European and American countries have spread the "China threat theory" for their own interests[17], which has also had a certain impact on China's investment. In fact, judging from China's investment in Arctic energy, the success of the project is also the result of the close cooperation with the local government. An important factor in the success of the Sino-Russian Yamal project is the Russian government's subsidies, tax exemptions and support for the construction of port facilities[18]. In the process of project implementation, China's investment not only faces the challenges of lack of infrastructure and high costs in the Arctic, but also faces strict requirements for environmental protection in the Arctic Circle, protests from green organizations, and strict labor management system constraints.

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[17] Xin HU, The United States is spreading the "China threat theory" in the Arctic, *WORLD AFFAIRS*, No.11,2019

[18] Maria Shagina.Is The Yamal LNG Project Overhyped?,

https://oilprice.com/Energy/Energy-General/Is-The-Yamal-LNG-Project-Overhyped.html,
Feb 19, 2018.

Strengths: --a huge energy consumption market --Capital advantage --Overseas investment accumulates experiences and technology accumulation	Weaknesses: -- The latecomer of Arctic development has high M&A costs -- There are differences in norms and standards --Cultural differences are large, and there are obstacles in communication --Geopolitical instability, questioning Chinese investment
Opportunities: --Arctic countries develop their economies and find investors and markets for huge energy reserves --China expands the supply of energy resources --The promotion of the "Polar Silk Road"	Threats: --The project cost is high and it is difficult to make a profit --Environmental protection requirements are high, and the public (indigenous people) have objections --Infrastructure and labor problems need to be solved

Fig.2 SWOT analysis of China's Arctic energy development

Despite various problems and challenges, as a near-Arctic state and an official observer state of the Arctic Council, the best way for China to enter the Arctic in the future is still based on respect for cooperation under institutional and legal frameworks, whether it is scientific projects or energy development, pursuing win-win results. Promoting the diversification of China's energy supply and promoting the sustainable development of the Arctic is also highly in line with China's concept of seeking peaceful development through cooperation in the Arctic.

5. Rethinking China's Polar Silk Road cooperation and Arctic Energy Development

Energy development in the Arctic region is of great significance to China's energy security and energy transition. The white paper "China's Arctic Policy" expresses China's basic position on Arctic development and explains the policy objectives, basic principles, and main policy propositions of China's participation in Arctic affairs. China enjoys the freedoms or rights of scientific research, navigation, overflight, fishing, laying of submarine cables and pipelines, and resource exploration and exploitation stipulated in international treaties such as the United Nations Convention on the Law of the Sea, Svalbard Treaty of 9 February 1920 and other international treaties and general international law in the high seas of the Arctic Ocean, the international seabed area and specific areas[19].While defending its right to develop

[19] Information Office of the State Council of China, White Paper on *China's Arctic Policy*.

in the Arctic, China is facing the new changes in Arctic development, summing up the lessons learned from past Arctic energy development, and rethinking and re-understanding the future Arctic energy development in order to be in a favorable position in Arctic energy development.

5.1How to deal with the escalation of the Arctic competition

The geopolitical situation in the Arctic region tends to escalate. In fact, it is mainly a competition between US-led NATO and Russia. In particular, American think tanks have paid great attention to and interpreted the energy development cooperation between China and Russia in the Arctic, and called on the United States to increase Investing in the Arctic. Arctic energy development and access to the North Sea route is an absolute priority of the Russian government, and the Trump administration in the United States has relaxed its control over Arctic energy development and encouraged the development of Arctic energy, but due to factors such as capital, cost and opposition from the Democratic Party, the development process has not been smooth. Coupled with the territorial disputes between the United States and Russia in the Arctic and the dispute over shipping lanes in the North Sea, the friction between the two will be more than cooperation[20]

After the Biden administration takes office, it may ban the development of offshore oil and gas in the Arctic globally, and the development of oil and gas in the Arctic will add variables. As countries around the world acquire Arctic resources through alliances, domestic legislation, and military exercises, China can and should play its due role in the ongoing international competition for resources in the Arctic[21].

Although China does not want to see the escalation of confrontation between the United States and Russia in the Arctic, the politicization of Arctic development is inevitable, and maintaining a "low conflict" in the Arctic will be a more realistic choice. As the three main factors affecting the development of Arctic energy, the three parties have different demands in the Arctic and have their own problems. In the long run, abandoning disputes, strengthening cooperation, and peacefully developing Arctic energy as an outcome is a win-win outcome.

5.2 Strive for win-win cooperation with more Arctic countries

Russia has reacted more positively to the establishment of the Polar Silk Road, and significant progress has been made in Sino-Russian Arctic energy cooperation. The U.S. Arctic region is

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[20] GUO Pei-qing, YANG Nan, On the Complicated Relationship among China, the United States, and Russia in the Arctic, *NORTHEAST ASIA FORU*, No.1, 2020

[21] Wang biao,etal. ,Military Utilization of Marine Environment in Arctic Region and Its Strategic Thinking, *Heilongjiang Science and Technology Information,*No.18,2016

rich in energy reserves, China and the United States have strong complementarity in the field of energy, and have great potential for future cooperation. If the United States and Russia are the first camp in Arctic development, then Nordic countries such as Norway, Finland, and Denmark are the second camp in Arctic development, and these countries are more inclined to attract extraterritorial powers to participate in Arctic development in order to improve their position in competition with Arctic powers[22],It is also very important to strengthen cooperation with these countries in the development of the Arctic. In 2017, President of China Xi Jinping met with leaders of seven Arctic countries and visited Alaska, showing China's concern for Arctic affairs.

The development of Arctic energy is also inseparable from China's participation, strengthen cooperation with these countries, give full play to the respective advantages of Arctic countries, and make the Arctic energy development cake bigger and better, so that most Arctic countries can enjoy the dividends of Arctic energy development, and at the same time which can avoid or reduce risks of the arctic energy development.

5.3 Strengthen cooperation with extra-regional countries of arctic

Japan, South Korea and India all have demand for energy in the Arctic, and are major buyers of the Asian LNG market, and are also important forces participating in the development of Arctic energy. Despite the competitive relationship in the energy market, China, Japan and Korea have launched a high-level dialogue on Arctic affairs to promote exchanges and cooperation among the three countries in strengthening International Cooperation in the Arctic, conducting scientific research and exploring commercial cooperation, and sharing relevant policies, practices and experiences.

First, build a community of energy destiny between China, Japan, and Korea, and lead the construction of the "Polar Silk Road". A major driving force for China, Japan and Korea to participate in the construction of the "Polar Silk Road" is the rich energy resources reserves in the Arctic region.

Therefore, if the three parties take energy cooperation as a breakthrough and cooperate with each other in energy and integrate with each other to form a community of common destiny, it will be of great significance to the construction and utilization of the "Polar Silk Road". At present, China, Japan, and Korea are all big energy importers and consumers in the forefront of the world, especially Japan and the Korea, and they are almost completely dependent on

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[22] Chongyang Institute for Financial Studies, Renmin University, Toward Europe, Northward: A Study on the Fulcrum Ports of China and Russia to Build the "Polar Silk Road" , http://www.rdcy.org/Uploads/file/20180717/20180717144042_82282.pdf，July,17,2018.

imports for oil and natural gas. In the past, Japan and Korea often resorted to exclusive competition to secure their own energy supply in order to obtain trading opportunities with energy sellers, which is likely to lead to vicious competition in Northeast Asia, where energy demand is similar. If China, Japan, and Korea fall into this vicious circle of competition in the construction of the "Polar Silk Road", they will be at a disadvantage compared with the Arctic countries, and eventually they will lose everything.

Therefore, China, Japan, and Korea can seize the major opportunity of cooperation in jointly building the "Polar Silk Road," actively cooperate in the energy field, abandon vicious competition, and strive to form a community of energy destiny between China, Japan, and Korea. Specifically, China, Japan, and Korea could establish a long-term dialogue mechanism in the field of energy under the framework of the "Polar Silk Road" to specifically explore exchanges and cooperation between the three parties in energy security, transportation, and utilization, and give full play to the complementary advantages of the three parties in energy.

For example, Japan can provide high-level energy technical assistance to China and Korea, Korea can provide high-level shipbuilding technology, and China can provide strong financial support for Japan and Korea. When the time comes, the three parties can further carry out in-depth cooperation, formulate charters or programmatic documents on energy cooperation, and finally form an energy alliance with a normative foundation[23].

Second, China, Japan and Korea can join forces, and even pull in India, another major buyer of the Asian energy market, to establish an organization similar to the Energy Consumers Alliance, and use the buyer's market power to strive for more benefits for themselves.

5.4 Strengthen technical cooperation

The ecological environment in the Arctic region is fragile, facing a huge contradiction between the intensity of development and the ecological environment, and improper development will lead to ecological disasters. Arctic development is based on "green", which is the key to Arctic governance and sustainable development of the Arctic. Technological innovations and breakthroughs are the key issues of arctic development, and the focus should be on addressing climate change, resources, environment, Arctic resource exploration and utilization technologies, and antifreeze high-tech ships. Therefore, energy cooperation under the Polar Silk Road should also be based on increasing research efforts in the fields of communication, ice breaking, antifreeze, low temperature general technology, transportation, Arctic big data, infrastructure and logistics. Chinese scientific and technological workers

[23] GAO Fei， WANG Zhi-bin， Cooperation of China, Japan and South Korea in the Construction of the "Polar Silk Road": Opportunities, Challenges and Paths， *Northeast Asia Economic Research*， No.1, 2022.

should pay attention to the use of green development technologies, and strive to contribute to the infrastructure construction and digital construction in the Arctic region and the technical demands of ice operation equipment. China and its partners can strengthen cooperation in related fields, give full play to their respective advantages, and further meet the technical demands of the "Polar Silk Road" through cooperation[24].

5.5 valuable learning opportunities for Chinese enterprises

Arctic energy development is not only a matter of technology and capital, but also a test of organizational capacity. As a latecomer to the development of Arctic energy, China is not only actively participating, but also taking advantage of the opportunity of cooperation to learn the strengths of its partners and improve China's capability of independent innovation in Arctic energy development technology. Many multinational oil and gas companies have developed in the Arctic for more than 50 years, accumulated rich technical experiences and formed advanced management models. They use the most modern drilling rigs, with advanced monitoring and automatic drilling control equipment, equipped with the latest safety and purification systems and 24/7 emergency services, focusing on the development of oil technology efficiency solutions from the perspective of simplification, standardization, and industrialization. In addition, Finland and Korea have also provided technical upgrading models for China's participation in Arctic energy development in the field of icebreakers and high-value icebreaking LNG vessels and other related equipment technology fields.

In fact, during the construction and operation of the Yamal LNG project, China has gradually acquired the technical capabilities of exploration, engineering design and module construction required for energy development in the Arctic region, and has also cultivated a large number of technical talents for Arctic gas field development. Through continuous learning and independent innovation, which can provide technical support for China's deep participation in the development of the Arctic, in order to achieve the goal of "Chinese goods are transported by Chinies Ship" in China's Arctic oil and gas development.

5.6 Actively participate in energy transition and community construction in the Arctic

The development of Arctic energy must have the concept of comprehensive and sustainable development, not only pay attention to interests and environmental protection issues, but also integrate into the development of local communities and fulfill corporate social responsibilities. The combination of oil and gas development and renewable energy transition to meet the interests and demands of local indigenous peoples can be successful in Arctic

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[24] FENG Duo, LIU Guang-dong, YU Tao, Sino-Russian Joint Construction of "Polar Silk Road": Construction Demands, Linking Paths and Cooperation Ways, *Northeast Asia Economic Research*, No.3,2022

energy development. Renewable energy resources in the Arctic region is very rich, and many places are suitable for the building of wind farms and the development of solar photovoltaic power generation. China's wind energy, solar energy and biomass energy fields have initially formed an industrial chain with a certain scale and international competitiveness. The output of solar photovoltaic modules has ranked first in the world for many years, and wind power investment and wind turbine equipment technology are also in the forefront of the world, and the international market share is gradually expanded. China's development of renewable energy in the Arctic region can not only expand the export channels of wind turbines and photovoltaic modules, but also try to help local communities solve the problem of excessive initial construction costs of renewable energy through appropriate cooperation and financing methods, to promote local energy transition and community development.

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Feb 19, 2018.

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18. GAO Fei， WANG Zhi-bin， Cooperation of China, Japan and South Korea in the Construction of the "Polar Silk Road": Opportunities, Challenges and Paths， *Northeast Asia Economic Research*， No.1, 2022

7- Hydrogen development, China, Japan, Korea

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Hydrogen energy development under the background of carbon neutralization：Experience and enlightenment of Japan, Korea and China

Abstract

To cope with the energy transition brought about by decarbonization, major countries and regions in the world have established different hydrogen development plans according to their advantages in resource endowment, and issued supporting policies. Hydrogen is particularly important in countries such as Japan, South Korea,and China, and has made positive progress currently. This paper chose these three countries for case study, introduce their hydrogen energy development strategy, compare and analyze their technical routes, and evaluate the effectiveness of support policy tools, especially fiscal and tax policy tools in solving the challenges of hydrogen production and application, and finally extract their common and different experience and challenges in the development of hydrogen energy.
Keywords: Hydrogen energy fuel vehicles green growth zero emission

Hydrogen energy materials have four advantages: no carbon pollution, high caloric value of combustion, good stability and rich application scenarios. To cope with the energy transition brought about by decarbonization, major countries and regions in the world have established different hydrogen development plans according to their advantages in resource endowment, and issued supporting policies. As of December 2022, 42 countries and regions in the world have issued clear hydrogen energy development strategies and plans, and these countries and regions account for more than 80% of the world economy[25]. The European Hydrogen Organization predicts that the global hydrogen industry will have an annual turnover of $700 billion by 2050. The Russian Ministry of Finance estimates that global annual hydrogen consumption will reach 150 million to 160 million tons in 2050. Hydrogen is particularly important in countries such as Japan, South Korea,and China, and has made positive progress currently. The three countries have formulated long-term hydrogen energy development plans and development goals at various stages, and strengthened support through legislation, loans, taxes and subsidies. This paper will chose these three countries for case study, introduce, compare and analyze their hydrogen energy and development strategy, and evaluate the effectiveness of fiscal and tax policy tools in solving the challenges of hydrogen production and application.

1. Strategic planning for hydrogen energy development

1.1 Japan

In order to solve the problems such as excessive dependence on imported fossil energy, difficulties in restarting nuclear power, and general domestic renewable energy endowment, the Japanese government attaches great importance to the development of the hydrogen energy, and has successively issued the "Japan Rejuvenation Strategy", "Energy Strategic

[25] IRENA(2019), Hydrogen: A renewable energy perspective, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Hydrogen_2019.pdf

Plan", the world's first national hydrogen strategy in 2017, the Basic Hydrogen Strategy. In the following year, Japan hosted the Hydrogen Energy Ministerial Meeting (HEM), aiming to build momentum for top-down hydrogen policies, and has since played a leading role in the transition into a global hydrogen community.

The Basic Hydrogen Strategy sets specific development goals for 2020, 2030, 2050 and beyond (Table 1). The Energy Conservation and New Energy Department of the Ministry of Economy, Trade and Industry (METI) is a dedicated hydrogen energy department of the Japanese government. In September 2019, METI issued the "Hydrogen Energy/Fuel Cell Strategy Development Roadmap", which gave the specific implementation methods and paths of the hydrogen energy strategy:

- The first stage is to create demand and accelerate the promotion and popularization of hydrogen energy transportation and civil markets by 2025.
- The second stage is to solve the supply problem, to achieve hydrogen fuel power generation by 2030 and to solve large-scale supply by expanding hydrogen energy imports;
- In the third stage, a zero-carbon hydrogen supply system will be established, and by 2040, hydrogen will be added to the traditional "electricity and heat" system to build a new secondary energy structure.

From the road map, there are three main paths for the development of hydrogen energy in Japan: to promote low-cost zero-emission hydrogen production from overseas fossil fuels using carbon capture and storage (CCS) technology or renewable energy electrolysis; then strengthen the import and domestic hydrogen transport and distribution infrastructure; and finally, to promote the large number of applications of hydrogen in various sectors such as automobiles, household cogeneration and power generation, and eventually move towards zero carbon emission hydrogen production, especially through renewable energy sources, to form zero carbon emissions throughout the life cycle. The roadmap also identifies ten strategic priority technologies in the areas of fuel cells, hydrogen supply chain and water electrolysis technology, with fuel cell technology focusing on automotive fuel cells/stationary fuel cells/auxiliary machinery and hydrogen storage related systems; Supply chain technology includes large-scale hydrogen production technology/transportation and storage technology/hydrogen power generation technology/hydrogen refueling station; Electrolysis technology, etc., includes water electrolysis technology/other industrial uses/discontinuous innovation technology.

Five years have already passed since the formulation of the Basic Hydrogen Strategy. Two epochmaking events have been experienced. The first is that, In October 2020, Japan issued the "Green Growth Strategy", announcing that it will achieve carbon neutrality by 2050, and the layout of 14 "carbon neutral" key industries, including the hydrogen energy industry(Figure 1). The Environment Innovation Strategy, rolled out in January 2020, has included hydrogen in technological innovation efforts to achieve carbon neutrality target. The strategy builds on the "Hydrogen Fuel Cell Technology Development Strategy" to expand the use of hydrogen fuel to ships, aviation and other transportation fields, while clearly focusing on building a global supply chain that can produce and transport hydrogen in large quantities. And then Japan revised the sixth Strategic Energy Plan, and envisions the power mix where hydrogen and ammonia will account for about 1% in FY 2030. The plan recharacterized hydrogen and ammonia as future energy fuel and carrier that also play a role in the power supply, rather than just new energy. The second is the conflict between Russia and Ukraine, which has significantly enhanced Japan's awareness of energy security and energy transformation. Green

Transformation (GX) initiatives and upfront investments worth 20 trillion yen were issued to bring about a shift from an industrial structure centered on fossil energy to one centered on clean energy.

Figure 1 14 key green sectors in Japan's green growth strategy

Source: the goverment of Japan website, www.japan.go.jp

Table 1 Brief table of Japan's basic hydrogen energy strategy scenarios

	By 2020	By 2030	2050 and beyond
supply	Integrated hydrogen production from fossil energy by-products and natural gas, development and mass production demonstration of hydrogen energy supply chain	Renewable energy to produce hydrogen, to develop the international hydrogen supply chain	Zero carbon emission hydrogen production (CCUS, hydrogen production from renewable sources)
yield	Up to 4000 tons/year	Form a commercial supply capacity of 300,000 tons/year	5 million tons/year to more than 10 million tons/year, mainly used for hydrogen power generation
cost	$10 / kg	Reduced by a third to $3 / kg	1/5 less, to $2 / kg
Fuel power station	Research and development stage: Hydrogen power generation demonstration, construction Environmental value assessment system	1 million kilowatts 17 yen/KWH	30 million kilowatts 12 yen/KWH, replacing natural gas power generation
Hydrogen refueling stations and cars	160 hydrogen refueling stations 40,000 fuel cell vehicles Fuel cell buses 100 500 fuel cell forklifts	900 hydrogen refueling stations 800,000 fuel cell vehicles 1200 fuel cell buses 10,000 fuel cell forklifts	Refueling stations replace refueling stations Fuel cell vehicles replace conventional gasoline-fueled vehicles Introduction of large fuel cell vehicles
Domestic fuel cell	Distributed fuel cells for domestic combined heat and power 1.4 million households	Up to 5.3 million households(10% of all households)	Home combined heat and power distributed fuel cells replace traditional residential energy systems

Source： METI,. Basic hydrogen strategy. https://www.meti.go.jp/english/press/2017/pdf/1226_003a.pdf。

1.2 South Korea

In October 2003, the Korean government established the Hydrogen Energy Research and Development Center (HERC) under the leadership of the Ministry of Science and Technology (MOST) to conduct research on key technologies for hydrogen energy production. In 2018, the South Korean government issued the "Strategic Investment Plan for Innovation and Development", which listed the hydrogen energy industry as one of the three strategic investment directions, and planned to invest 2.5 trillion won in the next five years to support the development of hydrogen energy.

In January 2019, South Korea officially released the "Hydrogen Economy Roadmap", which divides the development of hydrogen energy in South Korea into three stage[26]s:

- 2018-2022 for hydrogen energy legislation, technology research and development and infrastructure investment preparation period
- 2022-2030 for hydrogen energy promotion and development period
- 2030-2040 for hydrogen energy society building period.

Korea plans to source a third of its energy from hydrogen by 2050, making the gas the largest single source of energy nationally. The ultimate goal is to reach 5.26 million tons of hydrogen supply by 2040, produce 6.2 million hydrogen fuel cell vehicles (including 3.3 million exports), and build 1,200. In October 2019, the South Korean government announced three key strategies to accelerate the development of the automotive industry and set out four specific action plans seeking to become a leader in the green automotive industry, including: establishing a total of 660 hydrogen refueling stations by 2030 and 15,000 charging stations by 2025. Drivers will be able to use hydrogen refueling stations within 20 days to 2030 within minutes of major cities, or within 75 kilometers of motorways.

Table 2 Korea's hydrogen economy development roadmap

	By 2022	2022-2030	By 2040
supply	"By-product hydrogen" and "hydrogen extraction" are the main ways to prepare hydrogen Promote the initial application of green hydrogen energy	Hydrogen production from natural gas Cultivate 500 hydrogen energy enterprises	Establish overseas production bases, stabilize hydrogen production and imports, Hydrogen-powered vehicles and fuel cells occupy the first place in the global market share
Hydrogen production	Promote the operation of green hydrogen energy	Build a 100MW green hydrogen energy mass production system	Cultivate 1,000 hydrogen energy enterprises by 2040 Form a commercial supply capacity of 5.26 million tons/year
cost	From the current $5.7 to $7.1 / kg, it will be reduced to $4.8 / kg by 2022		Hydrogen production costs 1/3 down Price dropped to 3,000 won/kg
Hydrogen power generation	Tradable renewable energy certificates South Korea's total hydrogen fuel cell power generation should reach 1 GW by 2022	By 2025, the price of hydrogen fuel cell power generation will be reduced by 50%, and the price of small and medium-sized liquefied natural gas power generation will be equal。	Popularize hydrogen fuel cell installations for power generation, bringing their total generating capacity to 15 GW Popularize hydrogen fuel cell power generation devices for homes and buildings, so that their total power generation capacity can reach 2.1 GW
Hydrogen refueling stations and cars	Hydrogen refueling stations increased to 310 The number of hydrogen fuel cell cars will increase to 81,000 in 2022 The number of fuel cell buses increase to 2,000 in 2022 Hydrogen fuel cell trucks promoted to garbage collection trucks, sweepers, and water sprinklers by 2021	By 2025, annual production of hydrogen fuel cell cars 100,000 units, and the price lowered to 30 million won The number of hydrogen-powered vehicles reach 1.8 million To popularize 850,000 hydrogen vehicles by 2030 Hydrogen refueling stations were expanded to 660	1,200 hydrogen refueling stations will be built. 6.2 million hydrogen fuel cell vehicles 40,000 fuel cell buses 80,000 hydrogen fuel cell taxis 30,000 hydrogen fuel cell cards 40% of the country's cities will become hydrogen cities
Fuel cell	From 307.6MW in 2018 to 1.5GW(domestic 1GW, 2022) Achieve domestic self-sufficiency of all core materials by 2022	Converting conventional buses, delivery trucks and construction machinery to run on hydrogen fuel cells.	Fuel cell production expanded to 15GW Popularize hydrogen fuel cell devices for power generation, home use and construction.

[26] 'Hydrogen Economy Roadmap of Korea', Ministry of Trade, Industry and Energy (MTIE), January 2019

Source： Ministry of Trade, Industry and Energy (MTIE), Korea

1.3 China

Since 2006, China has included hydrogen energy and fuel cells in the development plan of the National Medium and Long-term Scientific and Technological Development Plan (2006-2020), and a series of policies, plans and subsidies have been issued, showing the importance of hydrogen energy and fuel cell development. Since 2019, provincial/municipal and local governments have issued hydrogen energy plans, most of which refer to stage development goals, including industrial output value, the number of vehicles put into use, hydrogen refueling station construction, and enterprise cultivation.

In March 2022, China officially issued the Medium and Long-Term Plan for the Development of the Hydrogen Energy Industry (2021-2035)[27], which clarified that hydrogen energy is an integral part of China's green and low-carbon energy system and an important way to achieve the "dual-carbon" goal, highlighting the strengthening of the construction of the hydrogen energy industry innovation system, accelerating the breakthrough of the bottleneck of hydrogen energy core technologies and key materials, and accelerating the industrial upgrading and expansion. Previously, most of China's hydrogen energy industrial policies focused on the transportation sector, especially the application of fuel cell vehicles, the Plan emphasizes the multiple applications of hydrogen energy in the field of industry and energy (including hydrogen energy, electricity and heat), and sets three stages of development goals for green hydrogen development:

- By 2025, a hydrogen energy supply system based on industrial by-production of hydrogen and nearby utilization of hydrogen production from renewable energy sources will be established. The goal is to produce 50,000 hydrogen fuel cell vehicles (HFCV) and build a sufficient number of hydrogen refueling stations. Renewable energy hydrogen production capacity reaches 100,000 to 200,000 tons/year, and carbon dioxide emissions are reduced by 1 to 2 million tons/year.
- By 2030, hydrogen production from renewable energy sources will be widely used, which will strongly support the realization of decarbonization goals, and focus on the development of low-carbon travel and industrial carbon reduction.
- By 2035, the proportion of hydrogen production from renewable energy sources in terminal energy consumption will increase significantly, which will play an important supporting role in the development of green energy transformation.

In June 2023, the National Energy Administration issued the "Blue Book on the Development of New Power Systems", proposing a "three-step" development path for new power systems, with special emphasis on hydrogen energy taking on heavy responsibilities in the path:

- By 2030, new energy will gradually become the main increase in power generation. The installed capacity accounted for more than 40%, and the power generation accounted for more than 20%.
- By 2045, the advanced electrification technology and equipment level in all fields and industries will be further improved, and new energy and hydrogen fuel cell

[27] The National Development and Reform Commission, the National Energy Administration (2022), the hydrogen industry long-term development planning (2021-2035) ". https://www.ndrc.gov.cn/xxgk/zcfb/ghwb/202203/t20220323_1320038.html?code=&state=123

vehicles will replace traditional energy vehicles in the transportation sector. New energy storage technology routes have been diversified, and breakthroughs have been made in long-term energy storage technologies of more than 10 hours, represented by mechanical energy storage, thermal energy storage, and hydrogen energy.

- By 2060, new technologies, new business forms and new models such as green hydrogen production, green methane production and green ammonia production in the fields of transportation and chemical industry will be widely promoted. Multiple types of energy storage, such as electricity storage, heat storage, gas storage and hydrogen storage, covering the whole cycle, achieve dynamic balance of the power system, and greatly improve the flexibility of the energy system operation.

2. the favorable policies for hydrogen energy development

Financial and policy support is an important driving force for the rapid development of the hydrogen industry. Japan and China's support for the hydrogen industry basically covers the whole industrial chain, focusing on four aspects: hydrogen and fuel cells, household fuel cell systems, fuel cell vehicles, and hydrogen fueling stations. In order to achieve these goals, both governments have made full use of fiscal and financial policy tools to vigorously promote hydrogen energy development, including technology research and development grants, commercialization subsidies, tax incentives, and encouraging private sector participation.

2.1 Japan

For now, Japan is more supportive of hydrogen and fuel cells than any other country. In the early stage of hydrogen energy development (2010-2015), the Japanese government invested 52.98 billion yen in the field of hydrogen energy. For the whole of 2017, the Japanese government provided a total of more than 39 billion yen in subsidies for hydrogen energy and fuel cells, and Japan's fiscal budget in this field in 2018 is as high as 30 billion yen.

To Support and subsidize domestic technology research and development, from 2013 to 2018, the Ministry of Economy, Trade and Industry (METI), the Ministry of Environment (MoE), and the Cabinet funded a total of $1.458 billion in hydrogen research and development and subsidies, including $1.112 billion for the Ministry of Economy, Industry and Trade, $195 million for the Ministry of Environment, and $150 million for the Cabinet (Table 3). In addition, METI and MoE have allocated approximately $150 million per year for CCS research and development to achieve zero emissions in hydrogen production[28]. In 2019, Japan allocated a total budget of 63 billion yen to promote the practical realization and efficiency improvement of hydrogen and fuel cell-related technologies.

Japan also provides R&D funds and subsidies for overseas hydrogen technology demonstration projects. Through NEDO, the Japanese government provides research and development funds and subsidies for Japan's overseas hydrogen technology demonstration projects. In the FY2021-2022 budget, METI allocated 4.75 billion yen (about $45.88 million) for liquid hydrogen transport between Australia and Japan, a renewable electricity hydrogen production pilot with the Norwegian government, an international hydrogen transport demonstration project from Brunei to Japan, and a hydrogen energy cooperation with Saudi

[28] International Energy Agency(IEA), 2020, CCUS in the Clean Energy Transition: The New Era of CCUS, https://www.iea.org/reports/ccus-in-clean-energy-transitions/a-new-era-for-ccus

Arabia. After the demonstration phase proves commercial viability, the project can apply for funding from the Japan Bank for International Cooperation (JBIC) and insurance from the state-run Japan Export and Investment Insurance Organization (NEXI) to reduce the risk of hydrogen research and development and application overseas. In 2020, a 2-trillion-yen Green Innovation Fund (GI Fund), which was set up in conjunction with the Carbon Neutrality Declaration, allocated approximately 800 billion yen to hydrogen-related technologies to finance technology development and demonstration efforts toward commercialization. The tasks of large-scale and resilient hydrogen and ammonia supply chains and support for supply infrastructure development will soon be placed on the agenda based on its latest GX initiatives.

Subsidies and tax incentives are provided for the construction of fuel cell and hydrogenation infrastructure. Japan mainly through high subsidies and joint development of two ways to speed up the strategic layout of hydrogen refueling stations. With the breakthrough of key fuel cell technologies, the Japanese government began to give continuous comprehensive subsidies to the construction of fuel cells and hydrogenation infrastructure for vehicles, households, commercial and industrial use, and set up subsidies for clean energy vehicles and fuel cell vehicle hydrogenation station construction subsidies.

There are also subsidies and tax incentives for hydrogen vehicles and home fuel cells. In order to expand the use of hydrogen in various industries, in addition to transportation, industrial and construction industries, power generation and commercial applications of residential cogeneration have also become key targets for hydrogen energy development in Japan. At present, Japan leads the world in the commercial application of fuel cells, mainly domestic fuel cell cogeneration fixed power stations, business/industrial fuel cells and fuel cell vehicles.

To promote the spread of hydrogen energy, the Japanese government offers subsidies to every consumer who buys a fuel cell vehicle. Hydrogen fuel cell vehicles are more expensive than traditional cars. In view of the manufacturing cost of hydrogen fuel vehicles, Japanese companies such as Toyota have reduced the use of platinum by 90% through patented technology, greatly reducing the cost of hydrogen fuel vehicles. The commercialization of fuel cell vehicles in Japan has been more successful mainly Toyota and Honda. Toyota's current hydrogen-powered model, the Mirai, sells for just Rmb260,000 after subsidies in Japan, a modest price relative to Japanese incomes.

Table 3 Public budget and subsidies for hydrogen energy in Japan 2013-2018 (Hundreds of millions of dollars)

	Budget type	Field	2013	2014	2015	2016	2017	2018	Total
ＭＥＴＩ	R&D	production	—	０．１	１４	8	１２	—	３４
ＭＥＴＩ	R&D	Supply chain	１８	４４	１０７	２５	４２	８５	３２１
Cabinet	R&D	Supply chain	—	３０	３０	３２	３３	２６	１５０
ＭＥＴＩ	R&D	Fuel cell	４０	—	—	３３	２８	２６	１２７
ＭＥＴＩ	R&D/Subsidies	cogeneration	１５６	１５３	１３５	８６	８４	８０	３８５

METI	R&D	Charging station	—	29	37	—	—	22	88
METI/MoE	subsidy	Charging station	41	65	123	114	90	106	539
METI	subsidy	CARS	—	—	—	123	111	117	351
METI	R&D	Generate electricity	63	56	—	108	119	129	475
METI			106	149	107	237	241	272	1112
MoE			—	—	24	59	49	63	195
cabinet			—	30	30	32	33	26	150
total			106	178	161	327	324	361	1458

Source：based on the information from METI, MoE and the Cabinet of Janpan

Japan adopts consortium-industry alliance to cultivate hydrogen energy industry. Led by the government-affiliated NEDO, Toshiba Energy, Tohoku Electric Power Company and Iwatani Industrial Co., with their different strengths, have teamed up to invest, not only to share the risks of the project, but also to pave the way for the plant's operation, electricity consumption and supply, and transportation and sales of hydrogen energy after the plant is officially commissioned. The downstream of hydrogen is represented by Toyota, and the upstream and downstream of the industrial chain, including enterprises in various aspects of hydrogen supply, transportation, consumption and terminals, are jointly developed in an industrial alliance. Japan has also established special professional associations to promote the upgrading of industrial technology, the improvement of standards and the development of commercialization, mainly including the Fuel Cell Commercialization Promotion Council (FCCJ), the Hydrogen Supply and Utilization Technology Association (HySUT), and the Japan Hydrogen Refuelling Station Network Contract Society (JHyM), which have become the channels of communication and interaction between Japanese industry, government and academia.

Japan attaches great importance to international cooperation on hydrogen energy. Japan proposed to build a full supply chain technology from hydrogen manufacturing to storage, transportation and utilization, and package it to the world, leading the development of international standards. In October 2018, Japan issued the "Tokyo Declaration" to coordinate national hydrogen energy development initiatives and standards, share information on hydrogen energy safety and supply chain, promote international joint research and development, and carry out education and promotion activities to increase public acceptance of hydrogen energy. During the G20 Summit hosted by Japan in 2019, the development of hydrogen energy was included in the agenda of the summit. Japan and the International Energy Agency (IEA) released a Hydrogen report and a joint statement with the US Department of Energy (DOE) and the European Commission's Director-General for Energy (ENER), and established the world's first national hydrogen energy and fuel cell technology cooperation Alliance, committing to cooperate on issues such as product specifications for hydrogen fuel cell vehicles and safety standards for hydrogen refueling stations. The direction of cooperation is modeled on the Tokyo Declaration.

2.2 South Korea

The South Korean government supports research and development, hydrogen fuel cell vehicles, hydrogen refueling stations, hydrogen power generation, hydrogen production, storage and transportation, and safety regulation through financial initiatives such as subsidies, tax breaks, price concessions, the establishment of funds, and the mobilization of private investment. In 2018, South Korea announced that it would invest 2.6 trillion won in the next five years to accelerate the development of the hydrogen fuel cell vehicle ecosystem and increase the number of hydrogen refueling stations to help the early popularization of hydrogen fuel cell vehicles.

For supporting technology development and localization, from 2015 to 2018, the Korean government invested 28.2 billion, 28.1 billion, 25.3 billion, 22.4 billion and 21.5 billion won in research and development of fuel cells, respectively. Within a year of the release of the hydrogen economy roadmap in 2019, the South Korean government invested 370 billion won in core technology research and development. In February 2020, the Ministry of Trade, Industry and Energy of Korea issued the "2020 New Energy and renewable Energy Technology Development and Utilization and Action Plan" to further increase research and development support.

To give price concessions to fuel cell equipment enterprises and natural gas hydrogen production enterprises, Korea has set a special fee system and lowered the price of natural gas by eliminating import surcharges, aiming to achieve the goal of achieving a market price of hydrogen energy below 6,000 won by 2030, so as to ensure that the profit of the main hydrogenation station companies is 3,000 won /kg.

Korea government also provides subsidies for the construction and operation of hydrogen refueling stations and promote the construction of hydrogen refueling stations. In South Korea, only new hydrogen refueling stations can enjoy subsidies, and the amount is 50%. To accelerate infrastructure construction, the South Korean government provides a construction subsidy of 3 billion won for each hydrogen refueling station, as well as an operating subsidy of 66% of the previous year's operating costs. From 2021 onwards, all additional equipment investment in hydrogen station expansion projects will also receive a 50% construction subsidy. It also waived 50% of the lease fee of state-owned land for hydrogen refueling stations, and used policy capital investment to encourage financial investment or long-term low-interest financing for private hydrogen refueling station construction companies.

In order to reduce the price of expensive electric vehicles, Korea iintroduced a subsidy restriction policy. On January 21, 2021, the Ministry of Finance of South Korea announced the "Comprehensive revision of pollution-free Vehicle subsidies" to increase support for the popularization of non-luxury electric vehicles and hydrogen fuel vehicles, and hybrid vehicles, electric locomotives, electric vehicles and hydrogen fuel vehicles are included in the scope of subsidies. Electric cars priced below 60 million won will be fully subsidized. The subsidy range of 60 million to 90 million won (340,000 to 520,000 won) is 50 percent. Electric vehicles costing more than 90 million won, such as the Tesla Model X and Audi e-tron, will not be eligible. In addition to the adjustment of the subsidy amount, 31,500 electric vehicle charging piles and 54 hydrogen refueling stations are planned to be built.

The private sector has played an important role in promoting investment in emerging industries. To establish a hydrogen economy development fund to mobilize private investment, in the fiscal year 2021, the South Korean government spent nearly $702 million on hydrogen projects, with an additional $2.3 billion committed to establishing a public-private partnership for the hydrogen fuel cell electric vehicle (FCEV) market by the end of

2022[29]. And then five corporate groups jointly announced plans to invest over $38 billion in the hydrogen economy by 2030. In 2020, South Korea announced the establishment of a 34 billion won ($28 million) Hydrogen Economy Development Fund, which will focus on supporting companies in five key areas: hydrogen flow, fuel cells, liquid hydrogen, hydrogen charging stations, and hydroelectrolysis. At the same time, local governments and public institutions will give priority to purchase the products of these enterprises to help enterprises improve their competitiveness. In March 2021, SK, Hyundai Motor, PoSCO, Hanwha and Hyosung announced that they will invest 43 trillion won (about 247.8 billion yuan) over the next 20 years (by 2030) to develop hydrogen economy industries such as hydrogen energy production, storage, transportation and application[30].

To promote the application of Hydrogen Energy, Korea has launched the Hydrogen Energy City plan, where hydrogen technology has been adopted in residential and transportation areas in three selected cities. Government provided a budget of about 800 billion won for hydrogen energy mobility, hydrogen energy supply infrastructure, hydrogen energy core technology R&D, and hydrogen energy demonstration cities from 2021. The three cities will each invest 29 billion won ($25 million), half of which will be paid by local governments.

Korea government attaches great importance to industrial agglomeration and international cooperation. Hydrogen Fusion Alliance Bureau (H2KOREA) is a government-established platform to promote the use of hydrogen as a new energy source. The Korea Gas Corporation (KOGAS) is the agency established to promote hydrogen distribution, and the Korea Gas Safety Corporation is the agency responsible for hydrogen safety in Korea. On October 15, 2020, Hyundai Motor signed a memorandum of understanding with government agencies, energy companies and other local companies to establish a dedicated company, Kohygen (Korea Hydrogen Energy Network). In February 2020, the organization representing South Korea's public/private hydrogen fuel cell industry also signed a memorandum of understanding with Hydrogen Europe and the Hydrogen Polymerization Alliance (H2KOREA) to promote bilateral cooperation in developing the hydrogen industry and strengthen international hydrogen industry cooperation.

2.3 China

In order to promote the development of the hydrogen energy industry, China's National Development and Reform Commission, the Ministry of Science and Technology and other key departments have issued a series of targeted policies, and allocated special funds to support hydrogen energy innovation projects, personnel training and laboratory construction. Up to now, China's hydrogen energy policy can be divided into three stages: the initial stage, the promotion stage and the rapid development stage. The industrial policies and main characteristics of each stage are as follows:

- The initial stage (2006-2015) mainly supports the research and development of cutting-edge technologies such as hydrogen fuel cells;
- The promotion stage (2016-2018) mainly supports the research and development of the whole industry chain from fuel cell extension to manufacturing, storage and

[29] Charles Lee, 'S Korea to provide 27.9 mil mt/year of 'clean hydrogen' by 2050, S&P Global Market Intelligence, 26 November 2021

[30] Andersson, J., and Gronkvist, S., Large-scale Hydrogen Storage 2019, Hydrogen Energy International, 44:23:11901-19. Website: https://doi.org/10.1016/j.ijhydene.2019.03.063

transportation;

- The rapid development stage (from 2019 to the present) clearly lists hydrogen energy as an important area of cutting-edge science and technology and industrial change, and focuses on supporting diversified demonstration applications of hydrogen energy.

Funding for basic research on hydrogen energy in China comes from a variety of sources, including government subsidies, corporate investment and international cooperation. During the "13th Five-Year Plan" period, China listed hydrogen energy technology as a national strategic emerging industry, providing strong policy support for basic research on hydrogen energy.

According to the latest data on the NDRC website, the amount of hydrogen energy subsidies ranges from hundreds of thousands to tens of thousands, and the types of support include: industrial investment, such as newly introduced hydrogen energy industry projects, key projects approved by the government; Demonstration applications, such as hydrogen fuel electric vehicles, hydrogen fuel cells, etc. Science and technology research and development, such as school-enterprise cooperation, hydrogen industry technological transformation investment projects, social research and development institutions; Financial services, such as related hydrogen energy funds, hydrogen energy industry project financing, hydrogen energy enterprise listing, etc.; Talent education, such as talent settlement, science and innovation platform, professional Settings, etc.; Publicity and promotion, such as hydrogen energy enterprises special industrial chain supply and demand docking, scene docking activities, hydrogen energy enterprises to promote products.

The Chinese government also supports hydrogen energy enterprises to increase scientific research investment and industrialization through subsidies. If the investment in R&D and production equipment reaches more than 10 million yuan , the maximum financial support will be 20 million yuan; For the products listed in the key parts catalog of the national fuel cell vehicle demonstration city cluster, additional incentives will be given in accordance with 30% of the national incentives; In order to encourage the development of enterprises, the newly admitted enterprises will be given a maximum of 10 million yuan of financial support for three consecutive years. Companies can also get subsidies of up to 5 million yuan if they apply for bank loans or financial leases. In order to support the coordinated development of the upstream and downstream of the industrial chain, China provides financial support of up to 10 million yuan for enterprises that purchase fuel cell vehicle parts and components; Enterprises purchasing fuel cell key parts and equipment for demonstration scenarios such as hydrogen energy comprehensive application will be given financial support of up to 10 million yuan. During the period from 2018 to 2020, a total of 2,317 fuel cell vehicles from 10 car companies have received state financial subsidies, with a cumulative amount of 1,024.1 billion yuan, and the average amount of subsidies available for each vehicle is 442,200 yuan.

Since the announcement of the hydrogen energy development plan in 2023, the governments of most provinces and urban agglomerations in China have successively issued key hydrogen energy projects in 2023, of which 76 projects have an investment of 138.583 billion, and the total investment of all projects is estimated to exceed 150 billion. 23% of the projects are planned to be commissioned by 2023, with hydrogen and fuel cell and parts production projects ranking the top two, and hydrogen production by by-product and natural gas are the main hydrogen projects in production. The production capacity of fuel cell systems on a public scale is 13,000 sets. Hydrogen production projects, green hydrogen projects accounted for 55.56%, 12 projects have announced green hydrogen capacity, 12 green hydrogen projects fully put into operation capacity of up to 195,100 Nm^3/h, conservative estimates that all green hydrogen projects will be the birth of more than 1GW of electrolytic cell demand.

The Chinese government has launched fuel cell vehicle pilots in five city clusters, and the incentive measures cover the entire value chain of fuel cell vehicles, including fuel cell vehicle demonstration applications, hydrogen fuel cell key components and hydrogen energy supply.

China has also actively participated in international hydrogen energy cooperation, carrying out cooperation projects with foreign enterprises and research institutions to jointly promote the innovative application of hydrogen energy in transportation, industry and other fields. Through international cooperation, a large number of foreign advanced hydrogen technology, equipment and experience have been introduced, which has effectively promoted the development and competitiveness of the hydrogen energy industry.

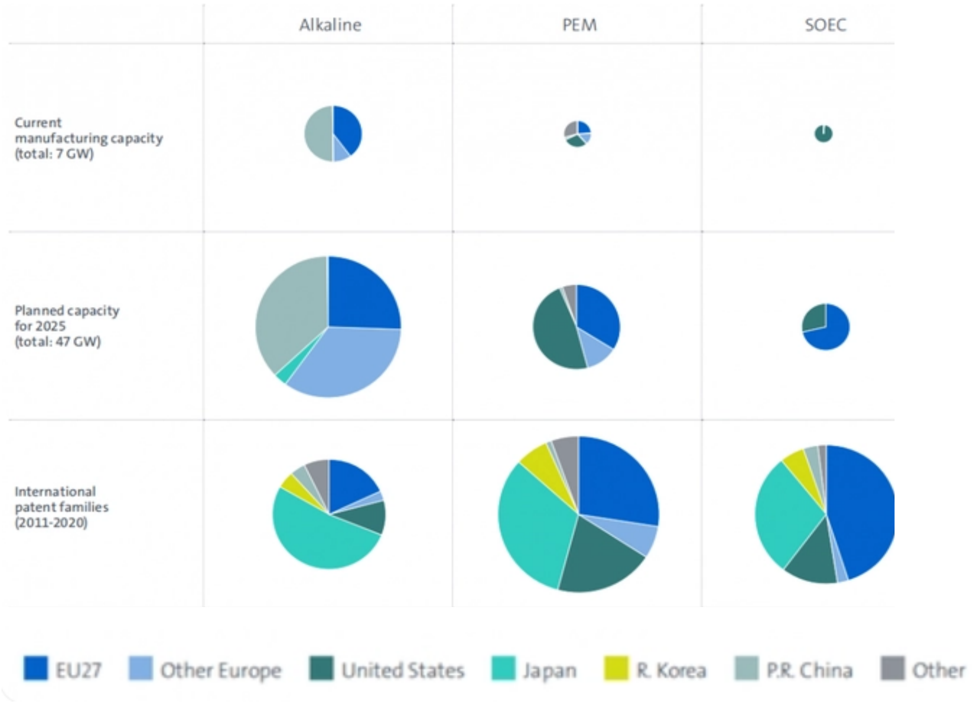
3. Comparison of hydrogen energy development strategies and policies among China, Japan and South Korea

3.1 Different development stages and technology roadmaps

Japan and South Korea are ahead of China in the hydrogen industry. Since 2001, the Japanese government has begun to promote the development of hydrogen technology, and has invested a lot of policy resources and financial support. Japanese companies have a number of core patents in fuel cells, hydrogen production, storage and refueling, and have high technical barriers. South Korea established the Hydrogen Energy Research and Development Center (HERC) in 2003, and officially released the "Hydrogen Energy Economic Development Roadmap 2040" in 2019, investing 2.5 trillion won to support the development of hydrogen energy in South Korea in the next five years. At present, Japan and South Korea have a number of internationally competitive enterprises in all aspects of the hydrogen energy industry chain, such as IHI, Sumitomo, Hyundai, Hanwha, Iwatani, NGK, Panasonic, SK, Hyosung, etc. China's hydrogen energy development started late, although in recent years, the Chinese government's attention to the hydrogen energy industry has been increasing, and some breakthroughs have been made in key technologies such as fuel cells and hydrogen production, but there are still shortcomings in some core technologies. There are also shortcomings in some links of the industrial chain, such as cost problems in hydrogen production links and materials and equipment problems in fuel cells.

Hydrogen production technology in China is also very different from that in Japan and South Korea. As the first country to introduce hydrogen energy policy, Japan is more mature than China in technology, especially in the aspect of hydrogen production by electrolytic water. There are three technical routes for hydrogen production by electrolytic water: alkaline electrolytic water (AWE), proton exchange membrane (PEM) and electrolytic water and solid oxide electrolytic water (SOEC) . In terms of the latest report of IEA(Figure 2), EU countries cover 28% of the total IPF (11% from Germany and 6% from France) and show technological advantages in three technical areas of the hydrogen value chain (hydrogen production, storage and transportation, end-use applications), and also make significant contributions in PEM and alkaline technologies. Between 2011 and 2020, Japan obtained several patents in the most advanced alkaline technology and the more cutting-edge PEM technology, covering 24% of IPF. China's patent contribution in hydrogen production is 5%, the patent contribution in storage and transportation is 3%, and the patent contribution in terminal applications is 3%. There is still a big gap between China and Japan in the high-speed development of proton exchange membrane (PEM) water electrolysis technology and catalysts. Chinese companies are particularly focused on cheaper and technically mature alkaline water electrolysis technology, little to PEM and electrolytic cell technology. However, China have high patent growth rates(Figure 2). Between 2011 and 2020, the average annual growth rate will be 15.2% and 12.2% respectively. China has the technological, geographical and market advantages in the development of green electrolysis water to produce green hydrogen by use of the huge amount of wind abandonment in northwest China to electrolysis water to produce green hydrogen[31]. The world's largest photovoltaic hydrogen production project, Sinopec Xinjiang Kuqa Green hydrogen demonstration project, has now entered the final construction sprint stage. While Japan and Korea's wind potential is very limited, and green hydrogen production is hard to increase based on its nature source. In 2021, water electrolysis accounted for about 49% of hydrogen production in Japan (mainly for brine electrolysis), followed by industrial by-product hydrogen (17.8%), natural gas hydrogen production (9.2%), coal hydrogen production (7.6%), other alcohols and commercial exhaust hydrogen production (16.3%). In 2021, hydrogen production in South Korea from natural gas accounted for 32.7%, hydrogen production from coal accounted for 29.4%, industrial by-product hydrogen accounted for 23.6%, hydrogen production from other alcohols and commercial exhaust accounted for about 11.4%, and hydrogen production from electrolytic water accounted for about 3%.

Figure 2 Origins of inventions related to electrolysers and manufacturing capacity



Source: IEA 2023, "Hydrogen patents for a clean energy future: Global Trends Building on the Hydrogen Value Chain)

China, Japan and South Korea have adopted different technological routes for fuel vehicles. Japan and South Korea have strong technical strength in hydrogen fuel cell systems, hydrogen storage technology, and hydrogen preparation technology, and Japan and South Korea have chosen the hydrogen fuel cell passenger car route. In terms of the development of

[31] China Hydrogen Energy Alliance Research Institute, 2023, The key to a new era of green hydrogen: China's 2030 "Renewable Hydrogen 100" development roadmap, http://www.cpuh2.com/UploadFiles/bg2.pdf

new energy vehicles, China focuses on the level of electric vehicles, fuel cell vehicles have two main technical routes, hydrogen fuel cell and hydrogen internal combustion engine, and the two technical routes have their own advantages for different application scenarios. Different from the development route of fuel cell production enterprises such as Toyota and Hyundai abroad, China's hydrogen fuel cell vehicle enterprises are mainly distributed in the field of commercial vehicles, especially public transportation. Passenger cars are still in the demonstration phase, and China aims to have one million hydrogen fuel cell vehicles on the road by 2035.

The way that industries are cultivated is also different. China has adopted a state-driven approach. The current layout of China's hydrogen energy industry has two major characteristics. First, the connotation of hydrogen energy industry is more abundant, and the hydrogen energy industry is developing in the direction of hydrogen power, green hydrogen industry and hydrogen energy storage. A number of energy central enterprises have become the main force in the construction of 10,000-ton green hydrogen chemical projects. Second, the hydrogen energy industry has shown a trend of regional development according to local conditions. The western region, which is rich in renewable energy, takes green hydrogen as its source, and focuses on developing green hydrogen chemical industry and hydrogen metallurgy. The eastern region with rich application scenarios focuses on the development of hydrogen energy transportation applications; In remote areas such as islands and border defense, explore the construction of distributed power-hydrogen coupled clean energy supply system. In Japan and South Korea, hydrogen energy is mainly promoted by a few giant companies, such as Honda, Toyota and Nissan. Japanese government policy is closely tied to the direction of these companies.

3.2 Shared development experiences

Goverment's strategic planning and policy support are the key to promoting the development of hydrogen energy. The early stage of hydrogen energy development especially needs to be led by the government to come up with national strategic plans to avoid wasting resources. All three governments have promoted substantial progress in the hydrogen industry through strategic leadership, legislative support, technological roadmap planning, and continued investment. The government also supports technology development, talent cultivation and international cooperation related to hydrogen business through subsidies or loans, and promotes the implementation of the hydrogen economy, standardization of hydrogen-related products, and development of overseas markets by providing administrative and financial support to hydrogen energy specialized companies.

Further, technology development is the core of hydrogen energy. Japan and South Korea and other developed economies of the hydrogen energy industry is relatively mature, especially Japan, has a strong technical reserve capacity, the number of hydrogen and fuel cell technology patents first in the world, occupied the international hydrogen energy industry key technology commanding heights, in the establishment of international trade in hydrogen energy, promote the construction of international standards for hydrogen energy system also has a leading advantage. China has stepped up research and development efforts in recent years, and has made certain progress in fuel cell technology and hydrogen energy storage.

Fiscal and tax policies play a key role in the cost reduction and market promotion of hydrogen energy and fuel cells. Government research and development support has also played an important role in leading social capital, prompting companies to invest several times more than the government in hydrogen and fuel cell technology research and development. The experience of Japan and South Korea shows that the government subsidy policy has the most significant effect on the downstream terminal applications of the hydrogen energy industry, especially the application of hydrogen fuel cells in the field of transportation. With the strong support of the government, from 2000 to 2018, Hyundai Motor developed more than 8 hydrogen fuel cell models, and the domestic production rate of hydrogen fuel cell vehicle parts reached 98%, basically achieving self-sufficiency. The cost of modern fuel cell system is reduced to about 1000 yuan /kW, the factory price of NEXO is less than 600,000 yuan, the government subsidy is 50%, the actual price paid by consumers is less than 300,000 yuan, and the fuel cell driver buys the car for free hydrogenation in the first half year, so the market purchase enthusiasm is relatively high.

3. Shared challenges facing the future of Hydrogen

The first challenge is that the technology in the field of hydrogen energy is more mature, while the cost is still high, and more than 50% of the cost is "paid (subsidized)" by the government. The fuel cell technology in the world has no new major breakthrough. Many hydrogen technologies are still in the demonstration stage, and the future is uncertain. Hydrogen power generation technology is still in the early stage of commercialization, hydrogen energy production, storage, transportation and other supply chains have not been established, hydrogen supply infrastructure is weak. Costs are reflected in preparation and production, storage and transportation. For example, when estimating the cost of producing hydrogen from natural gas, the following main factors need to be considered: Raw material cost, such as the price of natural gas as a raw material for hydrogen production; the price of electricity in the hydrogen production process; the equipment and operating costs; the Carbon capture and Utilization Costs, and specific equipment and technical in support of the transportation and storage of hydrogen.

The second challenge is about the technical standards of hydrogen energy. There are few technical standards involving hydrogen quality, storage and transportation, hydrogen refueling stations and safety. In the field of renewable energy hydrogen production, liquid hydrogen storage, industrial green hydrogen and other new hydrogen technology, equipment and production operations, sound international, national or industry standards haven't been set up to regulate the healthy development of the hydrogen energy industry market[32].

Weak infrastructure is the a big challenge. Hydrogen energy is an emerging energy, and at present, all countries lack the overall layout of corresponding infrastructure, and support facilities such as hydrogen refueling stations, hydrogen transmission pipelines, and industrial by-product hydrogen purification systems are seriously insufficient. Hydrogen refueling station is the most direct bottleneck in the development of fuel cell vehicles. The infrastructure required for the operation of fuel cell vehicles involves hydrogen production, storage and transportation, and refueling. The investment cost of hydrogen refueling station is 1.5-2.5 million US dollars, and its construction cost is mainly composed of core equipment procurement costs, equipment installation costs, and civil engineering costs. Equipment installation and civil engineering costs are relatively fixed, of which equipment procurement costs account for 70% of the construction investment. The current cost of a hydrogen station in Japan is about $2.4 million, and the Japanese government subsidizes 50 percent of the installation cost for companies. As of 2021, Japan has only built more than 160 hydrogen refueling stations.

[32] Yin Yilin, 2021, Present Situation and Prospect of Hydrogen Energy Industry, Chemical Industry and Engineering Vol. 38 No. 4, July,2021

Further, the operation of hydrogen refueling stations is not yet economical. Due to the lack of large-scale production, it is difficult for the upstream and downstream of the whole hydrogen energy industry chain system to form an effective linkage, and the construction and operation costs of hydrogen refueling stations in various countries are much higher than that of traditional gas stations. Almost all hydrogen refueling stations in South Korea are operated by local governments. Initially, the government's plan was to provide half of the total capital expenditure for hydrogen refueling stations, with the other half provided by private companies, but so far private companies have been hesitant to invest in hydrogen refueling stations. Even with a steady flow of hydrogen from hydrogen refueling stations every day, often accompanied by Hyundai Nexo SUVs to replenish hydrogen fuel, the company still fails to turn a profit. Despite a steady increase in public funding to support hydrogen development, the prospect of hydrogen playing a role in the entire economy has raised many doubts. Concerns about the safety of hydrogen fuel cells are also the focus of attention around the world.

At present, when the price of hydrogen in the hydrogen refueling station is reduced to less than 30 yuan/kg, hydrogen fuel cell vehicles will have the ability to compete with fuel vehicles. In terms of terminal price, the price of hydrogen products supplied by hydrogen refueling stations is currently about 60 yuan per kilogram, and each kilogram of hydrogen can drive the car to run about 100 kilometers, which is to spend about 60 yuan per 100 kilometers of fuel costs. In 2021, the cost of fuel vehicles in China is only about 30 yuan per 100 kilometers, which is half of the current fuel cost of hydrogen fuel cell vehicles. In order to solve the above problems related to the economy and competitiveness of hydrogen energy and fuel cells, we must innovate, iterate and upgrade the key aspects of technology, process, manufacturing and market application of hydrogen energy in the whole industry chain!

How to increase the demand is also the challenge that three case countries have to face. Almost all hydrogen and fuel cell technologies are highly dependent on public financial support. Fuel cells, hydrogen refueling stations and home CHP costs are relatively high and are not yet competitive. At present, the demand for hydrogen is mainly focused on hydrogen fuel cells and their transportation vehicles, which are relatively low in maturity and small in scale. As an energy carrier, the demand for hydrogen energy has not been fully developed in traditional energy-intensive industries and new hydrogen energy application scenarios.

4. Enlightenment and Conclusion

The healthy development of hydrogen energy industry cannot be separated from the coordinated development of all links in the industrial chain. The experience of China, Japan and South Korea in hydrogen energy development planning and design and fiscal and tax incentive policies can provide certain experience for other countries to develop hydrogen energy.

First of all, the healthy development of hydrogen energy requires the joint efforts of governments, enterprises, research institutions, and other parties, and also requires the coordinated development of the upstream and downstream industrial chain. This requires countries to draw on the historical experience and layout ideas of developed countries in accordance with their respective national conditions, formulate their own hydrogen energy strategies or plans, and strengthen top-level design and industrial collaboration.

Secondly, flexibly use fiscal and tax policies to ensure coordinated and effective development of the industrial chain. The whole chain of hydrogen energy industry is composed of research and development, production, sales and other links, which involves a lot of processes, therefore, the appropriate tax policy must be adapted to the entire industry, rather than a certain link, only a comprehensive and coordinated tax preferential policy can fundamentally promote the development of the industry. First, further strengthen the support for hydrogen production, storage and transportation, including hydrogen refueling stations, large-scale hydrogen storage and transportation demonstration devices, pure hydrogen pipelines and other key infrastructure to provide continuous funding; Second, according to the principle of combining incentives and constraints, flexible preferential tax policies can be used to encourage industrial development. The third is to increase support for the downstream diversification of the hydrogen energy industry. From the perspective of the global hydrogen energy strategic layout, hydrogen fuel cells and their application in transportation are the focus of global attention, but some countries are already expanding the application scale of hydrogen energy in power generation, energy storage and industrial decarbonization.

Thirdly, different stages of hydrogen development require governments to develop flexible policy tools. At the research and development stage, the government needs to formulate a list of technologies, and provide direct research and development subsidies to support long-term research and development and application, and can also attract private capital investment by setting up seed funds. In the demonstration phase, it is necessary to continue to provide tax incentives for new fuel cells, wind power generation, and semiconductor enterprises, reduce corporate costs, and guide private investment through the PPP model. In the scale stage, the government should improve standards and rules, increase government procurement to promote demand, attract ESG investment through financial market rules (such as disclosure and evaluation), and increase private investment through mass production to reduce costs.

Fourthly, technological innovation breakthroughs are the core driving force to promote the sustainable development of the hydrogen industry. From the perspective of technical layout, China's basic research and technical reserves of hydrogen energy have a certain strength, but the level of industrialization is low, has not yet established a complete industrial chain, the performance indicators of key equipment and products are significantly different from those of developed countries, downstream applications are mostly in the initial stage, have not formed scale, storage and transportation of hydrogen has become the bottleneck of downstream large-scale applications. China needs to continue to invest in the research and development of key technologies, tackle key technologies and equipment in fuel cell stacks, low-cost hydrogen production, hydrogen storage and transportation, and hydrogen refueling stations, and provide continuous funding for the demonstration operation of fuel cell vehicles, and promote the improvement of innovation capacity from basic research, key technology research, application demonstration to industrial transformation. Focus on the industrial upper, middle and downstream advantageous technologies and industrial main forces, improve the level of localization in hydrogen storage and transportation equipment and key components of fuel cells as soon as possible, and ensure the localization of the core technology of China's hydrogen energy industry. Enterprises with a good foundation for technological research and development and strong innovation capacity will be selected, and policies such as corporate income tax reduction and reduction and financial support will be implemented to stimulate the vitality of technological innovation and enhance the driving force of industrial development. At the same time, increase the cultivation of talents, especially the cultivation of professional and composite talents in the field of electrification and intelligence, and supplement the short board of talent demand in emerging fields to meet the demand for new talents in industrial reform.

Fifthly, laws and regulations guide the steady development of industries. When guiding investment in hydrogen energy industry, fiscal and tax policies will affect investors' confidence in the industry from the aspects of investment quantity, duration and change. Domestic and foreign experience shows that when the government makes the relevant policies clear in the form of formal legislation or implementation rules, it will make all kinds of investors more clear investment direction, have a good expectation of investment returns, and enhance investors' confidence and determination in the new energy industry. Otherwise, it will bring investment risk. Therefore, it is necessary for the government to provide support from many aspects such as capital investment, technological innovation and personnel training to enhance the investment willingness of enterprises.

finally, international cooperation is essential for the development, technological improvement and cost reduction of the hydrogen industry. A fair regulatory framework, coordinated global action, and incentives for developers will strengthen hydrogen technology development and accelerate its commercialization, ultimately benefiting consumers around the world, and enabling international harmonized policies and closer industry cooperation. International cooperation on hydrogen energy includes: promoting information sharing, international joint research and development, and strengthening hydrogen safety and infrastructure supply chains; Promote the standardization and rule-making of international hydrogen technical cooperation to promote the formation of a global hydrogen market; Promoting cooperation projects involving third countries; A wide range of decarbonization solutions for the world.

8- Geopolitical economy of China-led BRI in Central Asia and West Asia the cases of Kazakhstan, Turkmenistan, Iran, Iraq, and Turkey

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Part 1: the 1st edited step

Provisional Title

Geopolitical economy of China-led BRI in Central Asia and West Asia
the cases of Kazakhstan, Turkmenistan, Iran, Iraq, and Turkey

Key words,
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Abstract [206w]

This study employs a geopolitical economic framework to examine the implementation of the China-led Belt and Road Initiative (BRI), primarily through the involvement of state-entities and corporations in the selected countries of Central and West.

We focus on five pivotal BRI countries in Central and West Asia (i.e., Kazakhstan, Turkmenistan, Iran, Iraq, and Turkey). Positioned between the ascending power of China and the European Union, Russia, these countries are crucial for BRI projects in Eurasia. Within this context, we concentrate on two strategic sectors: energy and infrastructure. Our analysis covers: (i) the involvement of the Chinese state and state-led enterprises in these sectors, (ii) their domestic, and (iii) their geopolitical-economic impacts. By examining the transnational activities of China's state-led companies (i.e., trade, investment, and finance) in the energy and infrastructure sectors of the selected countries, we argue that These countries are increasingly integrating their economic and security systems with China. This gradual gradually integrating has significant geopolitical and geo-economic implications for the West (i.e., the European Union and the United States). The primary research question explores the national and geopolitical economic impacts of the China-led BRI activities (i.e., trade, investment, and finance) in two key economic sectors of selected countries.

This study adopts a geopolitical economic theory to investigate the implementation of the China-led Belt and Road Initiative (BRI), leveraging Chinese state entities and corporations to achieve its transnational strategic objectives. Geopolitical economy, a variant of Critical Geopolitical Studies, examines the interaction between the "territorial" (advanced-)state and the "transnational space" of capital accumulation in the era of the global capitalist economy (Amineh 2014; 2018 & 2022).□□□□□

INTRODUCTION

China's rise, in other words, rapid state-led capitalist industrialisation is characterized by its dynamics, limitations, and challenges. The primary challenges include "overaccumulation", which constrains domestic space for capital accumulation, and resource-scarcity. These issues, coupled with the leadership's ambitions, drive China's political economy, external relations and security to secure a larger share of the global power and wealth (Amineh and Houweling 2010; Amineh 2022). The Going-out strategy and the BRI are transnational manifestations of China's capitalist industrialisation. We argue that, in contrast to Wester had geopolitics, the colonial expansion and America's expansion to the Philippines and China in the late 19th century, the BRI's transnationalisation of China's economy may be seen as a peaceful "pathfinder", a soft geopolitics towards global dominance (Agnew 1995; Harvey 2001; Amineh 2022; []).

The selected Central and West Asian (CWA) countries: Iran, Iraq Turkey, Kazakhstan, and Turkmenistan, positioned between rising China, Russia and the European Union (EU), are strategically significant for the BRI. Within this framework, we select the energy and infrastructure sectors for detailed analysis, examining (i) the involvement of the Chinese state and state-led enterprises, and (ii) their domestic and (iii) geopolitical-economic impacts. Hypothetically, we argue that these countries are gradually reorienting their state and market towards China, a shift that poses significant geopolitical and geo-economic implications for the CWA.

This paper is divided into six sections. Following this introduction, the second section explains the theoretical framework with related concepts. The third section examines the economic activities (i.e., trade, investment, and finance) of the China-led BRI in the CWA and the five case countries. The fourth section discusses the nature of states, societies and markets of the five countries and their domestic implications for the BRI, and identifies the key risks for China and the BRI. The fifth section analyses the geopolitical economic implications of the BRI in the CWA in relation to the activities of the United States (US) and the EU. The paper concludes with a discussion and conclusion.

Geopolitical Economy of China-Led BRI and its Reflections

Literature Review (989 words)

The scholarly literature on China-led BRI is rapidly expanding, focusing primarily on two critical inquiries: (i) the rationale behind China's leadership in launching the BRI, and (ii) its multifaceted impacts and challenges on the global political economy and governance. This body of literature is principally divided into two major IR schools: (i) the (neo-)realists, who view the state as the fundamental actor in global affairs, analyze the BRI through the lens of conflict and threat perceptions, viewing it as a strategic policy by China to alter global power dynamics in light of its economic resurgence; and (ii) the (neo-)liberals, who emphasize the benefits of economic integration, arguing that market mechanisms and free trade serves as vital conduits to prosperity and are essential for state survival (Roserane 1986). Both schools, despite their distinct analytical approaches, agree that the BRI has a potential to reorient the axis of global politics, moving away from the dominance of post-Cold War America. However, they diverge in their interpretation of this shift: (neo-)realists perceive it as a calculated strategy by Chinese leadership to expand their influence, while (neo-)liberals view it as the inevitable outcome of China's developmental state model and its deeper integration into the global system.

The (neo-)realist perspective, drawing from an array of scholars including Gilpin (1975, 1981, 1987), Krasner (1976), Waltz (1979), Strange (1987), and Mearsheimer (2001), underscores the BRI's geopolitical implications. Although these scholars slightly diverge in their interpretations within the (neo-)realist framework, they collectively frame the BRI as a strategic maneuver by China to extend its global influence, challenge the prevailing international order, and potentially catalyze conflicts, especially with the US, and as tool for China to extend its objectives and challenge the current global order. This viewpoint is rooted in the understanding that the international system is inherently anarchic, with states acting primarily to safeguard their sovereignty and pursue their national interests. The (neo-)ralists analysis focuses on the BRI's political impacts across various regions, emphasizing themes including "national security," "military and strategic interests," "geopolitics," "conflict," "balance of power," and "hegemony." These analyses pivot on national security, military strategy, and the geopolitical chessboard, suggesting a zero-sum game of power politics where the BRI serves as China's leverage in quest for global dominance (Ferdinand 2016; Chan 2017; Khan and Guo 2017; Ostrovskii 2017; Peyrouse 2017; Poh 2017; Shariatinia and Azizi 2017, 2019; Timofeev et al. 2017; Xiaotong and Keith 2017; Zongyou 2017; Chen and Fazilov 2018; Garlick 2018; Kamel 2018; Demiryol 2019; Ponížilová 2019; Liao 2019).

Conversely, the (neo-)liberal viewpoint, informed by encompassing Keohane and Nye (1977, 1987), posits that the BRI fosters economic interdependence, cooperative development, and the integration of China into the liberal world order, albeit with nuances of challenge and adaptation. This perspective emphasizes the BRI's role in enhancing trade, investment, and economic growth in participant countries, suggesting a positive-sum game where all actors stand to gain within the prevailing global governance mechanism, casting China either as a collaborative force promoting shared wealth or as a formidable challenger poised to redefine the rule of the global order (Atli 2015; Fan et al. 2016; Liu and Dunford 2016; Ali and Wang 2018; Dave 2018; Du and Zhang 2018; Hameiri and Jones 2018; Kohli 2017; Liu et al. 2018; Selmier 2018; Shah 2018; Xinbo 2018; Huang et al. 2019; Na-Xi et al. 2019; Stephen and Skidmore 2019; Yu et al. 2019; Sohashi 2018; Wu et al. 2020).

While (neo-)realism and (neo-)liberalism offer insights into state-centric power politics and market-driven cooperation, respectively, they do not fully encapsulate the complexity of state-led foreign investments and their implications for the global political economy. Babic, Garcia-Bernardo, and Heemskerk (2020) expand on this analysis by examining transnational state-led investments through the lens of weighted ownership ties. They underscore the strategic positioning of states within the global economy and highlight the evolving nature of state power in the context of globalization. Their analysis provides a macroscopic view of the transnational state ownership network, showing countries including Norway and China as predominant investors, and revealing a complex interplay between sender and receiver countries within the liberal world order. However, their focus on the structural aspects of state capital flows, while illuminating, tends to overlook the deeper geopolitical and economic strategies at play.

Furthering this exploration, Babic (2023) adopts a geoeconomics perspective, mapping the sectoral and geographic concentrations of state-led foreign investments. This study brings to light the significant role states play as owners in the global economy, engaging in cross-border investments for various objectives ranging from financial returns to technological dominance. Babic's framework attempts to transcend the binary analysis of geopolitical versus commercial motivations, proposing a more nuanced understanding of foreign state investment as a multifaceted geoeconomics phenomenon. This approach highlights the concentrated nature of transnational state capital across specific geo-industrial clusters, underscoring the political and economic strategies that guide state investments. Despite its comprehensive scope, (Babic 2023) also hints at limitations, suggesting that the geopolitical dimensions of state investments might not be fully captured by focusing solely on economic motivations.

In synthesizing the insights from Babic, Garcia-Bernardo, and Heemskerk (2020) and Babic (2023) with the broader literature on the BRI, it becomes evident that while the strategic use of state capital in the global economy is crucial, existing IR theories may not fully grasp the interplay between economic motivations and geopolitical strategies. This gap underscores the need for a more integrated framework that transcends traditional dichotomies, blending geopolitical and geoeconomics analyses to fully comprehend the BRI's complex dynamics. By acknowledging the limitations of focusing predominantly on economic motivations and the necessity of considering the geopolitical intentions, a pathway emerges for employing geopolitical economic theory. This approach promises a more comprehensive exploration of the BRI, offering insights into China's strategic and economic engagements on a global scale. Hence, this conclusion advocates for a more nuanced analysis that bridges the identified gaps, ensuring a holistic understanding of the BRI's implications and its role in reshaping global power structures.

Theoretical Framework (1517 words)

This study proposes the theory of geopolitical economy to analyses the China-led BRI in CWA, focusing on its involvement in Kazakhstan, Iran, Iraq, Turkmenistan, and Turkey.

We have tried to create a synthesis between the Both IPE and critical geopolitics venture beyond the theoretical frameworks of IR in order to understand systemic change at the global level. In IPE, inter-state theorising cannot build on such dynamics alone. The global economy must be considered in a geo-historical context. However, the geographical assumptions of contemporary international relations theory are increasingly problematic. While the critical geopolitical approach addresses the major research questions already raised by IPE, its novelty lies in the return to a geographical to a geographical dimension in the analysis of complex systemic realities.
Critical geopolitics is concerned not only with the material spatial practices through which the by which the international political economy is constituted, but also the ways in which it is the ways in which it is represented and contested (Amineh 2003; Amineh 2022).

State, Society, and Market in China: the Question of Authority

The unit of analysis in Global Political Economy (GPE) and International Relations (IR) research is crucial for understanding the nuances of social reality, particularly in the study of political authority configurations and their interactions with society and market forms (see Cox 1986, 1987). Drawing from Cox's critical theory of IR and IPE (1987; 1986, 2002), Geopolitical Economy theory identifies two *ideal* governance models: the liberal state-society, market complex (LSMC) and the centralized state, society, market complex (CSMC). These models illustrate the spectrum of governance within capitalist state system, highlighting the influence of historical, spatial, socio-economic, and cultural contexts in shaping these structures (Cox 1987; Van der Pijl 1998; Amineh 1999).

The LSMC, evident in liberal democracies, such as the US and Great Britain, fosters a cooperative relationship between capital and labor, underpinning socio-economic policies conducive to a dynamic civils society and a market characterized by class and interest-groups autonomy (Moore 1966; Giddens 1973; Wright et al. 1998). This model encourages the active engagement of various social strata, leading to the development of a hegemonic social structure rooted in capitalist industrial development, which in turn fosters a "self-regulating society" (Van der Pijl 1998; Amineh 1999; 2010; Amineh and Yang 2018). The origin of LSMC can be traced back to Britain "Glorious Revolution" (1688/89), where the state's withdrawal from direct intervention allowed for a society governed by legal protections of private property and contractual obligations (Van der Pijl 1998: 68).

On the other hand, in the CSMC of which China is a concrete example, a distinction between ruling and governing class is not present or only to a slight degree. The "state class" derives its power from control of the state apparatus, society, and the market (see Elsenhans 1984).[33] In this configuration, contrary to the LSMC, autonomous social forces, mainly a strong capitalist class and worker's unions, are either underdeveloped or dependent on the state, and neither is able to assert its interests independent from state power[34]. Thus, for the ideal type of a centralized state that lacks the liberal, pluralist foundation, a framework

[33] The concept "state class" was designed by Elsenhans to explain the nature, origin, and role of the ruling class in modern authoritarian and developmental states in the process of socio-economic development. See H. Elsenhans (1984). Development and Underdevelopment: The History, Economics, and Politics of North-South relations. New Delhi/Newbury, Park/London: Sage Publications.

[34] Labor forces in some centralized state state-society complexes fall under a two-fold regime. First within the factory, as management determines the work scheme and allocates workers to particular jobs. Secondly, labor forces do not have a direct voice over positions unions take in bargaining with employer's organizations. The leadership of state-organized unions is not elected by workers.

of collaboration between capital and labor is/was imposed in an authoritarian manner, reflecting autonomy of the state from society. China's state class maintains strong political control at home and well as at external relations.[35] The driving forces of Chinese state-class during last decades was/is threefold: (1) the creation of a strong centralized state and the mobilisation of human and material resources to resist both exogenous and indigenous pressure towards marginalization and disintegration. (2) to develop state, society, economy, and capacity from above to resist economic backwardness through state-led industrial development, or a revolution from above[36]. It may also be considered a condition for domestic survival, and the legitimacy of the political system (3) to secure the power of the political system and economy by gaining a larger share of the global economy and necessary inputs in terms of resources (see Lieberthal and Oksenberg 1988; Nolan 2001: 199-200; McNally 2007; Breslin 2012). The outcome is global system-level change that is impossible for China's government to oversee or predict. The contradictions of capitalist industrial development in China, together with the ambitions of state class, is motivated to gain a larger share of the global economy and resources. The going out strategy and BRI are its expression (Jiang and Sinton 2011; Cheng 2012; Jiang and Ding 2014; Zhang and Xu 2019; see also Amineh 2021). To realize this, China is facing a long uphill struggle and geopolitical economic challenges. Nevertheless, because of its economic development, including military industrialization, and the formation of multilateral institutions such as the AIIB, SCO (Marketos 2009; Na-Xi 2019), and BRICS[37] (Vermeiren and Dierckx 2012; Becker 2014), China is climbing up in the global wealth-power hierarchy. The time when China belonged to the periphery of the global economy is over for good. However, the more successful China is, the more its economy will integrate into the global political economy at the cost of domestic control.

Forces Behind China's Capitalist Industrial Development

China is a successful example of industrialization in the global wave of sequential industrialization. Sequential industrialization refers to a series of interrelated and comprehensive social processes of change and upheavals in state, economy, and in the global system. It also refers to the sequence in time in which some strong states succeeded transitioning to industrially based politics, society, and economy (see Shin 1996; Houweling 2000 ; Amineh and Houweling 20010; Amineh 1999; Moore

[35] Colonization by western powers demonstrates that without successful industrialization, no state can be secure against invaders. The Japanese, for example, caught by surprise by the US during the Crimean War, took precautions. In trade negotiations between the US and Japan in 1955, the American side demanded from the Japanese to specialize in goods in which the Japanese had a comparative advantage. The US therefore would specialize in the production of automobiles and Japan in the production of tuna. The representative of the de facto one-party state of Japan rejected the liberal trade theory. Instead, the Japanese government would encourage and protect those industries which it believed were "important for reasons of national policy […]" Therefore the pace of opening up the domestic economy for foreign investors was set by government policy. See Testimony to the US Trade Review Deficit Commission of November 16, 1999, Alfred E. Eckes.

[36] This state-led catch-up development strategy and its domestic impacts have been termed by Antonio Gramsci as "passive revolution" (Gramsci 1971). Passive revolution has two main elements: (i) a revolution from above or a state-led development strategy by a revolutionary and/or nationalistic ideology to mobilize domestic human and material forces, directed towards catch-up development that has so far proven to be a condition of reactive successful industrialization and "rise" or even of survival, and (ii) creating socio-economic development, civil society, and corresponding progressive social classes (e.g., capitalist, middle and working classes). The passive revolution is generally the precondition for socio-economic transformation and the emergence of a civil society with related forces and institutions. It creates modern social forces demanding political influence and it produces the structural and societal conditions that make democratic transition possible. If, in the process of development, modern social classes and the private sector gain autonomy from the state, they can emerge as powerful actors, pushing for state accountability and political participation. The key to understanding successful passive revolutions, social emancipation, and democratic transitions, therefore, lies in the nature of state-society relations (that are the result of development or a lack thereof), rather than the nature of society's norms, values, and religion (Van der Pijl 1998; Amineh 1999; 2007: 1-40; 2010: 145-191; Amineh and Houweling 2010).

[37] See U. Becker (2014). The BRICs and Emerging Economies in Comparative Perspective Political Economy, Liberalisation and Institutional Change. London and New York: Routledge. The book provides an interesting critical comparative political-economic study on the emergence of the BRICS plus Turkey as a reflection of the shift in the global political economy underway.

1966; Senghaas 1985; Chang 2002; 2003). To resist marginalization from the global economy a number of peripheral states including China, the Asian Tigers, Turkey, India, Brazil, and Iran have pursued a state-led "catch-up" development strategy, akin to Antonino Gramsci's (1971) concept of a "passive revolution." This approach, aimed at economic self-reliance, diverges from liberal economic models and seeks to navigate economic stagnation through stat-led development, responding to exogenous pressures from dominant capitalist heartlands led by Britain and the US, and indigenous socio-economic challenges (Warren 1980; Balassa 1981; North 1981; Deyo 1987; Barkey 1990, 2019; Wade 1990; Lampton and Lieberthal 1992; Amineh 1999; Fieldhouse 1999; Nolan 2001; Chang 2002; Zheng 2004; Amineh and Houweling 2010; Walter and Zhang 2012).

Although these countries' political systems vary, their industrialization strategies are fundamentally capitalist, aimed at economic growth, profit maximization, and capital accumulation. While corporations in LSMC operate with relative independence, in CSMC, they are often state-directed or state-owned. However, as these entities operate globally, such as Chinese SOEs, state control over their behavior abroad diminishes (Jiang and Sinton 2011; Victor et al. 2012; Jiang and Ding 2014).

The BRI: Origin and Global Impact

China's rapid state-led industrialization has markedly increased its wealth and power, transitioning its population from agrarian to industrial sectors, notably in manufacturing agricultural machinery and fertilizers. This shift has not only boosted per capita income and military capabilities but is also reconfiguring the global order, challenging the US dominance, and steering China towards global economic integration through trade, investment, and finance. By 2014, China's GDP (PPP) reached $13.21 trillion, making it the world's largest trading country (WTO 2015). China's global competitiveness is bolstered by favorable exchange rates, low labor costs, and substantial foreign direct investment, fostering its ascendency in high-value markets, including high-speed trains, computers, and mobile technology. Over time, the proficiency of Chinese industrial products in higher value markets has significantly improved, placing China in competition with advanced economies, facilitating China's advancement into more complex, high-technology fields.

While China's state-led industrialization has significantly narrowed the global wealth-power gap, it has also introduced internal challenges crucial to its economic growth and social stability and security. Overaccumulation and resource scarcity, especially in fossil fuels, are primary concerns. Overaccumulation results in unprofitable capital and labor, causing idle factories, rising unemployment, and diminishing returns, further aggravated by market overproduction (Shen and Chen 2018; Xu and Liu 2018; Song 2022). The global financial crisis underscored these challenges, leading to a sharp decline in export growth rates and indicating a tough economic climate for China (Zhang 2017; Demiryol 2019; Jones and Zeng 2019; Song 2022). Efforts to address overcapacity, such as local government directives to manufacturing firms operating about 65% capacity to cut down, have led to the shutdown of 'zombie companies' (Shen and Chen 2017; Song 2022), while reductions in steel production have affected roughly 500,000 workers (Yao and Meng 2016).

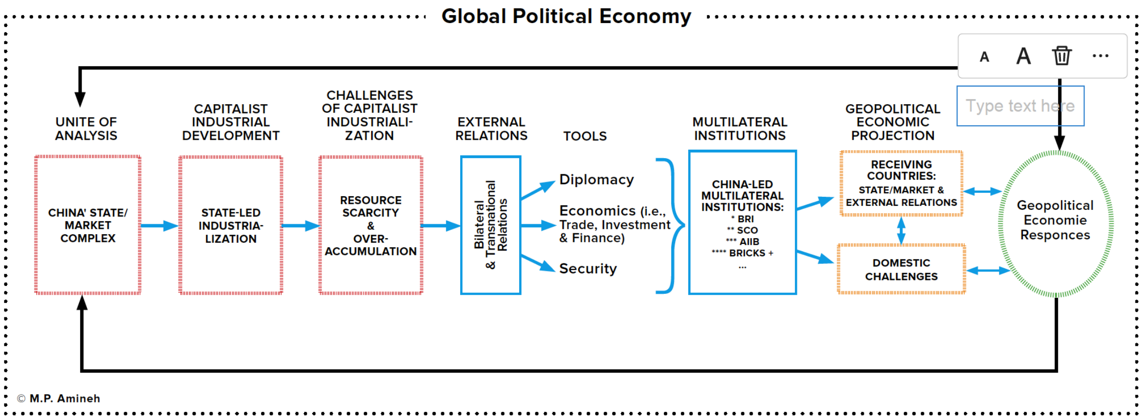
This scenario has necessitated what David Harvey describes as a "spatial fix", wherein the geographical expansion into new territories and markets becomes essential for the survival of capitalism by allowing for fresh accumulation spaces to address domestic limitations (Harvey 2001: 312-344; Song 2022). China's response to these dual challenges has been the launch of BRI, aimed at redistributing surplus capital and labor internationally while securing access to vital resources and mitigating domestic economic pressure through global engagement (Amineh & Yang 2014, 2017, 2018; Amineh 2022).

At the core of the BRI' global activities lies a complex interplay between the territorial (geopolitical) and the capitalist (geo-economic) logics of power, reflective of the dynamics at play in major capitalist states and markets extending beyond their national borders. This expanded perspective, underpinned by critical geopolitics since the 1970s, incorporates geographical and geo-economic dimensions, connecting the territoriality of politics with the spatial dynamics of capital accumulation. The logical interaction between 'the territorial logic of power' and 'the capitalist logic of the power of capitalist expansion is called geopolitical economics and determines the context of the current phase of the global (capitalist) economic system (Harvey 1985; Agnew & Corbridge 1995; Mercille & Jones 2009; Amineh 2010). The BRI illustrates the dynamic interplay between geopolitical strategies and economic expansion, showcasing China's engagement in territorial and capitalistic logics to extend its global influence. This initiative reflects a nuanced approach to global capitalism, merging territorial control ambitions with capital expansion goals. The BRI's strategic focus on trade, investment, and infrastructure development exemplifies the complex relationship between geopolitical and geo-economic strategies within the GPE, aiming to redefine global political economic relations (Agnew and Corbridge 1995; Harvey 2001; Mercille 2008; Amineh and Yang 2014, 2018).

Through the BRI, China navigates the dialectical relationship between accumulating capital and managing population through territorial configurations, projecting its power to safeguard and expand its geopolitical horizons without resorting to the military interventions characteristic of past global powers. By prioritizing diplomacy, trade, investment, finance, and infrastructure development, China seeks to align its internal economic strategies with its broader geopolitical ambitions, asserting itself as a pivotal force in shaping the contemporary economic and political landscape while maintaining the interdependence between state power and capital flows for mutual prosperity and security (Amineh & Yang 2014; Amineh 2022a&b).

To conclude, the analysis of the BRI through Geopolitical Economy highlights its role as a strategic response to the challenges of domestic capital accumulation namely, overaccumulation and resource scarcity. Focused on CWA, the study examines the China's transnational economic expansion through BRI, positioning as a non-coercive means to extend global influence, diverging from Western colonial models (Sse, [McNeill, John Robert, and Kenneth Pomeranz, eds. *The Cambridge World History. Volume 7, Production, Destruction and Connection, 1750-Present. Part 1and2, Structures, Spaces, and Boundary Making*. Cambridge: Cambridge University Press, 2015. It scrutinizes China's state-society-market complex, the motives behind its capitalist growth, and the BRI's impacts, showcasing a regional pivot towards China. This pivot reflects profound geopolitical and geoeconomics shifts, positioning the BRI as a central China's global strategy.

GEOPOLITICAL ECONOMY OF CHINA-LED BELT AND ROAD INITIATIVE



NOTES
* BRI: BELT & ROAD INITIATIVE
** SCO: SHANGHAI COOPERATION ORGANIZATION: The full members are China, India, Iran, Kazakhstan, Pakistan, Russia, Tajikistan and Uzbekistan
*** AIIB: ASIAN INFRASTRUTURE INVESTMENT BANK
**** BRICS +: BRICS - BRAZIL, RUSSIA, INDIA, CHINA, SOUTH-AFRICA + FROM 2024 EGYPT, ETHEOPIA, IRAN, SAUDI-ARABIA AND UNITED ARAB EMIRATIS

China-let BRI Economic Activities in Central and West Asia (2000-2022)

This section analyses trade relations (2000-2022) and investment (2005-2022) between China and CWA, with a particular focus on the five countries under study. The section discusses investment by Chinese companies in general and in the energy and infrastructure sectors in particular. It concludes by reflecting on how these activities contribute to the transnationalisation of the Chinese economy and the gradual reorientation of the CEA and selected countries towards China.

Transforming inter-regional trade

[Insert Figure 1a-1b]

Figures 1ab illustrates that trade within CWA has experienced significant structural transformations. While the EU was the dominant player for both imports and exports in 2000, China has rapidly closed the gap. By the mid-2000s, China has surpassed Central Asia (CA) in exports, achieving record levels during Covid-19 pandemic through rising demand for items such as computers, broadcast equipment, clothing and footwear, toys, and vaccines. In contrast, the EU has continued to solidify its role as Kazakhstan's primary export market, a trend that is mirrored in regional trade patterns. In West Asia (WA), the EU remains the leading exporter. However, after more than two decades of steady growth, China is on the verge of bridging the gap with its exports to the region expanding more rapidly than those from the EU during Covid-19 crisis. Concerning imports, China has emerged as the largest export destination for the region, driven by its escalating energy demand. Meanwhile, America's market share is minimal in CA and on a decline in WA.

[Insert Figure 2a-2e]

Figures 2a-2e illustrate trade relations between China, the EU, and the US with the five selected countries: Kazakhstan, Turkmenistan, Iraq, Iran, and Turkey. Despite the first 4 countries being rich in resources, the figures unveil a variety of trade pattern.

Kazakhstan's trade is indicative of CA's trends, given its significant contribution to over half of the region's GDP (World Bank 2023). From 2000 to 2010, trade between Kazakhstan and China relatively balanced. However, between 2011 and 2013, a drop in Chinese imports led to a series of Chinese trade surpluses, contrasting with a structural deficit with the EU, showcasing the EU's strong position in Kazakhstan's energy market. This is a reflection of Kazakhstan's diversified foreign policy and the EU's strategic investments. Turkmenistan, however, presents a distinct case. Until 2021, the Eu outperformed China in exports to Turkmenistan, mainly in machinery and transport equipment. Conversely, China has been the dominant importer from Turkmenistan, mainly due to gas exports via Central Asia-China gas pipeline commissioned in 2009, resulting in a substantial trade deficit with China since 2011.

In Iraq, Iran, and Turkey, the relationships vary. China has ascended to become the primary partner for Iraq and Iran, surpassing the EU and the US. Turkey's primary commercial relationship is with the EU. In Iraq, substantial investments from Chinese National Oil Companies (CNOCs) propelled China as a leading export and import destination by 2013 and 2017, respectively, shifting Iraq's trade balance favourably towards China. Iran's trade dynamic is unique due to sanctions, with China emerging as a key partner in 2011, adeptly navigating sanctions and cementing its economic influence through a 25-year agreement (Ehteshami 2022: 168). Meanwhile, the EU halted its imports from Iran in 2011, briefly resumed, and ceased again in 2018 following the reinstatement of American sanctions. Despite sanctions obscuring official oil trade data, small Chinese refineries reportedly import up to 1.5 million bpd (Reuters 14 Sept 2023). As for Turkey, it maintains trade surpluses with China, the EU, and the US, with the EU leading due to strong economic integration facilitated by the Customs Union (1995), positioning Turkey within European production networks (EC 2023b; Yalcin & Felbermayr 2021).

[Insert Figure 3a-3b]

Figures 3a and 3b illustrates the trade dynamics of oil and gas from CWA to China, the EU, and the US. According to the International Energy Agency (2022), projections under the Stated Policies Scenarios predict that by 2050, world energy demand will consist of 34% oil, 15% natural gas, and 8% coal. The Announced Pledges Scenarios adjusts these figures to, 23% for oil, 10% for natural gas, and 4% for coal by 2050. Under Net Zero Scenarios, the projections further decrease to 11% for oil, 5% for natural gas, and 2% for coal by 2050. This underscores the ongoing significance of fossil fuels and and the strategic importance of securing access to these resources in CWA, a region rich in energy resources. Over the past two decades, the figures reveal a significant shift as China emerges as the leading importer of oil from WA and gas from CWA. Conversely, the EU's maintains a strong position in CA oil exports, a result of early strategic investments by US- and EU-backed oil companies in Kazakhstan and the country's multi-vectoral diplomacy (see below). US imports of oil from WA have declined, attributed to the shale revolution fostering energy independence in the US (see also section on geopolitics).

Despite the impact of the 2014 oil price drop on export revenues (seen in Figures 1 and 2), Figure 3 shows that trade volumes, particularly CA oil exports to the EU and gas exports to China, has remained stable. In WA, China has rapidly become the primary destination for oil imports.

In summary, the trade patterns between China, the EU, and the US with CWA indicate an increasing focus on China and the EU for exports to CA, with China's exports continuing to grow while the EU's have stagnated since 2007 until Covid-19 pandemic, and the US maintaining a minimal share. In WA, China is a major trade partner for Iraq and Iran, while the EU leads in trade with Turkey. All three regions exhibit structural trade deficits with Iraq and surpluses with Turkey. The situation in Iran is complicated sanctions, potentially positioning China to dominate Iran's trade economy if current trends persist. The growing significance of China to both regions is propelled by its increasing demand for oil and gas, with Chinese national oil companies (NOCs) playing pivotal role in this shift. Meanwhile, American energy self-sufficiency and European efforts to diversify energy sources have encouraged CWA's pivot towards China. China's position as a reliable growth market, unencumbered by historical complexities, has facilitated this shift (see section on geopolitics). The extent of China's involvement in national economies through foreign direct investment, central to this trend, will be explored further in the next part.

China's energy and infrastructure investments since 2005 [1,474w]

[Insert Figure 4a-4d]

Figures 4a-d present the investment networks by Chinese State-Owned Construction Firms (CSCFs) in CWA and specifically in the five countries under study in (i) all invested sectors and (ii) the energy and infrastructure sectors. Excluding Turkmenistan, Saudi Arabia and the UAE are the only countries more central than Kazakhstan, Iraq, Iran, and Turkey in the network of projects. Highlighting the focus of Chinese investment, these five countries received 44% of all funds in CWA and 49% in energy and infrastructure projects. Among the 118 CSCFs in the dataset, seven are highlighted as the largest investors, contributing 47% of the total investment. These entities (CNPC, Sinopec, PowerChina, Sinomach, CSCEC, CITIC, and CRCC) comprise national oil companies or a construction firms, underlining the significance of CWA for China's energy supply security and the development of BRI corridors (see section on geopolitical economy). In total, these CSCFs have invested nearly US$291.5b. Figure 4b shows that since 2005 (2013) 54 CSCFs invested in Kazakhstan, Turkmenistan, Iraq, Iran, and Turkey, respectively, US$35.6b (US$18.9b), US$15.1b (US$7.7b), US$32.7b (US$19.2), US$36.49b (US$12.6b), and US$17.5b (US$11.7b) in 57 (38), 6 (2), 51 (39), 38 (18), and 29 (18) projects.

A detailed examination of the energy and infrastructure sectors (Figures 4b and 4d) reveals that US$217.1b was invested in those sectors in CWA, accounting for 75% of the total investment. The energy sector saw the majority of funds, particularly in oil and gas, with alternative energy receiving more investment than coal despite negligible. Railway investments were a significant part of infrastructure investment, aligning with BRI objectives to estaablish corridors connecting China with Europe through CWA. The total investment in energy and infrastructure in the five countries amounts to US$107.4b.

Energy investments are crucial for China's energy supply security and provide substantial revenue for CWA states and investors. They are also instrumental in bolstering China's economic influence in these countries, as seen in increasing exports from China to CWA markets.

Central Asia, particularly Kazakhstan and Turkmenistan, is oil and gas rich countries. Through strategic investments, China successfully tapped into the region's energy resources, utilizing pipelines for transportation due to their landlocked and proximal nature. A pivotal investment was the Kazakhstan-China oil pipeline (co-owned by KazMunaiGas and CNPC), which significantly bolstered Sino-Kazakh trade and encouraged further energy-related trade and investments. Kazakhstan's largest oil field, Kashagan, serves as the main supply source for this pipeline and is primarily controlled by a consortium of major energy companies, including KazMunaiGas (16.88%), ENI, ExxonMobil, Shell, and TotalEnergies (each holding a 16.61%), CNPC (8.33%), and NPEX (7.56%) (PSA 2023).

Sinopec's acquisition of a total 100% stake in Kazakhstan's Caspian Investment Resources from LukOil for US$1.1b in 2014 marked a significant milestone in the BRI's expansion, granting Sinopec full control over the company's assets and its four oil and gas projects in Kazakhstan (Farchy 2014). The construction of the Central Asia-China gas pipeline, China's inaugural transnational pipeline, facilitates gas transports primarily from Turkmenistan through Uzbekistan and Kazakhstan, connecting with China's West-to-East pipeline. Over a decade since its inception, the construction of its fourth stage ("Line D") began, highlighting the BRI's enduring significance and the economic opportunities it presents with China (Xinhua 24 Aug 2023).

In terms of renewable energy, although the dataset only covers four non-hydrocarbon energy projects, research indicates significant potential for green energy in Central Asia, particularly in Kazakhstan, across wind, solar, hydro and biomass (UNECE 2020). Kazakhstan aims to achieve a 50 per cent renewable energy mix by 2050, but structural constraints require external support. The 2015 Intergovernmental Framework Agreement with China outlines 55 joint projects worth US$27.6 billion, which should provide Kazakhstan with the necessary capital to develop its renewable energy sector (Kazakh Invest 2019).

In WA, particularly in Iraq, China has strategically targeted the oil sector, investing US$22.3b across 27 of the 51 recorded projects from 2009 to 2022. The CNPC is the leading investor, with US$13.9b invested during this period, including US$4.3b since 2013. The CNOOC made a smaller investment of $220m in Iraqi oil in 2018. Additionally, CITIC Group's two oil investments in 2021, totalling US$3.8b, underscore the magnitude of Chinese commitment. Figures 4a-d reveal that CSCFs predominantly invest independently, and as a result, this approach has led to Chinese companies dominating Iraq's oil industry. The "oil-for-construction" deals have been pivotal, positioning Iraq as the third most significant BRI partner for energy collaboration between 2013 and 2021, following Pakistan and Russia. Notably, over 10% of China's oil supply now originates from Iraq, a significant increase from net zero imports in 2007, with current figures suggesting nearly 400 million barrels annually (BP 2023).

Similarly, Iran's energy sector has been a primary recipient of Chinese investments, with the dataset documenting nine energy projects worth US$10.7b since 2005, and four projects valued at US$2.4b since 2013. This decline is largely attributed to sanctions impacting Iran's hydrocarbon sector. Sinopect and CNPC have been key players, investing $10.8b in Iranian oil industry between 2006 and 2017, in collaboration with the National Iranian Oil Company. In the gas sector, CNP undertook two projects from 2009 to 2016, worth US$2.4b, highlighting Iran's potential in natural gas. This sector's prospects were further evidenced by French TotalEnergies' initial involvement under the Joing Comprehensive Plan of Action (JCPOA) framework, though it withdrew following the reinstatement of sanctions (TotalEnergies

2018). The hydro energy sector saw investments of US$1.7b across two projects between 2007 and 2010d by Sinohydro (US$1.5b) and Gezhouba (US$210m). Additionally, Sinosteel marked its presence in Iran's coal sector with US$180m investment in 2014, being the sole CSCF to venture into this domain.

Turkey's heavy reliance on energy imports has spurred policies aimed at enhancing energy self-sufficiency, attracting investments from CSCFs totalling US$11.4b since 2005. Notably, the largest allocations within this investment, amounting to US$6.84b, were directed towards coal projects in Turkey, with CSCFs partnering with local companies on BRI projects. However, this investment trend is undergoing challenges following President Xi Jinping's announcement to halt foreign coal-fired power plants construction. The Hunutlu coal-fired power plant, supported by Chinese technology, demonstrated notable resilience during 2023 earthquakes, highlighting Chian's contributions to Turkey's energy infrastructure (GlobalTimes 2023). In the gas sector, the China National Chemical Engineering Corporation (CNCEC) invested US$640m, while China Electronics Engineering (CEE) allocated US$600m to the alternatives sector, and Genertec partnered with Aksa Enerji, investing US$460m in Turkey's hydropower sector. In response to energy import dependency, Turkey has prioritized renewable energy development, with nearly 40% of its electricity already being generated from hydro, solar, wind, and geothermal sources in 2022 (TMENR 2023). Yet, CSCFs are underrepresented in Turkey's renewable energy sector. According to Ergenç et al. (2023), the Turkish political elite has shown a preference for cooperating with European partners on renewable energy projects, while CSCFs have often declined invitations, citing concerns related to financial risks. Nonetheless, strategic investments reflect Turkey's evolving energy landscape and China's significant role in shaping it. Recent discoveries of oil and gas, coupled with Turkey's growing importance in BRI corridors following the Ukraine-Russian war, might further reshape its energy landscape.

Beyond improving China's energy supply security, the BRI focuses on developing corridors through key infrastructure projects including highways, railways, and pipelines, integrating national economies into a broader regional market and fostering economic opportunities. Notable among these is the investment by COSCO and Lianyungang in acquiring 49% (24.5% each) of the Khorgos Eastern Gates Special Economic Zone in 2017, in partnership with Kazakhstan Temir Zholy, Kazakhstan's national railway company (COSCO 2017). This US$38m investment grants COSCO access to a 600-hectare development area along the China-Kazakhstan border, vital for BRI's Europe-bound connectivity (Kirişci & Le Corre 2018). The railway initiative significantly reduces the transit time for goods between China and Germany to 13-15 days, compared to nearly a month by sea. Iran has benefited from substantial railway investments, receiving US$6.42b mainly for construction and electrification projects, alongside a US$500m investments from China Communications Construction for Tehran's northern highway development (Worldhighways.com 2015). In Iraq, an exemplar of oil-for-construction contracts in the 2021 US$370m project by CSCEC to construct the Nasiriyah International Airport near Sadr city (GCR 2022). In Turkey, a significant move was the acquisition of 65% of Fina Port's shares by a consortium of three CSCFs (CIC, COSCO, and China Merchants) totalling US$920m (HDN 2015), underscoring the strategic infrastructure investments under the BRI.

Concluding remarks

Need to be rewritten; WHY the conclusion didn't discuss [1] the geoeconomics outcomes [trade-investment network [2] de geopolitical consequences of cooperation: these economic are orienting their economy and diplomacy and in some extent security toward China/ explanation/ …

It may be concluded that the China-led BRI with related corporations, has significantly influenced the economic relations between China and the five countries under study. Trade volume has multiplied, and investments have been predominantly driven by state-led corporations. In this context, China's state apparatus and economy have emerged as crucial providers of capital, information, technology, resources, and employment, indicating the formation of a transnational (regional) network cantered around China and its state-led corporations. [the conclusion based of economic finding need more clarification; try to exten the conclusion based on the economic finding]

This evolving regional economic network not only strengthens Chain’s and its corporation’s stature but also encourages other countries to participate in China’s efforts to established multilateral institutions beyond the influence of the US-led. China's initiative to integrate CWA countries into the SCO exemplifies its strategy for regional cooperation. Despite many contradictions and problems within the organization as well as between the member states, the SCO could play a key role in mobilizing human resources and material forces for regional development and security.

States, and societies, of the selected courtiers [2,399w]

States and societies [1,461w]

The ongoing crises in most CWA countries can be attributed to (i) the presence of weak, fragile and/or failed states; (ii) a lack of regional cooperation and internal as well as interstate conflicts; and (iii) external interventions. Regarding the five selected countries for this study, several commonalities and differences exist. Firstly, four of these countries exhibit various forms of "authoritarian"[38] state/society-market complex, while the fifth (Turkey) is, despite its challenges, more "liberal". Secondly, societies in these countries are either fragmented due to ethno-religious and tribal-based structures (Iraq, Kazakhstan, Turkmenistan) or are experiencing *deep* polarisation between two primarily opposing political ideologies (Iran and Turkey). Oil is a crucial factor for the governments' survival in the four "centralised" countries, particularly in Iraq and Turkmenistan, and to a lesser extent, Kazakhstan.[39] Iran and Turkey, in contrast, possess comparatively strong nation-states with a relatively diversified, modern sectoral economy oriented toward their national markets.

The modern state of Iran and Turkey were shaped by their constitutional revolutions of 1905/6 and 1908, respectively (Tabataba'i [][];Zurcher 2022; Add on Turkey). These revolutions significantly influenced their societies through socio-economic development from above (1920s until approximately late-1970s), leading to the emergence of modern social forces such as the business, middle, and working classes. This process was accelerated in the 1960s and 1970s, thanks to American support in exchange for assistance in combating communism, which contributed to rapid urbanisation. However, this swift urbanisation soon led to unequal development, demands for change, and crises in political systems by the late-1970s, along with the advent of politicised Islamic forces (Eligur 2010; Gulalp 2001; Amineh 1999: ch. 4-8). In Iran, religious forces took over the the secular state during the Iranian Islamic Revolution (1978/79), transforming it into a semi-theocracy (Keddie 2006; Amineh & Eisenstadt 2007). Consequently, Iran severed ties with America and began to challenge US influence in West Asia (Amineh 2022b; Fathollah-Nejad 2021). In Turkey, secular and Islamic forces incrementally introduced liberal reforms. The Justice and Development Party (AKP), the inheritor of the Islamic political movement, along with its alliance with the US and EU, was instrumental in liberalising the country through the 2000s. However, there has been an uncertain yet gradual return to the authoritarian politics since the mid-2010s (Ozbudun 2022; Turan 2015; Demiralp 2009). Concurrently, Turkey's foreign policies became more autonomous, creating tension between Turkey and its Western allies, the US and the EU (Ozturk 2021; [][]; see also below).

Despite their differences, Iran and Turkey share a common structural issue: *deep* polarisation between forces, generally, culturally or politically align with Islam and those that do not (see, e.g., Arjomand [][]; Rakel 2009; Amineh 2010: 188-89; Amineh & Eisenstadt 2007; Ozbudun 2020; Avci 2022). This divide is evident in their differing perspectives on the political and social system, leading to regular controntations, such as the ongoing protests against the Islamic Republic in Iran (Iran Primer n.d.) and the unresolved constitutional debate in Turkey (Ozbudun 2022). Additionally, Turkey faces a unique challenge to its constitutional order and state legitimacy from the militant Kurdish separatist movement (Jongerden 2021).

Iraq faces internal conflicts and external interventions, grappling with the main structural issue in post-Saddam Hussein Iraq, which F.H. Jabar (YEAR) described as the "state of no-state" (*al-ladawla*). "State-society" relations in the no-state are blurry, and the power configurations are captured by a mixture of forces and interest groups, mainly families, clan leaders, armed groups, and militias. This condition is underpinned by the historical challenge of unsuccessful nation-state building, despite efforts by the last ruling (Ba'ath) party (Tripp 2010). The 2003 US invasion, which led to to regime change and the failure to

[38] **Mehdi needs to write about that they are not the same as China**.

[39] In Iraq, oil makes up 85% of government budget and 42% of GDP (World Bank 2023). In Turkmenistan, reliable data and extra-budgetary funds makes it difficult to estimate, but 2021 exports are nearly completely dominated by hydrocarbons (Hojanazarova 2023). In Kazakhstan, the government's budget consisted nearly three-fifths of oil revenues in 2022 and one-third in 2021 (IMF 2023).

establish a de-Ba'athified order based on federal parliamentarianism, added another layer to the failed state (Ismael & Ismael 2015; Kadhum 2023; Ardovini & O'Driscoll 2023; Dodge 2014). The causes of this failure are, firstly, competition by ethno-religious and tribal-based groups to secure oil wealth, leading to nepotism, rampant corruption (Arab Barometer 2022), and an inefficient and discredited central administration, which paradoxically also prevented a total collapse (Abdullah, Gray & Clough 2018). Secondly, the Kurdistan Regional Government (KRG) boasts its own state-like structures, including armed forces, and continuously challenges the central authority, thereby deepening Iraq's political and social fragmentation (Rafaat 2018). Thirdly, there is a permanent threat of external intervention by a regional and global powers (e.g., the US, Iran, Saudi Arabia, the UAE, and Turkey) (SOURCES). Fourthly, major security challenges have given rise to parallel armed forces alongside the regular army (Aboultaif 2023; Al-Kaabi and Knights 2023) and provided the conditions for the rise of militant politicised Islamic groups (e.g., Daesh).[40]

Turkmenistan and Kazakhstan are among the eight former Soviet republics of CEA that legally became independent nation-states for the first time in history in 1991. Unsurprisingly, they developed regimes characterized by authoritarian presidentialism (Amineh 2003: 39-43). In their patrimonial political structures, the president wields extraordinary powers, influencing almost all aspects of state functions, extending well into their societies through state control over strategic economic sectors. The centralisation of power and the pacification of other elite groups are essential to secure widespread endorsement of the president, which contributes to regime stability (Amineh 2003). [Mehdi will insert comment on the reason of the authoritarian structures in these countries.]

In Kazakhstan, regime stability can be attributed to narrow interests and the persistence of informal patrimonial networks (Sayabayev 2016; Mallinson 2019; Groce 2020; Ibadildin & Pisareva 2020). 'Treasurers' manage the patronage system, ensuring that no single ruling elite gains autonomy over assets (Mallinson 2019), while SOEs dominate key economic sectors (Sayabayev 2016; Mallinson 2019; Groce 2020; Ibadildin & Pisareva 2020). The gradual emergence of a modern business class is a consequence of privatisation policies implemented during Nazarbayev's government in the 1990s, but these new business elites were distant from Nazarbayev's inner circle and wielded no significant power (Ibadildin & Pisareva 2020). Despite efforts towards diversification (e.g., *Kazakhstan-2030* and *Kazakhstan-2050*), Kazakhstan's economy remains burdened by the resource curse and vulnerable to external shocks that could destabilise the political system. The society is pacified through emphasis on economic development and social benefits, in exchange for unrestrained governance (Ibadildin & Pisareva 2020; Lemon 2021; Terzyan 2022). The ability of informal networks to subvert efforts that alter rent-seeking mechanisms and power distributions limit the scope of possible reforms that would change the central administration. The system's vulnerability was once again underscored when the state sought Russia's intervention under the CSTO to resolve the 2022 civil unrest, aiming to maintain the current leadership (Kudaibergenova & Laruelle 2022).

Turkmenistan stands as an outlier in Central Asia due to its strong tribal political culture, which prevents social uprising as long as the government continues to effectively provide social and economic services and keeps external forces at bay by selling its gas (Anceschi 2008; Sullivan 2020; Bohr 2016). After declaring 'neutrality' in foreign relations in 1995, Turkmen policymakers reoriented the external security focus internally and avoided regional involvement (Anceschi 2010; Sullivan 2020). The president holds a 'prophet-like' status in the country. The *Ruhnama* (Soul Book), introduced by the first president Niyazov, aimed to codify spiritual conduct and establish a pseudo-ideology consisting of folk histories and tales. This book has been central to nation-building efforts and the government's attempts to unify the people and mitigate regional and tribal divisions (Horák and Polese 2016). Following Berdimuhamedov's succession in 2006, he immediately replaced Niyazov's inner circle with his own family members. The institutionalisation of family corporations into Turkmenistan's political structure allowed Berdimuhamedov's power to extend

[40] The Popular Mobilisation Forces (PMF), formed in 2014 to counter Daesh, operates autonomously despite being officially part of Iraq's defence system. With ties to Iran, Syria, and Russia, it functions both within and outside the central administration, leveraging ideological sentiments and political power in elite negotiations.
Unknown, " From Syria to Ukraine: the growing relationship between Russia and the PMF factions [من سورية إلى أوكرانيا: العلاقة المتنامية بين روسيا وفصائل الحشد الشعبي في العراق]", *The Emirates Policy Centre*, January, 5, 2023, https://epc.ae/ar/details/featured/alalaqat-almutanamia-bayn-rusia-wafasayil-alhashd-alshaabi-fi-aleiraq

across all facets of political and economic life, perpetuating tribe-based structures. For example, the Party of Industrialists and Enterpreneurs of Turkmenistan (PIET), sponsored by Alexander Dadaev, owner of the largest private business in Turkmenistan, illustrates the shift towards 'façade multipartism' that prioritises economic development opportunities and regime longevity. PIET reportedly controls 60% of Turkmenistan's non-hydrocarbon exports (Durdyzhan 2018). Despite this, PIET and Dadaev's influence remain dependent on patronage to the president.

Bibliography [2,156w]

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9- Re-evaluation of China's BRI activities in Central and Eastern Europe and its domestic and geopolitical and geoeconomic-dimensions

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Re-evaluation of China's BRI activities in Central and Eastern Europe and its domestic and geopolitical and geoeconomic-dimensions

Keywords: 1. China-led BRI, 2. state and companies/firms complex, 3. investment and finance, 4. Central and Eastern Europe (CEE), 5. energy and infrastructure, 6. geopolitical economy, 7. the EU. 8. Russian-Ukrainian War and its impacts on China-BRI in CEE.

ABSTRACT
This study deploys a (geo-)political economic perspective to analyze how the China-led BRI had been implemented in Central and Eastern Europe (CEE)-countries, mainly through China's state and firms.
We selected CEE as one of the main geographical locations for China's BRI activities in Europe. We have selected two main economic sectors of CEE namely energy and infrastructures where the China's firms are involves. The study analyses (i) the role of the Chinese state and state-led companies and firms involved with these sectors and their cooperation with the local companies and firms, (ii) their domestic impacts on local agents, and (iii) the geopolitical and security impacts on the Europea (EU).

By examining the presence and activities of China's state-led companies and firms in the energy and infrastructure sectors of the countries belonging to CEE, we argue that China is gradually increasing its weight over the economics and politics of CEE countries by contributing to their economies. However, the unfolding war between Ukraine and Russia seems to have disrupted this trend, the war seems to have raised suspicions on China's BRI activities and intentions.

The main Research question that guided study
What are the national and (geo-,)political economic impacts of the China-led BRI activities (i.e., trade, investment and finance) in two key economic sectors (energy and infrastructure) of selected countries in Central and Eastern Europe (CEE), and what challenges do they raise for the European Union's economic and security interests in this region and their respective countries?
Do BRI involvement in CEE pave the way for Chinese state-led companies to institutionalize their activities in the selected countries and region? How does the institutionalized politics of EU and its member states adapt to these changes? How will the EU deal with the impact of the Russian-Ukrainian War on the EU's political and economic cooperation with China?

Main research question

What are the national and (geo-,)political economic impacts of the China-led BRI activities (i.e., trade, investment and finance) in two key economic sectors (energy and infrastructure) of selected countries in Central and Eastern Europe (CEE), and what challenges do they raise for the European Union's economic and security interests in this region and their respective countries? How does the institutionalised politics of EU and its member states adapt to these changes?

Subquestions: What are the trends of changes in trade, investment, finance, and diplomacy mainly since the collapse of the Soviet Union and what are the impacts of the launch of the BRI? What are the roles of Chinese (co-)designed international and multilateral institutions (e.g., the Belt and Road Initiative, Shanghai Cooperation Organisation, and Asian Infrastructure Investment Bank) for the mobilisation of material and human resources for creating a China-led regional network of trade, capital, information, and technology? Do these activities and organisations pave the way for Chinese state-led companies to institutionalise their activities in the selected countries and regions? What are the dual impacts of China's comprehensive political and economic activities on national-

, and geopolitical levels? What is the geopolitical economic impacts of the China's BRI activities ? How should the EU respond to the changes in the regional order underway? How should the EU deal with the impact of the Russian-Ukrainian War on the EU's political and economic cooperation with China?

This research paper consists of [following ?] section. Following part one (i.e., research objectives, questions, literature review and theory) section two ……

Research Methodology [try to summarize this part]

The methodology used in this research is based on mixed methods (i.e., qualitative and quantitative) and semi-structural interviews. The interviews tap into time-bound and partly personal points of view. These data will be compared against the ongoing data trends noted above. Qualitative data is partly gathered from primary and secondary sources in the selected case countries….

The methodology used in this research is based on mixed methods (i.e., qualitative and quantitative) and semi-structural interviews. The data originating from the mixed methods will be compared against the ongoing data trends noted above. Qualitative data is gathered from primary and secondary sources in the selected case countries.

Economic data has been gathered from the following institutes for trade, investment, and finance: *Trade* data from UNComtrade and IMFdata provide import/export data desegregated by countries of origin/destination. This data serves to (1) analyse the evolution of China's trade with the observed regional (i.e., Central and Eastern Europe) and national actors (e.g., Poland and Hungary), and (2) identify China's place in their trade relations in comparison to other major trade partners. Data from UNComtrade and Atlas of Economic Complexity provide import/export data desegregated per commodity types. This data serves to determine the nature of trade interdependencies of the observed actors with China.

Investment data is gathered from the following databases that complement each other to complete the investment analysis:

- The "China Global Investment Tracker" from the American Enterprise institute (AEI) gathers China's overseas investment and construction combined since 2005.
- The "Chinese Investment in Central and Eastern Europe Data Set" from the Central and Eastern European Center for Asian Studies (CEECAS) aggregates Chinese FDI and infrastructure investment in CEE since 2005.
- The "Global Power Database" from Boston University tracks global power plants outside of China financed by Chinese foreign direct investment (FDI) and/or China's policy banks.
- The "China Overseas Finance Inventory Database" from the World Resource Institute which consolidates nine different source databases to include the transaction details of 584 investments in 509 power plants. The database is a collaboration between the Boston University Global Development Policy Center, the Inter-American Dialogue, the China-Africa Research Initiative at Johns Hopkins University and World Resources Institute.
- The "Reconnecting Asia Project Database" from the Center for Strategic and International Studies tracks seven types of infrastructure projects – power plants, roads, rails, ports, intermodal, transmission, and pipelines – active across Eurasia since 2006.
- The website of the Ministry of Commerce of the People's Republic of China (MOFCOM) provides further details about specific projects. While all investments will be included in the analysis, a special attention will be given to the energy and infrastructure sectors.

These datasets will serve to (1) show the evolution of Chinese investments in the region and each country, (2) determine the share of Chinese investments in comparison to other major investor countries, (3) find in which sectors of which countries Chinese companies invest most, and (4) determine which Chinese companies invest in which countries and sectors, and how they are related to one another.

Finance data is gathered using two sources. The first source is Aiddata "Chinese development finance dataset" and will serve two purposes. First, to understand which countries, sectors, and projects China decides to provide finance. Second, to highlight the connectivity between Chinese financial institutions, host countries, and sectors. The second source is the World Bank "International Debt Statistics" dataset and will serve to analyse each country's debt level to China.

The interviews tap into time-bound and partly personal points of view. The interviews based on a questionnaire will target academic audiences in CEE countries, like Poland (Adam Mickiewicz University Poznan), Romania (Babeş-Bolyai University), Croatia (Center for International Relations and Sustainable Development at University of Zagreb), Hungary (Institute for Foreign Affairs and Trade; Lajos Kossuth University of Debrecen). Depth interviews with key policy makers in selected CEE countries.

Theoretical and conceptual framework for the study of China's-led BRI activities
To be added

Chinese foreign policy towards Central and Eastern Europe (CEE)

To understand Chinese foreign policy towards Central and Eastern Europe (CEE) and its specific features, we will begin by considering three broader aspects within which China-CEE relations have developed in previous years.

- First, Chinese policies towards CEE are driven by the general context of Chinese foreign policy.
- Second, most of the countries of Central and Eastern Europe are members of the European Union (EU), and China, as well as the EU members, have insisted that China-CEE relations are in line with the EU-China relations, allegedly even promoting them and the European integration.[41]
- Third, China-CEE relations have become part of the BRI, which has almost exclusively engaged the developing countries of the Global South.

Understanding these three broader contexts within which China-CEE dynamics take place will help us identify China's interests in the region, as well as the challenges it is facing.

Chinese foreign policy

China's external relations are designed by the party-state that controls the public and key socio-economic institutions. Former high ranking diplomat Dai Bingguo offered a general picture of China's foreign relation's purpose.[42] First, to preserve China's form of government and political system, namely the leadership of the Communist Party of China, the socialist system and socialism with Chinese characteristics. Second, to preserve China's sovereignty, territorial integrity and national unity. Third, to guarantee sustainable economic and social development of China.

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[41] Song, Lilei. 'China Is Uniting, Not Fracturing, Europe'. East Asia Forum, 2018. https://www.eastasiaforum.org/2018/08/11/china-is-uniting-not-fracturing-europe/.

[42] Dai, B. (2010, December 13). *"Stick to the path of peaceful development."* China Daily. http://www.chinadaily.com.cn/opinion/2010-12/13/content_11690133.htm.

It is noteworthy that this classification puts the Party-State security first, meaning that China's foreign policy should first and foremost contribute to the stability of the political system. In this understanding, national security, economic development, and external relations are supposed to contribute to securing the dominant role of the leadership or state-class in China's political system. In power since 2012, President Xi Jinping has put more emphasis on the role of the party state in every aspect of China's political, economic, and social spheres. In the words of President Xi, "Party, government, military, civilian, and academic; east, west, south, north, and centre, the Party leads everything."[43]

EU-China relations: partners, competitors, rivals

China's relations with the EU and its Member States are an important part of China's external relations. The importance of EU-China relations is often underestimated but it is arguably the second most important bilateral relationship in contemporary Global Politics after the US-China one – and perhaps the most important economic relationship altogether.

This position is a result of the volume and nature of the EU-China trade and investment, frequently involving technology transfers on which China has relied significantly for its economic development.[44]

The EU is also a crucial strategic actor for China who together with a number of regional major developing countries (e.g., the member states of the BRICS+) among others, which has long called for a multipolar world order in which the US would not dominate the global system as a hegemonic power, as it has tried to do at least since the end of the Cold War. Such a multipolar system, however, would be difficult to achieve without the EU taking the role of a 'autonomous' order separated from the US. Thus, China has long called for the EU to become more active in its external relations – which in this context means that the EU would not follow the US in its increasingly all-round strategic opposition to China.[45]

In this context and with its policies towards the countries of CEE, China has been accused of 'dividing' the EU's unity and undermining the trans-Atlantic partnership.[46] Based on the above-mentioned analysis, an internal division of the EU does not seem to be in China's interest, although growing the trans-Atlantic gap indeed does.[47] Yet, other aspects making the EU critically significant for China are the Union's substantive role in global governance, including key issues and bodies such as climate change, the G20, the United Nations (UN), and its symbolic weight as a long-time (more or less consistent) supporter of international law and norms. Indeed, the EU has long made it clear that it sees China as a necessary partner to deal with on various global issues and would continue to engage it.

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[43] Tiezzi, Shannon. 'Xi Jinping Continues His Quest for Absolute Party Control'. The Diplomat. 10 July 2019. https://thediplomat.com/2019/07/xi-jinping-continues-his-quest-for-absolute-party-control/.

[44] Šebeňa, Martin, 'Chinese economic miracle: How did an underdeveloped country change into a world leader?' in Kironska, Kristina, and Richard Q. Turcsanyi, 2023, *Contemporary China: A New Superpower?* New York: Routledge.

[45] PRC Ministry of Foreign Affairs. (2021). "*China, EU agree to promote multilateralism, support free trade*", https://www.fmprc.gov.cn/mfa_eng/zxxx_662805/t1577723.shtml.

[46] Thorsten Benner and Jan Weidenfeld, 'Europe, Don't Let China Divide and Conquer,' *Politico*, March 19, 2018, https://www.politico.eu/article/europe-china-divide-and-conquer/.

[47] Filip Šebok Richard Q. Turcsányi, China as a Narrative Challenge for NATO Member States, NATO StratCom Centre of Excellence, Riga, 2021. https://stratcomcoe.org/publications/china-as-a-narrative-challenge-for-nato-member-states/220

As a result, contrary to often repeated claims about China's uniformly 'anti-Western' position,[48] China's foreign policy towards the EU and its Member States has long significantly differed from its policy towards the US. As an example, Chinese diplomacy is much more restrained with Europe than with the US.[49] At the same time, this is not to say that the EU-China relations have been friendly and stable. On the EU side, there has been growing disappointment with China's domestic and external relations, including in the areas of human rights and the question of Taiwan or the South China Sea, among others.[50]

Since 2019, the EU has publicly described China as a 'systemic rival promoting alternative forms of global governance'.[51] This label only became more visible in 2023, when the European Commission (EC) President Ursula von der Leyen introduced the concept of 'de-risking' approach towards China,[52] which has subsequently become influential across the EU.

The described dynamics of the EU-China relations has also taken place in the context of the much more critically worsening US-China relations since Donald Trump became the US president in 2017. Being a close partner of the US, the EU and its member states have been under considerable US influence to take a more assertive stance towards China. Although it is difficult to assess the actual impact, at least in some instances, such as the issue of the Huawei involvement in 5G, the US has probably played a significant influence.

The political disparities between the EU and China were most evident in relation to the Comprehensive Agreement on Investment (CAI) between the EU and China.[53] CAI was supposed to replace bilateral investment agreements China had with most of the individual EU Member States and thus substantially enhance the investment between the two sides. Besides, CAI could serve as a step towards a potential EU-China free trade agreement to be negotiated and concluded in the future and, symbolically, as a further step in deepening economic relations between the two sides.

It took seven years to negotiate CAI, and an agreement was finally reached at the end of Germany's Council of the EU presidency in December 2020. The agreement was, however, still supposed to be ratified by the European Parliament (EP) before being put in place. While contemplating the future of CAI, in a separate process, the EP sanctioned four Chinese individuals and one entity which it saw as directly responsible for human rights abuses in Xinjiang. In response, China announced sanctions on 10 individuals and four entities in the EU, including Members of the EP, independent scholars and a think tank. In turn, the EP announced it would freeze the process of CAI ratification until China puts down the sanctions.[54] (Need to investigate the changing attitude of the EU towards China here)

48 Zheng Wang, Never Forget National Humiliation. Historical Memory in Chinese Politics and Foreign Relations, New York: Columbia University Press, 2014.

49 Mochtak, Michal, and Richard Q. Turcsanyi. 'Chinese Ministry of Foreign Affairs Press Conferences Corpus (CMFA PressCon)'. Harvard Dataverse, 21 January 2023. https://doi.org/10.7910/DVN/BAKGET.

50 Andrei Lungu, EU–China relations disintegrating on autopilot, East Asia Forum, 2023. https://www.eastasiaforum.org/2023/02/02/eu-china-relations-disintegrating-on-autopilot/

51 "EU-China – A strategic outlook", European Commission, 12 March 2019.

52 European Commission - European Commission. 'Speech by the President on EU-China Relations'. Text. Accessed 15 July 2023. https://ec.europa.eu/commission/presscorner/detail/en/speech_23_2063.

53 https://www.csis.org/analysis/rise-and-demise-eu-china-investment-agreement-takeaways-future-german-debate-china

54 EP, 2021, Chinese counter-sanctions on EU targets, https://www.europarl.europa.eu/RegData/etudes/ATAG/2021/690617/EPRS_ATA(2021)690617_EN.pdf

In hindsight, CAI might be seen as a turning point in EU-China relations. On the one hand, its negotiation and conclusion were in line with the previous practice of more or less unrestricted and unconditional deepening economic relations between the two sides. On the other hand, its freezing could be seen as the 'new normal' of the relationship when political disagreements put clear limits on the economic exchanges, making further deepening – and even current level – seen as potential political and strategic problems.

Belt and Road Initiative (BRI) and CEE

Finally, let us consider the BRI, which was initially announced in 2013 by President Xi Jinping and has since become the flagship of most of China's international and transnational relations (see theoretical section[][]).

The China-watching community has naturally paid great attention to this initiative and has come up with several interpretations of what China trying to achieve with the BRI.[55] While positions naturally differ, in can generally said that the prevailing view has been gloomy about the nature of China's plans, while more sceptical about its abilities to deliver due to the challenges.

The China-led BRI purpose seems to mobilise various actors to contribute to its making and continuous reshaping. Moreover, although China naturally wants to expand its power and influence, akin to the ambitions of numerous other international actors, China-watchers have harboured enduring scepticism regarding assertions that China seeks to dominate the global system or emerge as a contender to the US.[56]

What is important to underline for our purposes, is that the BRI initiation was not such a revolutionary event in Chinese foreign policy but rather a continuation of many previous trends. Particularly for the China-CEE relations it is telling that the 16+1 platform was started already in 2011-2012 under the administration of Hu Jintao and Wen Jiabao – thus, before Xi Jinping came to power and announced the BRI. As such, it is noteworthy, that the 16+1 platform has copied many of the patterns applied previously (and subsequently) by Chinese diplomacy.[57]

The formation of the China-CEE 16+1 platform occurred against the backdrop of the 2008 financial crisis, which notably impacted the CEEC due to their reliance on Western neighbours. This circumstance spurred the emergence of "economic patriotism" in nations such as Poland and Hungary. Consequently, the allure of potential economic gains led these countries to diversify their economic partnerships beyond their traditional alliances, including forging closer ties with external powers like China.[58][59]

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55 Hall, Todd H, and Alanna Krolikowski. 'Making Sense of China's Belt and Road Initiative: A Review Essay'. *International Studies Review* 24, no. 3 (1 September 2022): viac023. https://doi.org/10.1093/isr/viac023.

56 Doshi, Rush. *The Long Game: China's Grand Strategy to Displace American Order*. Bridging the Gap. Oxford, New York: Oxford University Press, 2021.

57 Injoo Sohn, "After Renaissance: China's Multilateral Offensive in the Developing World," *European Journal of International Relations*, Vol. 18, No. 1 (2012), pp. 77–101; Chris Alden and Ana Cristina Alves, "China's Regional Forum Diplomacy in the Developing World: Socialisation and the 'Sinosphere'," *Journal of Contemporary China*, Vol. 26, No.103 (2017), pp. 151-65; Jakub Jakóbowski, "Chinese-led Regional Multilateralism in Central and Eastern Europe, Africa and Latin America: 16 + 1, FOCAC, and CCF," *Journal of Contemporary China*, Vol. 27, No.113 (2018), pp. 659-73.

58 Oehler-Şincai, Iulia Monica (2017) 'The 16+1 Process: Correlations between the EU Dependency/Attitude Matrix and the Cooperation Intensity with China', Conference Paper, Institute for World Economy, Romanian Academy.

59 In fact, the '16+1 Cooperation' was already started in 2011-2012 under the administration of President Hu Jintao and Wen Jiabao – thus, before Xi Jinping came to power and announced the BRI. As such, it is noteworthy that the 16+1 platform has copied many of the patterns applied previously (and subsequently) by Chinese diplomacy (Injoo Sohn, "After Renaissance: China's Multilateral Offensive in the Developing World," *European Journal of International Relations*, Vol. 18, No. 1 (2012), pp. 77–101; Chris Alden and Ana Cristina Alves, "China's Regional Forum Diplomacy in the Developing World: Socialisation and the 'Sinosphere'," *Journal of Contemporary China*, Vol. 26, No.103 (2017), pp. 151-65; Jakub Jakóbowski, "Chinese-led Regional

In 2012, the CEEC judged that developing relations with China was an acceptable political move to achieve economic benefits. However, ten years later, the political costs of being seen as overly cosy with China have increased, while economic benefits have not materialised. Eventually, this led in 2021 to Lithuania announcing it would leave the China-CEE platform entirely – Latvia and Estonia followed the year later. Meanwhile, several other CEEC have led the EU in opposing China's inclusion in 5G (such as the Czechia, Poland, and Romania) and limiting their willingness to continue in the high-level exchanges with China, although not publicly announcing that they would leave the platform.[60] Finally, when Russia started its full-fledged invasion of Ukraine in February 2022, China was largely seen as a culprit across the region.[61] Several CEEC became even opposed to any engagements and exchanges with China, criticising Western European politicians for their efforts to continue channels of communication and paying official visits to China.[62]

Unless China misunderstood the region and its capacities, it is reasonable to argue that China initiated the China-CEE exchanges with the aim of increasing its unusually limited economic role in the region, improve in some cases problematic political relations, and thus build presence which could allow China to increase its political influence in the EU and NATO. Hungary has proven that China has, to some extent, succeeded in this respect. A reasonable explanation is that China has become a political tool for Prime Minister Viktor Orban in messaging that Hungary has more options than just its Western partners.[63]

The CEE region is not China's special economic partner in the EU or worldwide – instead, it may be the region with the least economically developed relations with China. The CEE countries do not contribute significantly to the goals of BRI [64].

Thus, it may be concluded that the political role of the CEE countries – defined both through symbolic and strategic reasoning – far surpasses its economic role. Indeed, while economically they are for China almost irrelevant, politically they offer a chance to influence some of the most important international dynamics from China's perspective, while they also carry some specific potency in touching upon China's most sensitive issues as they emerged from decades under the Communist rule. Moreover, rather than being a consistent bloc of China-friendly countries with high levels of China's economic influence – most of the CEE countries are at best open to

Multilateralism in Central and Eastern Europe, Africa and Latin America: 16 + 1, FOCAC, and CCF," *Journal of Contemporary China*, Vol. 27, No.113 (2018), pp. 659-73.). Already at the end of President Jiang Zemin era, in 2000, the first such multilateral forum was established with the African countries – FOCAC (Forum of China-Africa Cooperation). Thus, the '16+1 Cooperation' of China-CEE relations became formally a regional subproject of the BRI in 2015 during the summit in Suzhou (the first taking place on Chinese soil). In effect, the management and the overall process of the China-CEE exchanges have not changed much since the BRI label was formally applied, although the process did benefit from additional available avenues through which it could further develop and from the yet higher emphasis China has placed on anything related to the BRI. In other words, various projects of national or subnational character within the China-CEE scope could have been promoted even more effectively when referring to the BRI label. Many projects previously started before the BRI were then included under the initiative of the BRI. See: Garlick, Jeremy. 'China's Principal–Agent Problem in the Czech Republic: The Curious Case of CEFC'. *Asia Europe Journal* 17, no. 4 (1 December 2019): 437–51. https://doi.org/10.1007/s10308-019-00565-z.

60 https://thediplomat.com/2021/02/how-chinas-171-became-a-zombie-mechanism/

61 https://www.foreignaffairs.com/articles/china/2022-06-10/has-china-lost-europe

62 https://www.chinafile.com/conversation/macron-arrives-beijing-whats-next-europe-and-china

63 Turcsanyi, Richard Q., Kamil Liškutin, and Michal Mochtak. 'Diffusion of Influence? Detecting China's Footprint in Foreign Policies of Other Countries'. *Chinese Political Science Review* 8, no. 3 (1 September 2023): 461–86. https://doi.org/10.1007/s41111-022-00217-5.

64 Turcsányi, Richard, and Runya Qiaoan. 'Friends or Foes? How Diverging Views of Communist Past Undermine the China-CEE "16+ 1 Platform"'. *Asia Europe Journal*, 2019, 1–16.

engagements with China to the extent these would be economically beneficial for them, while not undermine their relationship with the EU and NATO. We need to discuss this sentences!

To sum up, the political role of the CEEC – defined both through symbolic and strategic reasoning – far surpasses its economic role. Although almost irrelevant economically, they provide a political opportunity to influence some of the most important international dynamics from China's perspective. Additionally, they carry some specific potency in touching upon China's most sensitive issues as they emerged from decades under Communist rule (need to elaborate what is meant by Communist rule and how that relates to their view on China).[65]

Moreover, rather than being a consistent bloc of China-friendly countries with high levels of China's economic influence – most of the CEEC are at best open to engagements with China to the extent these would be economically beneficial for them while not undermining their relationship with the EU and NATO.[66] **Need to discuss**

China-CEE economic section

This section discusses the economic relations between China and the 17 Central and Eastern European countries (CEE17) which were once part of the Cooperation between China and Central and Eastern European Countries (CCCEEC) (i.e., Albania, Bosnia and Herzegovina (BiH), Bulgaria, Croatia, Czechia, Estonia, Greece, Hungary, Latvia, Lithuania, North Macedonia, Montenegro, Poland, Romania, Serbia, Slovakia and Slovenia). When looking at the exports to China and Chinese investments, CEE exhibits relatively underdeveloped economic ties with China, especially when compared to their Western neighbours.

1) **Trade**

Our first analysis regards the European Union (EU) and CEE17 trade relations with China and the United States (US) between 2000 and 2022. Figure 1 shows that the EU has an established positive trade balance with the US and a negative one with China. This trade imbalance became a reason for the Trump administration to promote economic nationalism by introducing restrictions on European goods in 2018. Simultaneously, Sino-European economic ties were being fostered through the negotiation of the CAI (see introduction).[67]
Although accelerated by the pandemic, these relational developments were instrumental to China's short-lived takeover from the US as the EU's first trading partner for goods in 2020. Member States' trade with China nevertheless evolved heterogeneously, with for instance Germany's imports increasing by $10.56b and France's reducing by $18.41b.
The Biden administration's return to multilateralism enabled the 2021 launch of the 'EU-US Trade and Technology Council' (TTC) aiming at fostering transatlantic cooperation on

[65] Turcsányi, R., & Qiaoan, R. (2020). Friends or foes? How diverging views of communist past undermine the China-CEE '16+ 1 platform'. *Asia Europe Journal*, *18*(3), 397-412.
[66] Turcsányi, R. Q. (2020). China and the frustrated region: Central and Eastern Europe's repeating troubles with great powers. *China Report*, *56*(1), 60-77.
[67] Casarini, Nicola (2022) 'A European strategic "third way?" The European Union between the traditional transatlantic alliance and the pull of the Chinese market', China International Strategy Review, 4:91–107 https://doi.org/10.1007/s42533-022-00095-1

strategic economic sectors as a way to isolate China.[68] However, the main boost in EU-US trade leading Washington to regain its position was the $45b increase in petroleum gas imports in 2022 stemming from the energy crisis brought about from the Russia-Ukrainian war. Nevertheless, given the reliance on a singular commodity for this shift and historical trade trends, one can argue that China may reclaim its status as the EU's foremost trading partner in a close future.

With the largest part of CEECs being EU Member States, CEE17 and EU trade relations with China and the US follow similar trends (see Figures 2a and 2b). In 2022, some Western European countries like Germany or Italy re-equilibrated trade with the US by increasing the exportation of pharmaceutical products, mechanical appliances, or cars. Conversely, the CEECs export increase was insufficient to rebalance the sharp rise of petroleum gas imports and CEE17 experienced its first trade deficit with the US since 2010.

The escalating trade deficit arising from limited access to the Chinese market is a growing concern for both the EU and CEE17, as reiterated during the 24th EU-China summit where Brussels emphasized the necessity for a 'more balanced economic relationship'.[69]

However, it is noteworthy that much of the goods produced in CEE17 transits first through Western Europe – often Germany – before being exported to China and do not appear in the CEE17-China trade statistics. In 2022, China's share of CEE17 imports was the highest for electrical machinery (28.15%); raw hides, skins, and leather (23.37%); and machinery and mechanical appliances (20.28%).

Bilateral trade with China among CEECs nevertheless varies significantly. The Baltic states, who left the CCCEEC to pursue relations with Beijing under the EU umbrella, entertain weak economic ties with China. The sharp fall of Lithuanian exports to China (-61.62%) the year following its disengagement from the CCCEEC could similarly impact Estonia and Latvia in 2023.[70] Further south, Albania's abrupt 2022 shift in imports-exports from the US and China towards the EU can be attributed to its EU membership process acceleration, which incentivised tightening economic relations with the Union.[71]

Conversely, the Visegrád 4 (V4) (i.e., Czechia, Hungary, Poland, and Slovakia) being some of the largest CEE17 economies, they are also China's main trade partners, with Poland and Czechia being far ahead. Pro-China governments in Poland, Czechia, and Hungary seeking export and investment inflow opportunities during most of the 2010s were nevertheless dissatisfied by the results. Consequently, Czechia's new government is considering following the Baltic states and leave the CCCEEC. China's high share of Polish and Greek imports can also be explained by their key location on BRI corridors, namely the New Eurasia Land Bridge and the Maritime Silk Road.

Events in Poland may signify a possible distancing from Beijing in favour of Washington. In 2019, Huawei equipment was banned from the 5G rollout after Warsaw and Washington signed

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[68] See: Feng, Zhongping (2022) 'Internal and external factors affecting China–EU relations' China International Strategy Review (2022) 4:74–90, https://doi.org/10.1007/s42533-022-00108-z
European Commission, 'EU trade relationships by country/region', accessed on 26 September 2023, https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/united-states_en

[69] European Council, 'EU-China Summit, 7 December 2023', 7 December 2023, Accessed on 9 December 2023, https://www.consilium.europa.eu/en/meetings/international-summit/2023/12/07/

[70] Bērziņa- Čerenkova, Una Aleksandra, and Kārlis Bukovskis (2023) 'People's Republic of China in the Baltic states' Latvian Institute of International Affairs

[71] European Council, 'EU enlargement policy', Accessed on 24 September 2023, https://www.consilium.europa.eu/en/policies/enlargement/albania/

a joint declaration on 5G security.[72] Last year, imports shifted significantly from China (-$2.54b) to the US (+$5.46b) amid the war.[73] Poland's main import reduction from China was a $4.8b decrease electrical machinery and equipment. Conversely, Poland's main import augmentations from the US were $1.26b in mineral fuels (+$866m of petroleum oil), and $3.4b in commodities not specified according to kind. The latter's increase raises further questions regarding the specific type of goods so suddenly and direly needed from the US.

In the Western Balkans (WB), BiH, Montenegro and Serbia's high imports from China can be attributed to their inflow of Chinese loans, often conditional to importing Chinese goods.[74] Besides, Serbia and China entertain strong diplomatic relations and, contrarily to Brussels, Beijing is a key support to Belgrade's non-recognition of Kosovo as a sovereign state.[75]

In sum, although bilateral trade relations are heterogeneous, European countries are facing a structural and deepening trade deficit with China. In the following section we will see how Chinese state-led and private companies and firms'[76] (CSCFs) investments were instrumental in this endeavour.

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[72] Stolton, Samuel, 'US and Poland 5G agreement an 'example for Europe', Pence says', Euractiv, 3 September 2019, Accessed on 22 October 2023, https://www.euractiv.com/section/5g/news/us-and-poland-5g-agreement-an-example-for-europe-pence-says/

[73] Poland's mineral fuels import increase from the Us were a $866m in petroleum oils an $251m in coal.

[74] Conley et al., 2020b, 14.

Ghossein et al., 2021, 132.

Soyaltin-Colella, 2022, 9.

[75] Zweers et al. (2020), 18.

[76] Foreign investments by private firms are often guided by the state.

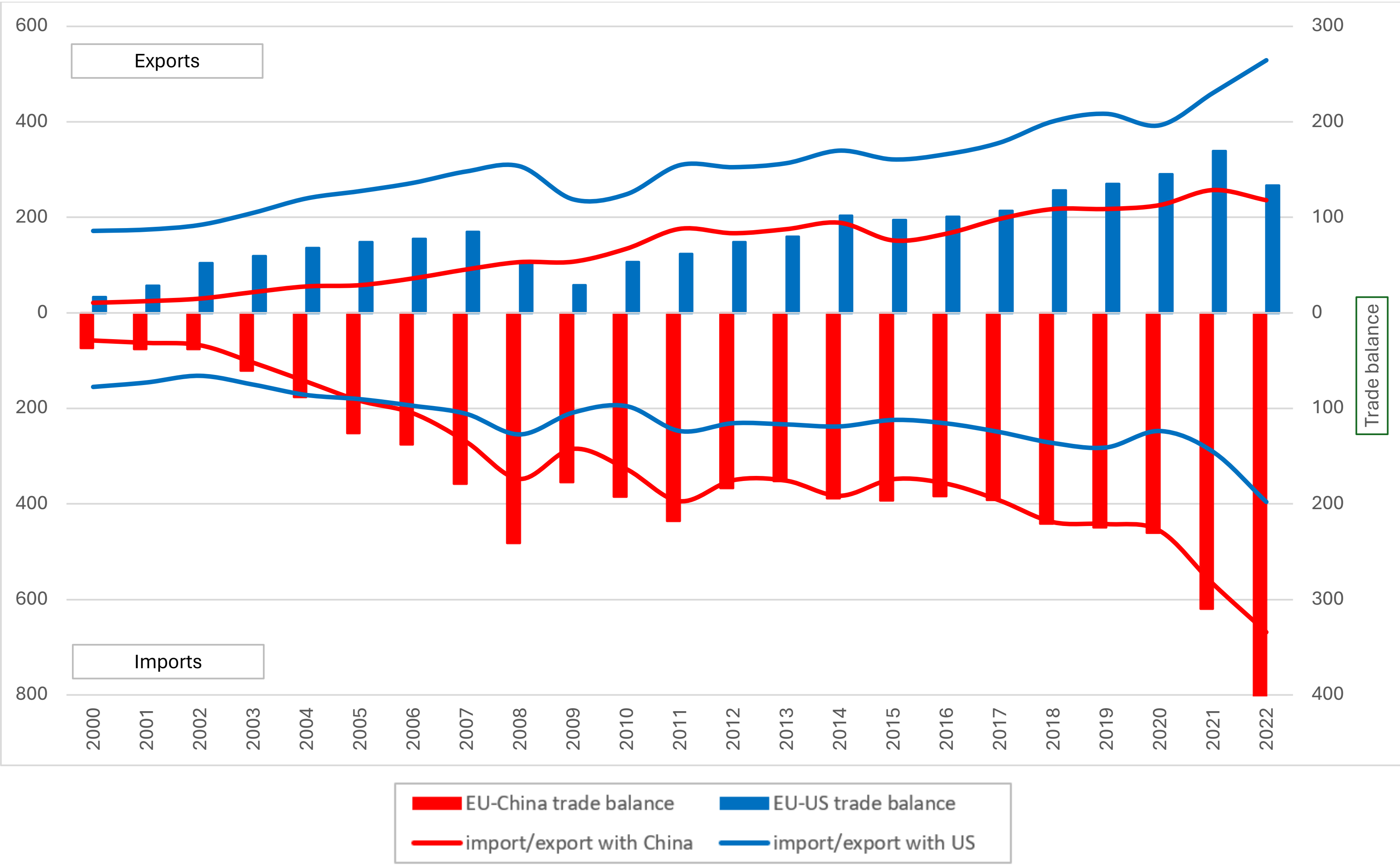

Figure 1. EU trade with China and the US, from 2000 to 2022 (in billion USD).
Source: UN Comtrade.
Note: Trade data compiles all bilateral trade with the 27 EU Member States from 2000 to 2022.

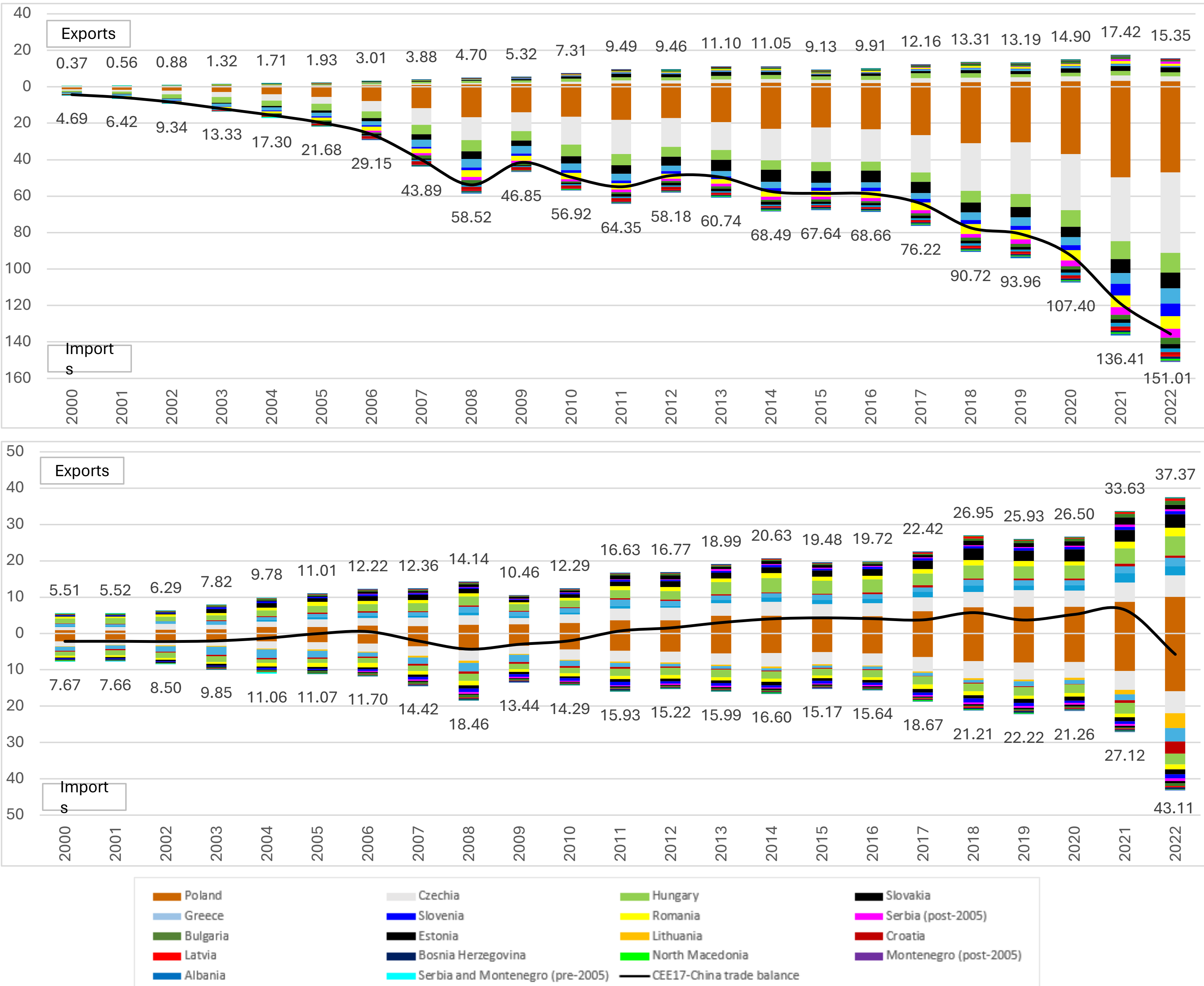

Figure 2a (top). CEE17 trade with China, from 2000 to 2022 (in million USD).
Figure 2b (bottom). CEE17 trade with the US, from 2000 to 2022 (in million USD).
Source: UN Comtrade.
Notes: Data compiles all bilateral trade with the 17 CEECs from 2000 to 2022.

2) Investments

This part analyses Chinese investments in CEE17 from 2012 to 2022 to encompass both the CCCEEC and the BRI. Mirroring trade trends, China's investments predominantly favour Western European nations with non-CEE Member States receiving approximately 90% of these investments over the covered period. Nevertheless, when interpreting such statistics, it is crucial to recognize that specific Chinese investments, such as the €1.2 billion investment made by Geely-owned car manufacturer Volvo in Slovakia, frequently bypass attention and are not consistently accounted for in datasets.[77]

Figure 3 illustrates the investment relations of CSCFs, and Figure 4 presents solely the energy and infrastructure[78] sectors, where most investments are concentrated (respectively 26% and 57.90%). China Communications Construction Company's (CCCC) overshadows other Chinese investors in the region with over $10b invested over 12 projects. As depicted in Table 1, Serbia is by far the largest recipient of Chinese investments, followed by Hungary and Greece. The predominant factor linking these three countries revolve around their strategic location along the China-Europe Land-Sea Express Route (Express Route). This initiative aims to modernise existing railway systems and bridge two BRI corridors, namely the New Eurasian Land bridge and the Maritime Silk Road. Moreover, as mentioned in the introduction, these nations have exhibited a notably receptive stance toward Chinese investments, viewing them as a means to bolster their political leverage in their relations with the EU. Noteworthy instances include Viktor Orban's implementation of the *Keleti nyitás* (Eastern Opening) strategy following the 2008 financial crisis,[79] Greece's perception of Chinese investments in the port of Piraeus as economic prospects amid Brussels-imposed austerity measures,[80] and Serbia's pressing need for infrastructure development and financial support, partially fulfilled by China in the face of unmet requirements from the EU.[81]

	Investment value	Number of investments
Serbia	16,780	27
Hungary	6,500	8
Greece	4,010	8
Poland	3,500	26
Bosnia	2,220	11

Table 1. Largest recipients of Chinese investments between 2012 and 2022, in million USD.
Source: American Enterprise Institute (2023), Boston University (2023), World Resources Institute (2023).

[77] Reuters 'Volvo to create 3,300 jobs at $1.25 billion EV plant in Slovakia', 1 July 2022, Accessed on 23 December 2023, https://www.reuters.com/business/autos-transportation/volvo-cars-build-electric-only-plant-slovakia-2022-07-01/#:~:text=OSLO%2C%20July%201%20(Reuters),based%20automaker%20said%20on%20Friday.

[78] Infrastructure sectors from our dataset include transport, technology, real estate, utilities, and logistics sectors.

[79] Marácz, L. 2023. "An assessment of the Hungarian partnership in the Chinese Belt and Road Initiative." In *The China-led Belt and Road Initiative and its Reflections: The Crisis of Hegemony and Changing Global Orders*, edited by Mehdi P. Amineh, 133-157. Abingdon: Routledge.

[80] Trigkas, Vasilis 'The Role of China in Southeast Europe: The Case of Greece' In 'The Role of China in Southeast Europe' by Anastas Vangeli, Friedrich Ebert Stiftung Report, June 2022.

[81] Zweers et al. (2020), 18.

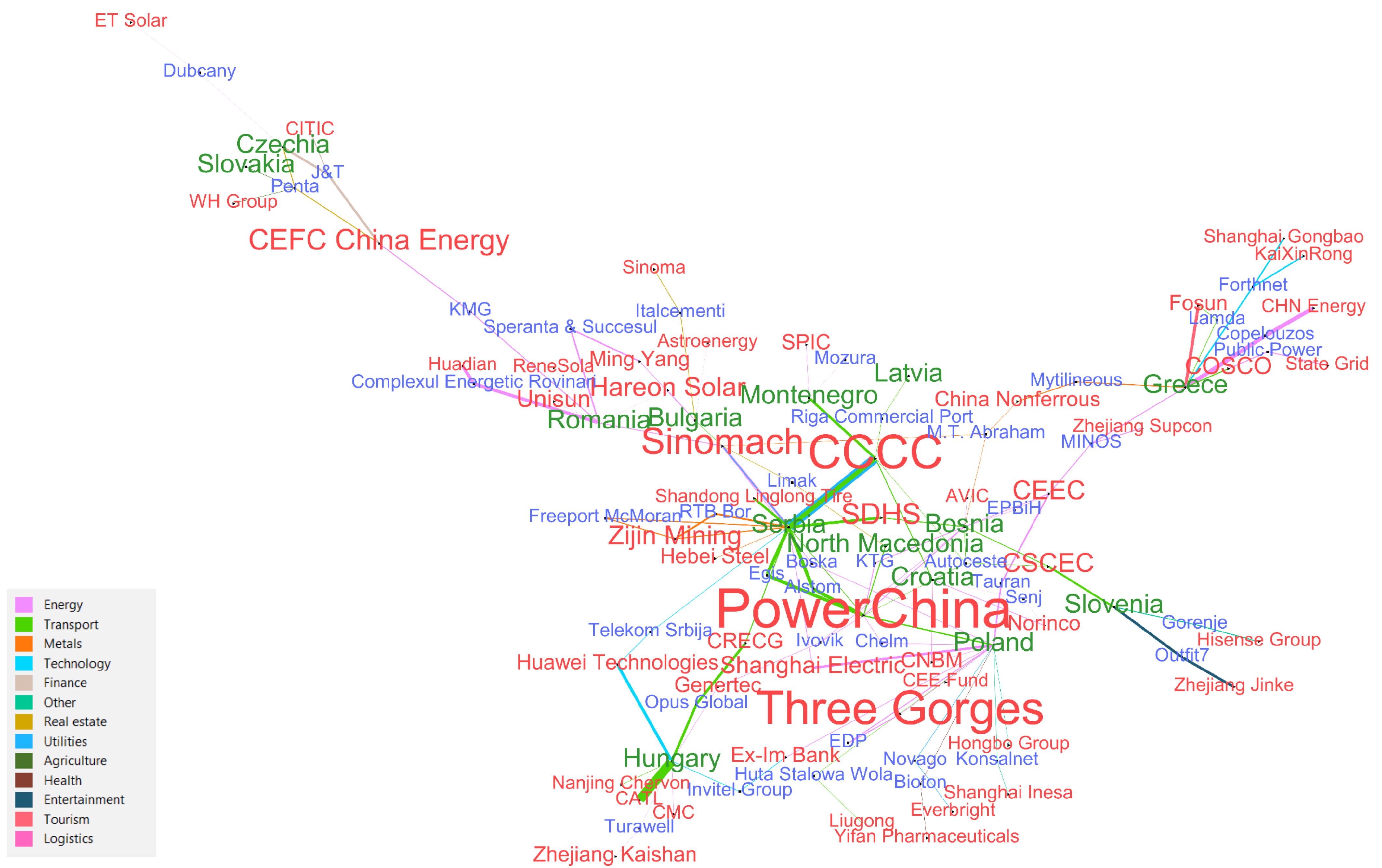

Figure 3. Chinese corporations' cross border investments in Central and Eastern Europe between 2012 and 2022 (all sectors).
Source: American Enterprise Institute (2023), Boston University (2023), World Resources Institute (2023).
Notes: The label colours differentiate Chinese CSCF (red), their transaction parties (blue), and the recipient country (green). Line represents investment connections between companies and countries. CSCF label size varies according to their number of investments. Lines thickness varies based on summed investment values.

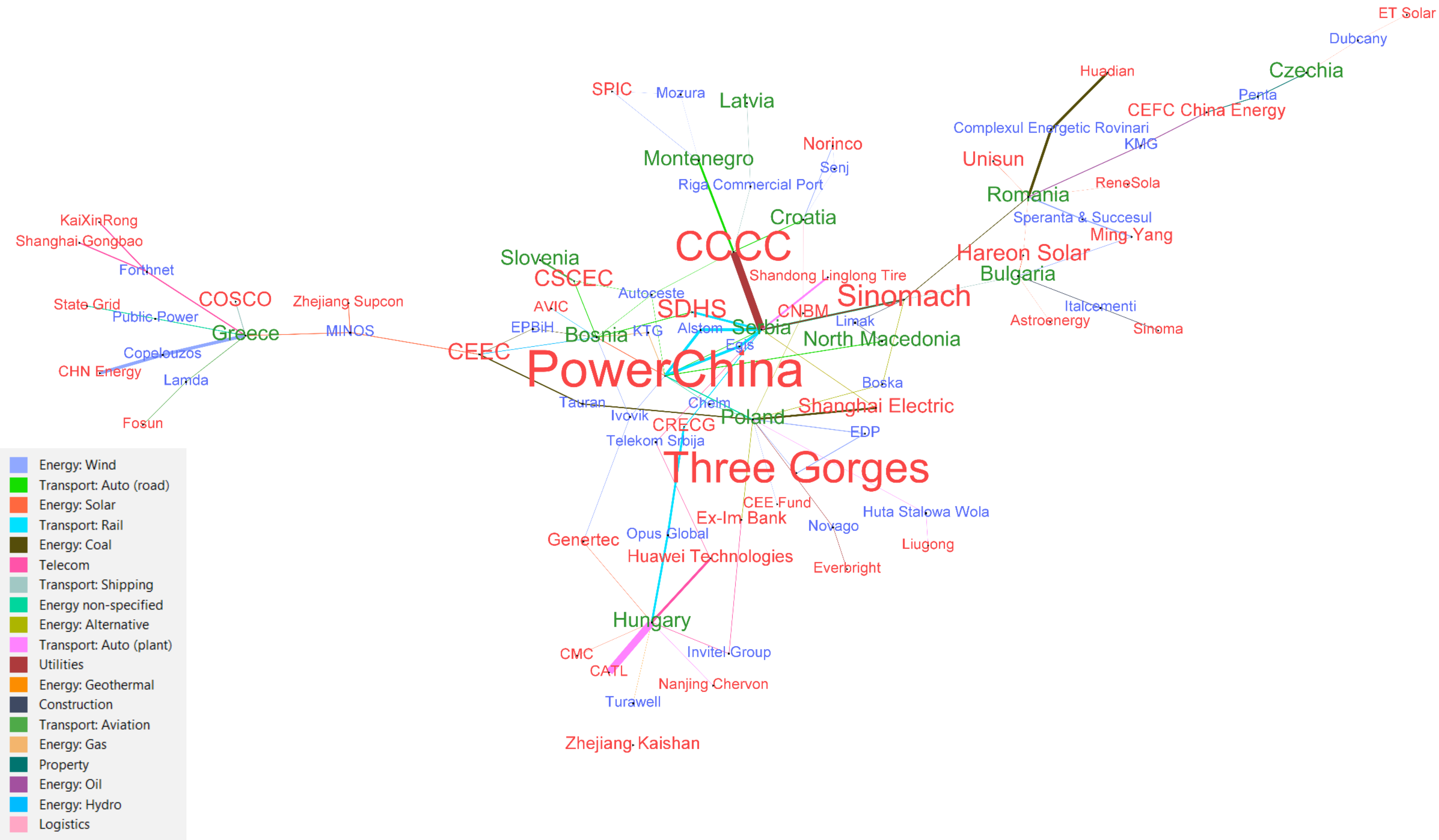

Figure 4. Chinese corporations' cross border investments in Central and Eastern Europe between 2012 and 2022 (energy and infrastructure sectors).
Source: American Enterprise Institute (2023), Boston University (2023), World Resources Institute (2023).
Notes: The label colours differentiate Chinese CSCF (red), their transaction parties (blue), and the recipient country (green). Line represents investment connections between companies and countries. CSCF label size varies according to their number of investments. Lines thickness varies based on summed investment values.

2.1.Infrastructure sectors

From Figure 4 and 5, we see that the lion's share of infrastructure investments is found in the transport sector, especially in road construction. CCCC's subsidiary China Road and Bridge Corporation (CRBC) and PowerChina are the leading CSCFs investing in multiple road construction projects across Poland, Serbia, Bosnia, Croatia, Montenegro, and North Macedonia. These investments are mostly sections of pan-European corridors, a European project aiming to improve transport connectivity across the continent Montenegro is home to the second-largest Chinese investment in road infrastructure in CEE17. CRBC was contracted to build the controversial 41-kilometre-long highway connecting Smokovac to Mateševo (see below section on finance). Over a third of the road infrastructure investments are in Serbia, where CRBC began in 2022 the construction of a 75-kilometre section of pan-European Corridor XI worth €1.7b.[82]

Three other Chinese investments in Serbia deserve further attention. The first is the largest Chinese project in the region to date: CRBC's €3.2 billion contract with the Serbian government for the *Čista Srbija* (Clean Serbia) project. CRBC provides the design and construction of wastewater treatment plants, sewage networks, and pumping stations, and the rehabilitation or construction of regional landfills.[83] Second, Zijin Mining's successive investments since 2018 highlight China's quest for critical minerals necessary for its domestic economy. Serbia's copper exports increased from $416.5m in 2019 to $1.77b in 2022, of which 51.68% went to China. Another major CRBC project in Serbia is the construction of the country's first industrial park, which will be jointly managed with the Serbian government. There will be three sub-parks (i.e., manufacturing and processing, trade and logistics, and high-tech industries), underlying the China's areas of desired expansion.[84] Adjoined to it is the Express Route, arguably the flagship project of the BRI in CEE17. In addition to boosting China-Europe trade, the Express Route should also be seen as a strategy to boost China's market shares of maritime container freight and has the advertised potential to enhance regional North-South trade.[85] The Express Route entry is the Greek port of Piraeus, in which China Ocean Shipping Company (COSCO) first invested in 2008. Coming to power in 2015, the SYRIZA party used China's support as leverage in negotiations with European creditors and the IMF. As part of a 2016 deal, the party allowed COSCO to first acquire 51% shares of the port in the same year, then to increase its shares to 67% in 2021.[86] In 2019, COSCO's subsidiary Ocean Rail Logistics acquired 60% of PEARL's shares, a Greek railway firm connecting Piraeus to Czechia and Austria, hence going through all countries along the Express Route.[87] Meanwhile, Athens has been a strong supporter of Beijing as it blocked EU statements critical of China in South China Sea events (2016) and

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[82] https://seenews.com/news/chinas-crbc-breaks-ground-for-17-bln-euro-motorway-section-in-serbia-777761
[83] https://balkangreenenergynews.com/serbia-invests-billions-of-euros-in-wastewater-treatment/
[84] https://industryeurope.com/sectors/construction-engineering/chinese-investment-to-build-serbias-first-industrial-park/
[85] Jakóbowski, J., Popławski K., Kaczmarski M. 2018. "The Silk Railroad. The EU-China Rail Connections: Background, Actors, Interests." Center for Eastern Studies.
Li, X. 2022. "China-Europe Land-Sea Express Route with the Belt and Road Initiative." In The Routledge Handbook of the Belt and Road, 2nd ed., edited by Cai Fang, Peter Nolan, and Wang Linggui, 496-499. London and New York: Routledge.
[86] Trigkas, Vasilis 'The Role of China in Southeast Europe: The Case of Greece' In 'The Role of China in Southeast Europe' by Anastas Vangeli, Friedrich Ebert Stiftung Report, June 2022.
[87] https://en.coscoshipping.com/art/2019/11/15/art_6923_124985.html . Accessed on June 23rd, 2023.
https://pearl-rail.com/

human rights records (2017).[88] Incidentally, it puts Piraeus at the core of the Sino-Greek relations as the port is essential to both Athen's economic growth and the development of the BRI in Europe. On the other end of the Express Route is the Budapest-Belgrade railway. While the project had already been agreed upon by China, Hungary, and Serbia in 2013, the first investments were only officialised in 2019.[89] The Hungarian section is to be built by China Railway Engineering (CRE) and the Hungarian firm Opus Global, of which each owns 50% of the project.[90] CRE and CRBC have each been contracted to build different sections on the Serbian side of the railway.[91] While no concrete project has been confirmed yet, future investments in North Macedonia are planned to connect the railway to Piraeus.[92] The geoeconomic significance of the Express Route is best highlighted by CATL's single investment (2022) (i.e., the second largest CSCF investment in the region) in Hungary. Building what is planned to be Europe's largest battery plant, CATL eyes the rapidly growing Western electric vehicle market – especially Germany. Although, there are concerns about the long-term benefits of the projects for the Hungarian economy.[93]

2.2.<u>Energy sector</u>

Figure 3 and 4 show that the energy sector attracts the largest number of Chinese investments, with the lion's share going to wind and solar. Coal-fired projects were undertaken in 2014 in Poland, Serbia, and Romania. In 2017, Shanghai Electric was contracted to build the last Chinese investment in fossil fuels in CEE17, a gas-fired plant for a joint venture between Serbian oil company NIS and Russian Gazprom.[94] Between 2012 and 2020, five fossil fuel investments have been cancelled, of which three were in large part abrogated due to domestic implementations of EU-led environmental policies. These three investments were from Huadian in Romania (i.e., Rovinari), China Exim Bank (CHEXIM) in BiH (i.e., Tuzla), and PowerChina in Serbia (i.e., Kolubara).
Three events in the renewable energy sector are noteworthy. First, investments in the solar sector in Bulgaria and Romania were prominent between 2012 and 2014 but ended abruptly. In Bulgaria, a 2012 policy cutting previously attractive Feed-in Tariffs stopped short Chinese investments in this sector.[95] On the Romanian side, successive governments unwilling to foster ties with China sided with the US on strategic issues, as exemplified by their blocking of Huawei's 5G network plans.[96] Second, the period from 2015 to 2019 saw investments in widerspread renewable energy sectors and countries. The surge in the wind sector is largely

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[88] Trigkas, Vasilis 'The Role of China in Southeast Europe: The Case of Greece' In 'The Role of China in Southeast Europe' by Anastas Vangeli, Friedrich Ebert Stiftung Report, June 2022.

[89] Li, X. 2022. "China-Europe Land-Sea Express Route with the Belt and Road Initiative."

[90] Rogers, S. 2023. "The emergence of the 'rentocrat'", *New Political Economy*, 8.

[91] The State Council Information Office of the People Republic of China, 'Chinese expertise brings cities closer together', 28 April 2023, accessed on 25 September 2023, http://english.scio.gov.cn/beltandroad/2023-04/28/content_85260685.htm.
Xinhua, 'Chinese-built Belgrade-Novi Sad railway celebrates 1st anniversary', 20 March 2023, accessed on 25 September 2023, https://english.news.cn/20230320/659a3a71409a4c8db3939840e19aefeb/c.html.

[92] See Arnaudof, M., Klimoska, K., Mileski, T., Nedic, P. (2023), and Vangeli, A (2022)

[93] Hompot, Sebestyén 'China's Controversial €7.3 Billion EV Battery Investment: A Game Changer in China-Hungary Relations', Central European Institute of Asian Studies, 20 November 2023, https://ceias.eu/chinas-controversial-e7-3-billion-ev-battery-investment-a-game-changer-in-china-hungary-relations/

[94] Reuters, 'Chinese group signs deal to build 200 MW cogeneration plant in Serbia', 31 October 2017, Accessed on 25 September 2023, https://www.reuters.com/article/serbia-nis-energy/chinese-group-signs-deal-to-build-200-mw-cogeneration-plant-in-serbia-idUSL8N1N6639

[95] Curran, L., Lv, P., Spigarelli, F. 2016. Chinese Investment in the EU Renewable Energy Sector: Motives, Synergies and Policy Implications. Energy Policy 101, 670-682.

[96] https://chinaobservers.eu/in-or-out-of-the-141-format-romanias-short-lived-romance-with-china-is-over/

due to Three Gorges activities in Poland. The company's largest investment was the acquisition of 49% of the wind portfolio in Poland and Italy from EDP (Energias de Portugal) in 2015.[97] Lastly, since 2021, virtually all Chinese energy investments went to BiH's wind and hydroelectric sectors. The increased appeal of BiH's renewable energy sector has likely been enhanced by the country's commitment to decarbonization in line with the EU's energy transition goals.[98] Particularly in Republika Srpska, the attraction to China's 'no-strings-attached' approach and financial aid contributes to this trend.[99]

3) <u>Financing key BRI investments</u>

The majority of Chinese loans are allocated to the less developed non-EU Balkan states, predominantly secured through state-to-state agreements with CHEXIM. These loans are typically exempted from conditionality, carry lower interest rates, and often include significant Chinese content requirements, making them riskier for the borrower.[100]

While the Chinese loan/investment ratio seems insignificant, some projects have major geoeconomic implications. Chinese financial institutions have chiefly focused on the WB transport and energy sectors.[101] Besides, the fact that all sections of the Express Route have been largely financed by Chinese loans underscores China's geoeconomic aspirations with this project.

The WB is a geopolitically strategic region attracting the attention of major players such as the EU, China, Russia, or Türkiye. The region's chief specificities are their EU membership candidacy and their dire need of infrastructure development investments. While the EU is their main economic partner – for trade, investments, and finance – its involvement is deemed insufficient and Chinese firms and financial institutions fill this vacuum. As such, China's economic involvement is ultimately helping to reduce the economic gap between WB countries and accelerate their accession process.[102]

As mentioned above, Serbia's role and location as a hub of the Express Route is essential for the implementation of the BRI in CEE. Consequently, Serbia may be the only country where 'China's promises' have been kept as its imports and exports rose significantly after experiencing a surge of Chinese investments and loans since the second half of the 2010s.[103]

The Montenegrin highway is the most controversial loan as it brought Podgorica to the centre of numerous debates concerning its indebtedness to China.[104] After failing to receive EU funding, Montenegro obtained a China Export Import Bank (CHEXIM) loan with a USD 10 billion credit line and including conditionality to contract CRBC without an open public tender.[105] However, costs increased rapidly and the country's public debt surpassed 100% in

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97 https://www.edp.com/en/news/2016/10/27/edpr-concludes-sale-minority-stakes-poland-and-italy

98 Kapetina, Sanja 'Country Commentaries: Bosna and Herzegovina', World Energy Council, March 2022.

99 Hasić, Jasmin 'the Role of China in Bosnia and Herzegovina' In 'The Role of China in Southeast Europe' by Anastas Vangeli, Friedrich Ebert Stiftung Report, June 2022.

100 Oldrich Krpec, and Carol Wise (2022) Grand Development Strategy or Simply Grandiose? China's Diffusion of Its Belt & Road Initiative into Central Europe', New Political Economy, 27:6, 972-988, DOI: 10.1080/13563467.2021.1961218

101 Gelpern et al., 2021; Matura et al., 2021

102 Danijela Jaćimović, Joel I. Deichmann, and Kong Tianping (2023) The Western Balkans and Geopolitics: Leveraging the European Union and China, Journal of Balkan and Near Eastern Studies, 25:4, 626-643, DOI: 10.1080/19448953.2023.2167164

103 Zweers et al. (2020), 18.

104 https://ecfr.eu/special/china-balkans/montenegro/

105 See Grgić (2017),
Sošić, M. (2021). Montenegro's Road Ahead: Infrastructure Between EU and China. Clingendael Institute. https://spectator.clingendael.org/en/publication/montenegros-road-ahead-infrastructure-between-eu-an

2020. After initially refusing, the EU assisted Montenegro in 2021 by setting up a hedging deal with four international banks, leading to renegotiations with CHEXIM and a reduction of the interest rate from 2.00% to 0.88%.[106] It remains to be seen whether the combination of its indebtedness to China with its NATO membership and Brussels assistance will bring the country away from China and closer to the EU. In the meantime, imports from China reached a new high (US$334.12m) on the year of the highway opening in 2022.

In BiH, Chinese imports and investments in road infrastructure and renewable energy grew sharply from 2020. Although both political entities – the Federation of BiH and Republika Srpska – were attracted to China's strategy of non-conditionality, their views of Beijing diverge increasingly. The latter, representing the country's Serbian population, follows Belgrade's strategy in fostering ties with Beijing.[107] However, there is no significant difference in their attractiveness for Chinese investments.

While WB countries are committed to the EU accession process, the combination of 'enlargement fatigue' and China's non-conditionality and prospect of low-cost infrastructure development incentivise fostering bilateral relations to meet short-term domestic needs. On the other hand, China would benefit from their EU accession as CSCFs would directly be integrated into the European market.[108] Besides, similarly to what happened with Greece after COSCO's investments, Beijing could push its agenda within the EU decision-making process through the WB countries. Still, there is potential for the EU, China, and the WB to all benefit from an improved tri-partite cooperation in supporting the region's economic development.

The impact of the Russian-Ukrainian war on China's 'Belt and Road Initiative' (BRI) activities in Central and Eastern Europe (CEE) against the backdrop of energy security in the European Union (EU)

On 24 February 2022, the Russian army invaded Ukraine, bringing war on the European continent. Here we will analyze the impact of the war on energy security in CEE and the consequences for China's BRI activities in that region.[109] Before discussing these issues, the deeper causes of the Russian aggression against Ukraine will be investigated.

During the 'Cold War' the US, and the Soviet Union including its main successor state the Russian Federation were the opposing parties. This period saw initiatives to de-escalate the US-Soviet tensions on the European continent. The first rapprochement between Europe and the Soviet Union was initiated by the German chancellor Willy Brandt in 1969. Brandt was

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Danijela Jaćimović, Joel I. Deichmann, and Kong Tianping (2023) The Western Balkans and Geopolitics: Leveraging the European Union and China, Journal of Balkan and Near Eastern Studies, 25:4, 626-643, DOI: 10.1080/19448953.2023.2167164

[106] See: IMF (2019), 2019 Article IV Consultation—Press Release, Staff Report, and Statement by the Executive Director for Montenegro, IMF Country Report No. 19/293, Washington, DC, International Monetary Fund.

Bennon, M., Fukuyama, F. (2022) "The obsolescing bargain crosses the Belt and Road Initiative: renegotiations on BRI projects." Oxford Review of Economic Policy, Volume 38, Number 2, pp. 278–301.

https://www.reuters.com/article/us-montenegro-debt-idUSKBN2ER1GO

https://balkaninsight.com/2021/07/09/montenegro-reduces-currency-risk-on-costly-chinese-highway-loan/

[107] See Krstinovska, A. (2022) "China's Aid in the Western Balkans: Supporting Development, Undermining Good Governance." Prague, Czech Republic, Association for International Affairs (AMO).

[108] Danijela Jaćimović, Joel I. Deichmann, and Kong Tianping (2023) The Western Balkans and Geopolitics: Leveraging the European Union and China, Journal of Balkan and Near Eastern Studies, 25:4, 626-643, DOI: 10.1080/19448953.2023.2167164

[109] 'Energy security' is here defined as "the uninterrupted availability of energy sources at an affordable price (IEA, 2019)."

ready to cooperate with the communist bloc to make the reunification of Germany possible.[110] The cooperation included mainly and foremost trade, and energy supply. With the fall of the Berlin Wall in 1989, the Cold War ended. According to Francis Fukuyama, the Western liberal system had won the Cold War over communism.[111]

Successive American presidents decided to push the West's political and military expansion further to the East.[112] This, contrary to what Western political leaders had promised to the last communist leader of the Soviet Union, Mikhail Gorbatsev.[113] As a consequence,Between 1999 and 2007, NATO integrated former Soviet satellites in CEE, including parts of the former Soviet Union.[114] The Western expansions to the East triggered suspicion among the new Russian leadership that NATO's eastward expansion was threatening the safety and security of Russia.[115]

The first serious clash between the West and Russia erupted in 2008. This year at the NATO Bucharest summit, the US pushed for another round of enlargement further to the Russian borders.[116] As the joining of Ukraine to NATO was perceived as extremely problematic by Moscow, France and Germany feared a Russian retaliation and obstructed the expansion. Besides, Germany wanted to keep expanding its trade and energy relations with Russia as the cheap supply of gas has had rendered its industries competitive.
The second crisis between the West and Russia in February 2014 events and led to the ousting of the elected, the Russian-leaning president Viktor Yanukovich.[117] Protesters in Kiev rallied for a closer cooperation between Ukraine and the EU and started the installment of a pro-Western government. As a reaction, strategic positions in the Crimea peninsula became occupied by the Russian army.[118] Backed by the Kremlin and Russian forces, the Luhansk and Donetsk regions in the Donbass – largely populated by ethnic Russians and traditionally oriented towards Moscow – declared their independence and started organizing a military resistance. Negotiations between Ukraine and Russia, involving France and Germany, did not de-escalate the conflict.[119] Contrariwise, the stalemate in the Donbass contributed to the Russian invasion of Ukraine in February 2022.[120]

Global actors have displayed a different stance on the Russian-Ukrainian war. The Western bloc, NATO and the EU fully supports the continuation of the Ukrainian war efforts.[121] Turkey, although a NATO member, represents a 'neutral' position.[122] The BRICS countries are neutral or have been supporting Russia. China, which has been criticized by the West for not condemning the Russian aggression, is the only major global power that has presented a blueprint for peace so far.[123]

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110 Van Meurs et al (2018, 85).
111 Fukuyama (1989).
112 See Nazemroaya (2012); Mearsheimer (2014, 2022).
113 National Security Archive.
114 Compare McCormick (2015), Van Meurs et al (2018).
115 Reuters (2007).
116 Nazemroaya (2012).

118 See Sakwa (2015), Van der Pijl (2018).
119 Galeotti (2019).
120 Reuters, Kevin Liffey, December 9 2022.
121 See Deutsche Welle, January 27, 2023.
122 Soner Cagaptay (2023); Jordan Mclean and Luanda Mpungose, September 19, 2022.
123 Ministry of Foreign Affairs of the People's Republic of China, February 24, 2024..

The impact of the Russian-Ukrainian war on energy security in CEE

CEE has inherited its energy dependency on Russia from the Soviet occupation. Much of its fossil fuel supply has been delivered from Russia via pipeline routes (see table 0a), starting with the Druzhba oil pipeline in 1964 and the Bratstvo gas pipeline in 1984. Building on the success of this initial gas pipeline, more were constructed to increase the supply of gas to already connected countries and connect new ones. The most important and controversial are the Nord Stream pipelines.[124] Nord Stream 2 was constructed in 2011 and to double the Nord Stream maximum annual discharge.[125] Although finished in September 2021, it did not enter into service due to sabotage most likely related to the Russian-Ukrainian war.[126] Both pipelines cross through the Baltic Sea directly from Russia to Germany.[127] Bypassing Ukraine and Poland resulted in a reduction of fees paid by Russia and in major budget cuts in their economies.[128] Ukraine and Poland have viewed the construction of these projects as a security threat since its inception.[129]

Pipeline	Type	Operation year	Route	Receiving country(ies)
Druzhba (northern branch)	Oil	1964	Belarus	Poland, Germany
Druzhba (southern branch)			Ukraine	Slovakia, Czech Republic, Austria, Germany, Hungary, Croatia, Serbia
Bratstvo	Gas	1984	Ukraine	Slovakia, Austria, Italia, Czech Republic, Germany
Yamal Europe	Gas	1997	Belarus	Poland, Germany
Blue Stream	Gas	2003	Turkey	Bulgaria
Nord Stream 1	Gas	2012	Baltic Sea	Germany (later joined by France and the Netherlands)
Turk Stream	Gas	2020	Turkey	Bulgaria
Nord Stream 2	Gas	2021	Baltic Sea	N/A

Table 0a. Pipelines from Russia to Europe.
Source: Data collected by authors.

The Russian-Ukrainian war and the resulting EU-sanctions against Russia hindered fossil fuels imports to the EU. The effects are most strongly felt in CEE where gas is important in the industry, power generation and space heating. Consequently, Russian gas share in the EU's gas demand fell from 40 percent in 2021 to 9 percent in 2022.[130] The Baltic states and Finland have largely ceased importing Russian gas. Gazprom has cut gas deliveries to Finland and Latvia in August 2022. Lithuania and Estonia stopped importing Russian gas for domestic

[125] Siddi (2022).
[126] Wettengel (2023).
[127] Maltby (2013).
[128] Siddi (2022).
[129] Euronews (21 July 2021); Taylor (14 September 2011).
[130] Beyer and Molnár (2022).

consumption. In April 2022, Gazprom unilaterally halted all supplies to Poland. Landlocked CEECs (Austria, the Czech Republic, Hungary, and Slovakia) and Romania have not announced targets for phasing out Russian gas, with the exception of Austria, which plans to be independent of Russian supplies by 2027.[131] Across much of South Eastern Europe (SEE), reliance on Russian gas remains high.[132] The only pipelines still carrying Russian gas to CEE are those passing through Turkey to SEE. For now, the EU has not sanctioned the operations of these pipelines.[133]

The annexation of Crimea and the ensuing conflict in eastern Ukraine intensified the tensions between the EU and Russia.[134] However, despite both sides expressing a desire to reduce their mutual dependence, Russia's gas exports to Europe hit new records between 2016 and 2018. Given the challenges of transporting gas and the difficulty of finding alternative suppliers, the EU had no other choice but to meet its demand by importing more Russian gas.[135] Only after the Russian invasion of Ukraine did the EU began decreasing its energy imports from Russia significantly. The war had a profound impact on energy supply, demand, and infrastructure and resulted in EU sanctions.[136] In one year, eleven sanction packages were adopted. Sanctions would specifically target sectors playing a vital role in Russia's revenue, such as energy and transportation.[137] EU leaders collectively decided to gradually reduce and ultimately eliminate fossil fuel imports from Russia and to accelerate the transition to clean, renewable energy, secure other gas suppliers and mitigate the effects of high energy prices on households and businesses.[138] By May 2022, the European Council agreed on banning nearly 90 percent of all Russian oil imports, with a temporary exemption for crude oil delivered via pipelines.[139] This exemption was granted to land-locked EU Member States heavily dependent on Russian energy imports with no alternative energy import route. Note that this is the case for most of the countries in CEE.[140]

The restrictions on Russia had far-reaching consequences, particularly for energy security.[141] The restrictions on Russian energy exports resulted in a scarcity of these sources on the European market.[142] As supply could not reach demand, prices increased.[143] Additionally, sectors engaged in trading commodities, such as raw materials and agricultural products, were severely impacted by these embargoes, resulting in their prices rising exponentially.[144] A direct economic effect of the restrictions was observed through increased energy prices and widespread inflation across Europe. These factors also played a role in exacerbating the

[131] Engjellushe (3 July 2023).
[132] European Commission (25 May 2022).
[133] European Council (4 July 2023).
[134] Krickovic (2015).
[135] Barron (4 November 2022).
[136] European Council (4 July 2023); European Council (13 March 2023); European Council (13 February 2023); European Council (4 February 2023).
[137] European Council (3 June 2022); European Commission (9 September 2022).
[138] See for further elaboration of the transition from fossil fuels to renewables against the backdrop of the Russian-Ukrainian war Hosseini (2022).
[139] European Council, 'Impact of Russia's Invasion of Ukraine on the Markets: EU Response', Council of the European Union (13 February 2023).
[140] European Council (3 June 2022).
[141] This supports the claim defended in Khan et al. (2023) that geopolitical risks affect energy security and vice versa.
[142] Prohorovs (2022) convincingly argues that as a result of the Ukrainian conflict and the Western responses and sanctions against Russia there will also be a long-term, large-scale negative impact on most European companies and economies.
[143] European Council (13 February 2023).
[144] Feás and Steinberg (11 May 2022).

energy crisis and its broader impact.[145] The EU was to combat the energy crisis with the implementation of an oil price cap. However, Russia rejected the price cap and blocked oil supplies to those countries supporting it.[146] Despite Brussels' efforts to challenge the energy crisis, EU Member States suffered from record-high energy prices which rose to an all-time high in August 2022. Only in March 2023 did energy prices approximately reached pre-war levels.[147]

"Crisis" of BRI activities in CEE

Despite the EU and China being each other's largest trading partner,[148] the High Representative of the EU for Foreign Affairs and Security Policy Joseph Borrell recalls that their political relations remain tensed.[149] Rising tensions stem from China's reluctance to condemn the Russian aggression against Ukraine, the Chinese pressure on Taiwan sovereignty, and the respect for fundamental freedoms.[150] The question arises how the Russian-Ukrainian war has impacted BRI activities in CEE against the backdrop of deteriorating energy security?

The '17+1 Cooperation' has been impacted by the war in two respects. Firstly, as mentioned above, some countries have quitted the framework. Secondly, as CEECs are no longer guaranteed to benefit from Russia's cheap energy, it is to be expected that the geopolitical tensions and the rising costs of energy will affect the BRI activities in CEE.

As mentioned above, the Baltic countries left the Chinese-led framework (i.e., Lithuania in March 2021 before the Russian invasion; Latvia and Estonia in August 2022 after the outbreak of the war).

Although Lithuania left the BRI before the Russian invasion of Ukraine it is reasonable to assume that its departure is also connected to similar geopolitical tensions in the Baltic region that triggered the Russian invasion of Ukraine. This becomes clear from the declaration of the Latvian foreign minister specifying that Latvia wants to cooperate with China mainly through the EU-China relations based on "mutual benefit, respect for international law, human rights and the international rules-based order."[151] It is unclear whether other CEECs will quit the BRI cooperation with China. The Czech government has mentioned that the project has no future, although it formally has not cancelled its participation in the '14+1 Cooperation' .[152] Due to the Russian-Ukrainian war, the European sanctions and the EU's policy of energy diversification, EU countries will no longer benefit from cheap Russian energy. Activities in the China-led BRI, such as the big infrastructural and lithium-ion battery development projects, are however energy consuming. Note furthermore that the energy supply in the northern parts of CEE has started to become fundamentally different from that of the southern parts. In the former, as discussed above, the Baltic countries, Poland and Finland no longer import Russian gas for domestic consumption. A number of replacement projects have taken place. One is the Baltic Pipe activated in September 2022 to provide Norwegian gas to Poland and Denmark.[153] Further diversification projects include the building of LNG terminals in the Baltic ports to host LNG from the US and Qatar.[154] However, Russian energy supplies –

[145] Andrea Pescatori and Martin Stuermer (December 2022).

[146] Aljazeera (3 December 2022).

[147] Statista (4 May 2023).

[148] Contin Trillo-Figueroa (2023).

[149] Borrell (13 April 2023).

[150] European Parliament. 'Resolutions against China.'; AFP (14 April 2022); Bunde et al (2023).

[151] Minister of Foreign Affairs Republic of Latvia (2022).

[152] Politico (May 4, 2022).

[153] JAIC (13 April 2021).

[154] Bloomberg 7 November 2022.

especially gas – to southern-CEE remains mainly unaffected. This North-South differentiation in the energy supplies is accompanied by a difference in energy prices, as the household electricity and natural gas prices unambiguously demonstrate. Since the start of the war in February 2022, the electricity and gas bills in all EU capitals have increased by nineteen and twenty percent respectively. Adjusted to purchasing power standards (PPS), the changes are even intenser. In February 2023, Oslo, Valletta, Budapest and Bern had the lowest adjusted household electricity prices , while the highest ones were registered in Prague, Rome and Berlin. Some CEE capitals ended up with electricity prices which stayed below the European average, including Budapest, Belgrade, Zagreb, Bratislava, and Sofia, whereas Bucharest, Prague, Riga, Tallinn, Vilnius and Warsaw were the capitals in which the price was above the European average.[155] In the case of natural gas prices, a similar 'north-south CEE asymmetry' is observed.[156]

Consider now the Chinese investments listed under table (0). Table (0) lists three groups of BRI activities in CEE, including (1) major Chinese investments in CEE for over a decade; (2) cancelled Chinese investments in CEE; and (3) recent Chinese investments in CEE. The first group demonstrates that renewable energy and transport projects in the northern parts of CEEhave not been cancelled contrary to expectations. Further delays in the construction of the Hungarian section of the Budapest-Belgrade high-speed railwaywere caused by the rising costs of the project which have been lifted by the Russian-Ukrainian war. The second group of projects discussed in table (0) is mainly due to the cancelling of fossil fuel projectswhich are contrary to the EU's environmental policy . In the third group of projects in table (0), we observe the 'north-south CEE asymmetry' outlined above. Chinese investments in the northern parts of CEE are no longer made mainly due to political reasons. Recent Chinese investments are concentrating on the southern parts of CEE. In this area, the supply of cheaper Russian energy sources is guaranteed for the time being to facilitate Chinese BRI activities in the renewable energy and the transport sector, especially in Bosnia, Serbia and Hungary.

Geopolitics

4) Conclusion and findings

While our study backs Bharti (2022)[157] argument that China's economic impact in CEE is relatively small in terms of investments and finance – especially when compared to intra-European economic exchanges – we conversely found that trade relations had particular geoeconomic implications. Indeed, the US regaining its position as the EU's first trading partner is only incidental as resulting from the Russia-Ukraine war, while the long-term trade structure indicate that China will regain its position as the EU's first trade partner. In the footsteps of Turcsányi (2020)[158], our study confirms that the trade imbalance in favour of China continues to deepen at an accelerating rate. Consequently, some CEECs, like the Baltic states or Czechia – and as we will develop in the following section, the EU – are reconsidering their bilateral relations with China. Hence, we further support Choroś-

[155] Bucharest displays the norther pattern being one of the southern CEEC that is disconnected from Russian gas supplies.

[157] Bharti, M.S. (2022). The evolution of China's economic engagement in Central and Eastern Europe/ Ewolucja zaangażowania gospodarczego Chin w Europie Środkowej i Wschodniej. Economic and Regional Studies, 15(1), 90-106. https://doi.org/10.2478/ers-2022-0007

[158] Turcsányi, Richard Q. (2020) 'China and the Frustrated Region: Central and Eastern Europe's Repeating Troubles with Great Powers', China Report 56:1: 60-77, DOI: 10.1177/0009445519895626

Mrozowska (2019) [159] and Góralczyk (2017)[160] claims that the lack of mutual market access is a growing cause of concern for most European economies. Furthermore, if no concrete actions are taken to 'balance economic relationship' and key projects materialise, like the CATL's battery factory, the European quest for market equilibrium could be challenged as current trade trends could intensify the deficit.

However, this trend is not consistent across all CEE17. The nations that have captured the most Chinese investment in recent years appear to be motivated by a convergence of political and economic incentives, as exemplified by CATL battery factory in Hungary, the development of the Greek port of Piraeus, Serbia's numerous infrastructure investments and loans, and BiH's focus on renewable energy. Besides, the WB is an increasingly attractive region for Chinese investments as weaker regulations and a dire need for finance and infrastructure development meet with the prospect of future EU adhesion. Whether an EU-China synergy is possible will be determinant for the region's economic development. Amid current geopolitical developments such as worsening US-China tensions and the Russo-Ukrainian war, the EU and some CEECs are re-evaluating their positions towards Beijing. In the following section, we will evaluate the geopolitical implications of the BRI for the EU.

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10- BRI in Pakistan's green energy sector

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List of Abbreviations

Agricultural Bank of China (ABC)
Arcplus Group PLC (Arcplus)
Arcplus Institute of Shanghai Architectural Design & Research Co.,Ltd. (Arcplus Shanghai)
Azad Jammu and Kashmir (AJK)
Bank of China (BoC)
Beijing Urban Construction Group (BUCG)
Central Development Working Party (CDWP)
China Airport Construction Group Co., Ltd (CACC)
China Coal Technology & Engineering Group Corp (CCTEG)
China Communications Construction Company Industrial Investment Holding Company (CIHC)
China Communications construction company Ltd. (CCCC)
China Communications Construction Group (CCCG)
China Construction Bank (CCB)
China Construction Seventh Engineering Division Corp., Ltd. (CSCEC7)
China Development Bank (CDB)
China East Resource Import & Export Corporation (CERIECO)
China Electric Power Equipment & Technology Co. Ltd (CET)
China Energy Engineering Group Co., Ltd. (ENERGY CHINA/CEEC)
China Energy Engineering Group Guangdong Electric Power Design Institute Co. Ltd. (GEDI)
China Energy Engineering Group Tianjin Electric Construction Company (TIANJIN ENERGY)
China Export & Credit Insurance Corporation (SINOSURE)
China Gezhouba Group Company Limited (CGGC)
China Gezhouba Group International Engineering Co. Limited (CGGC Intl.)
China Harbour Engineering Company (CHEC)
China Huaneng Group Company Limited (CHNG)
China Hydropower Engineering Consulting Group (HydroChina Corporation)
China International Contracting Engineering Chamber of Commerce (CICECC)
China International Contractors Association (CHINCA)
China Machinery Engineering Corporation (CMEC)
China National Coal Development Company (CNCDC)
China National Coal Group Corporation (China Coal Group)
China National Machinery Industry Corporation (Sinomach)
China North Industries Corporation (Norinco)
China North Industries Group Corporation Limited (Norinco Group)
China Overseas Ports Holding Company Ltd. (COPHC)
"China Power Hub Generation Company (CPHGC)
China Railway Beijing Engineering Group (CREG Beijing)
China Railway Construction Corporation Limited (CRCC)
China Railway Engineering Consulting Group Co., Ltd. (CEC)
China Railway Engineering Corporation (CRECG)
China Railway Eryuan Engineering Group Co,. Ltd. (CREEC)
China Railway Group Limited (CRG/CREC)
China Railway Rolling Stock Corporation Shandong Co. Ltd. (CRRC Shandong)
China Road and Bridge Corporation (CRBC)
China Shipbuilding Industry Corporation (CSIC)
China State Construction Engineering Corporation Ltd. (CSCEC)
China Telecom Corporation Limited (China Telecom)
China Three Gorges Corporation (CTG)
China Three Gorges International Corporation (CTG International)
China Three Gorges South Asia Investment Limited (CSAIL)

China-Pakistan Economic Corridor (CPEC)
CIHC Pak Power Company Limited (CIHCPPCL)
CRRC Zhuzhou Locomotive Co., Ltd. (CRRC ZELC)
Debt Management and Financial Analysis System (DMFAS)
Dhabeji Special Economic Zone (DSEZ)
Digital Television Terrestrial Multimedia Broadcasting (DTMB)
Dongfang Electric Corporation (DEC)
Engineering, Procurement, and Construction (EPC)
Executive Committee of National Economic Council (ECNEC)
Federally Administered Tribal Areas (FATA)
foreign direct investment (FDI)
Foreign Economics Assistance (FEA)
Free Trade Area (FTA)
Guangzhou Metro Group Co., Ltd. (GZMG)
Gwadar Free Zone Company Limited (GFZL)
Gwadar International Terminals Ltd. (GITL)
Gwadar Marine Services Ltd. (GMSL)
Huatai Insurance Agency & Consultant Service Limited (Huatai)
Huawei Technologies Co., Ltd (Huawei)
Huawei Technology Pakistan (Huawei Pakistan)
HydroChina Dawood Power (Private) Limited (HDPPL)
Industrial and Commercial Bank of China (ICBC)
Joint Cooperation Committee (JCC)
Karot Power Company Ltd. (KPCL)
Khyber Pakhtunkhwa (KP)
KKH (Karakoram Highway)
Kohala Hydro Company (Pvt.) Limited (KHCL)
Memorandum of Understanding (MoU)
Mingyang Smart Energy Group Co., Ltd (Mingyang Smart Energy)
Minister of Commerce People's Republic of China (MOFCOM)
Ministry of Foreign Affairs, the People's Republic of China (MFAPRC)
Ministry of Planning Development & Reform Government of Pakistan (MoPD)
Ministry of Planning, Development & Special Initiatives (PSDP)
National Electric Power Regulatory Authority Islamic Republic of Pakistan (NEPRA)
Ningxia Communications Construction Co. Ltd (NXCC)
No Objection Certificate (NOC)
Northwest Electric Power Design Institute Co. Ltd. (NWEPDI)
Pakistan-China Business & Investment Forum (PCBIF)
Pakistani Air Force (PAF)
Pearl River Planning Surveying and Designing Co. Limited, China (PRPSDC)
People's Bank of China (PBoC)
People's Republic of China (PRC)
People's Republic of China National Development and Reform Commission (NDRC)
Planning Commission Ministry of Planning, Development & Reform (PC)
Policy Analysis & Development Wing Ministry of Economic Affairs Government of Pakistan (PADW, MoEA, GoP)
Power Construction Corporation of China (POWERCHINA)
Prime Minister Office, Board of Investment (Invest Pakistan)
Rashakai Special Economic Zone Development and Operations Company (RSEZDOC)
Security and Exchange Commission of Pakistan (SECP)
SEPCO1 Electric Power Construction Corporation (SEPCO1)

Shangdong Electric Power Construction Corp. (SEPCO)
Shanghai Donghua Engineering Consulting Company (SECEC)
Shanghai Electric Group Co., Ltd. (SEG)
Shanghai Electric Hongkong Co. Ltd (Shanghai Electric HK)
Silk Road Fund Co., Ltd (SRF)
Sindh Economic Zones Management Company (SEZMC)
Sino-Sindh Resources (SSRL)
State-owned Enterprises (SOEs)
Spcecial Economic Zones (SZEs)
Special Purpose Vehicle (SPV)
Special Security Division (SSD)
State Administration of Foreign Exchange (SAFE)
State Grid Corporation of China (SGCC)
State Power Investment Corporation (SPIC)
Suki Kinari Hydro (Private) Limited. (SK Hydro)
Sumec Group Corporation Company Limited (Sumec Group Corporation)
TBEA Xinjiang Sunoasis Company Ltd (TBEA Sunoasis)
Thar Energy Limited (TEL)
The Organization for Economic Cooperation and Development (OECD)
Three Gorges Second Wind Farm Pakistan Ltd. (TGSWFPL)
Three Gorges Third Wind Farm Pakistan Ltd. (TGSWF)
Tianjin Energy Investment Group Company Limited (TIANJIN ENERGY)
UEP Wind Power Pvt. Limited (UEPL)
United Energy Group Co., Ltd. (UEG)
United Nations Educational, Scientific and Cultural Organization (UNESCO)
World Integrated Trade Solution (WITS)
Xinjiang Goldwind Science & Technology Co., Ltd. (Goldwind)
Yangtze Three Gorges Technology and Economy Development Company (TGDC)
Zonergy Company Limited (Zonergy)

Introduction

…

Theoretical Framework

This study employs a geopolitical economic theory to analyze the BRI in CWA focusing on China's strategic engagements in Pakistan. This theory transcends the limitations of traditional (neo-)realism and (neo-)liberalism by providing a comprehensive perspective on the roles and impacts of Chinese state entities and corporations in the energy and infrastructure sectors of Pakistan. It allows for an in-depth examination of China's state-led initiatives, assessing their domestic and geopolitical-economic implications. Through this lens, we explore how the selected countries are realigning economically and security-wise with China, signaling a notable geopolitical and geo-economic shift with broader implications for Western powers.

State, Society, and Market in China: Question of Authority

The unit of analysis in Global Political Economy (GPE) and International Relations (IR) research is crucial for understanding the nuances of social reality, particularly in the study of political authority configurations and their interactions with society and market forms (see Cox 1986, 1987). Grounded in the seminal works of Cox (1986, 2002) ~~and Jessop (2016~~), Geopolitical Economy theory identifies two *ideal* governance structures: the liberal state-society-market complex (LSMC) and the centralized state-society-market complex (CSMC), emerging as state-crafted institutions that regulate markets both domestically and internationally.

These models, seen not as polar opposites but as part of a spectrum highlighting the nuanced governance within authoritarian capitalist states, underscores the importance of historical, spatial, socio-economic, and cultural contexts in shaping governance structures (Cox 1987; Van der Pijl 1998; Amineh 1999).

The distinction between 'liberal' and 'contender' states, such as Germany, Japan, the USSR, historically, and currently China and to an extent Russia, emphasizes the evolving roles of state from challengers of hegemonic powers to transformative forces in the global economy, thus enriching the discourse on state-society-market dynamics.

The LSMC is characteristic of liberal democracies, notably the US and Great Britain, which were among the first to industrialize and subsequently established a liberal hegemonic world order. This model, prevalent in these pioneering nations, fosters a cooperative relationship between capital and labor, underpinning socio-economic policies that support a dynamic civils society and a market defined by class autonomy (Moore 1966; Giddens 1973; Wright et al. 1998). This model encourages the active engagement of various social strata, leading to the development of a hegemonic social structure rooted in capitalist industrial development, which in turn fosters a "self-regulating society" (Van der Pijl; Amineh 1999; 2010; Amineh and Yang 2018). The origin of LSMC can be traced back to Britain post the "Glorious Revolution"(1688/89), where the state's withdrawal from direct economic intervention allowed for the emergence of a society governed by legal protections of private property and contractual obligations (Van der Pijl 1998: 68).

Conversely, the CSMC, typified by today's China and a numbers of the late industrialized countries, represents an authoritarian governance model where the distinction between the ruling and the governing class is significantly diminished. These states, including China, emerged as contender states challenging the established liberal hegemonic world order. Here, the "state class" wields control over the state apparatus, society, and the market, imposing a collaborative framework between capital and labor that significantly restricts the independence of social forces from state influence (see Elsenhas 1984). China's approach is driven by three main objectives: (i) establishing a strong centralized state to mobilize against external and internal pressures; (ii) advancing the economy and society through top-down industrial development essential for national survival and political legitimacy; and (iii) expanding its influence in the global economy to secure critical resources (Lieberthal and Oksenberg 1988; Nolan 2001: 199-200; Mcnally 2007: Breslin 2012). In this governance model, civil society, particularly the business or capitalist class, finds itself either non-existent, underdeveloped, or too entangled with the state power to act independently. This dynamic is indicative of a broader trend within centralized systems where significant economic sectors remain under state control, limiting the emergence of an autonomous business class (Amineh & Houweling 2010: 251-272). The "Going Out" strategy and the BRI underscores China's ambition to consolidate state power, resist marginalization, and pursue aggressive state-led industrial development (Jiang and Sinton 2011; Cheng 2012; Jiang and Ding 2014; Zhang and Xu 2019; Amineh 2022).

Forces Behind China's Capitalist Industrial Development

Sequential industrialization outlines the broad historical process through which states have navigated the transition to industrially based politics, society, and economy, facing the challenges posed by the interplay of global system changes, exogenous pressures from dominant capitalist centers, and indigenous socio-economic structures. This concept captures the time-sequenced evolution of industrial development, signifying a series of interrelated social transformations with states and the global economy (Moore 1966; Senghaas 1985; Shin1996; Houweling 2000; Chang 2002; Amineh and Houweling 2005; Amineh 2007).

To resist marginalization and exclusion from the world economy, mainly after the WW- II, the state class of several states, including China, the Asian Tigers, Turkey, and Iran, Brazil, has engineered an autonomous, state-led "catch-up" development process through industrialization, emblematic of a "passive revolution" as described and theorized by Antonio Gramsci (1971). This strategy diverges from the liberal economic model by focusing on economic self-reliance within a Global Capitalist System. Such centralized strategies, though varied in national objectives, converge on the goal of navigating economic stagnation through state-driven development (Warren 1980; Balassa 1981; North 1981; Deyo 1987; Barkey 1990, 2019; Wade 1990; Lampton and Lieberthal 1992; Amineh 1999; Fieldhouse 1999; Nolan 2001; Chang 2002; Zheng 2004; Amineh and Houweling 2010; Walter and Zhang 2012), a response to both exogenous pressures from established capitalist heartlands led by Britain and the US and indigenous challenges entailing fragmented socio-economic structures.

China's state-led industrialization, embodying the CSMC, reflects a deliberate strategy to integrate into a rise within the global economy, underpinned by the authoritative role of the Chinese Communist Party (CCP). China's transformation led by the CCP since its founding in 1921 and through its evolution under Mao Zedong (1949-1976) and Deng Xiaoping (1978-1992) to the current era of Collective Leadership, illustrates the profound social and political changes accompanying this process. The CCP's control extends over significant economic actors, including state-owned and private enterprises, positioning it at the heart of China's "catch-up" development aimed at asserting its place in the global economy. Integral to this ambition, the state class – comprising key economic sector managers and leaders of SOEs – is instrumental, driving the "Going Out" strategy to bolster China's economic influence on a global scale. This approach not only aims at enhancing China's position in the international market but also ensures the CCP maintains stringent political oversight within the country, signaling a nuanced balance between pursuing global economic integration and sustaining domestic control (Nolan 2001: 199-200; Goodman 2014; Rothenberg 2015).

The BRI: Origin and Global Impact

China's state-led industrialization has played a pivotal role in bridging the global wealth-power gap, leveraging its rapid industrial development to transform both its domestic landscape and international standing. With its GDP (PPP) reaching $13.21 trillion in 2014 and foreign trade escalating from less than $21 billion in 1978 to over $2 trillion in 2015, China has emerged as the world's largest economic nation. This growth is not just a testament to its burgeoning economy but also a strategic push towards global economic integration, challenging the US-dominated world order. Beyond economic achievements, China's military capabilities have also seen significant growth, indicating a comprehensive enhancement of national power. The country's competitive edge in the global market, underscored by favorable exchange rates, low labor costs, significant foreign direct investment, and a vast domestic market, has enabled its lead into high-value product markets, including high-speed trains, computers, and mobile technology. Through strategic trade, investment, and an emphasis on export-oriented growth, China is redefining global economic and political dynamics, underlining its pivotal role in closing the wealth-power gap (IEA 2012; World Bank; Jiang 2009).

Building on China's monumental strides in closing the global wealth-power gap through state-led industrialization, the country faces internal challenges that are intricately tied to its rapid economic ascent. Key among these challenges are overaccumulation and resource scarcity, particularly of fossil fuels, which pose threats to sustained economic growth and domestic social security. Overaccumulation, characterized by surplus of capital and labor that cannot be profitably utilized, has led to economic inefficiencies encompassing idle factories and rising unemployment, exacerbated by market overproduction, and diminishing returns (Shen and Chen 2018; Xu and Liu 2018; Song 2022). The global financial crisis further highlighted these issues, with the export growth rate dramatically declining, indicating a challenging economic environment for China (Zhang 2017; Demiryol 2019; Jones and Zeng 2019; Song 2022). For instance, some manufacturing firms, operating at roughly 65% capacity, were directed by local governments to reduce overcapacity, resulting in the shutdown of inefficient 'zombie companies' (Shen and Chen 2017; Song 2022), while the steel industry saw a government-led reduction in raw steel production, impacting an estimated 500,000 workers (Yao and Meng 2016).

This scenario has necessitated what David Harvey describes as a "spatial fix," wherein the geographical expansion into new territories and markets becomes essential for the survival of capitalism by allowing for fresh accumulation spaces to address domestic limitations (Harvey 2001: 312-344; Song 2022). China's response to these dual challenges has been the launch of BRI, aimed at redistributing surplus capital and labor internationally while securing access to vital resources (Amineh and Yang 2014, 2017, 2018; Amineh 2022). This strategic initiative underscores a comprehensive approach to mitigating the domestic economic pressures through international engagement, illustrating a complex interplay between China's interlay economic dynamics and its global strategic ambitions.

At the core of the BRI lies a complex interplay between the territorial (geopolitical) and the capitalist (geo-economic) logics of power, reflective of the dynamics at play in major capitalist states and markets extending beyond their national borders. This duality, involving strategic management of both domestic and international spheres and the pursuit of wealth creation through transnational capital flows, is not merely an investment scheme but a multifaceted strategy aimed at navigating the challenges of global capitalism. It signifies China's effort to balance territorial interests within the drive for global expansion and integration, highlighting the BRI as a key component in its strategy to transform global trade routes, investment patterns, and economic dependencies (Agnew and Corbridge 1995; Harvey 2001; Mercille 2008; Amineh and Yang 2014, 2018).

To deepen the understanding of this initiative, the synthesis between traditional geopolitics and the geo-economics of the GPE is essential. Drawing insights from David Harvey's concepts of the "territorial logic of power" and the "capitalist logic of power," the interaction between these dimensions underpins the geopolitical economy framework, situating it within the current global capitalist system. This framework transcends the binary of territoriality associated with political and military power within and between states, and the boundless nature of wealth creation and capital accumulation, offering a nuanced analysis of state actions in a geo- historical context. It challenges the "space-less" capitalist logic posited by (neo-)liberal scholars and the "fixed territorial logic" of realists, presenting these logics as dialectically interrelated and inseparable, yet fraught with tensions and conflict (Harvey 1985; Amineh 2003; Mercille 2008; Mercille & Jones 2009; Amineh & Yang 2014).

Through the BRI, China navigates the dialectical relationship between accumulating capital and managing population through territorial configurations, projecting its power to safeguard and expand its geopolitical horizons without resorting to the military interventions characteristic of past global powers. By prioritizing trade, investment, and infrastructure development, China seeks to align its internal economic strategies with its broader geopolitical ambitions, asserting itself as a pivotal force in shaping the contemporary economic and political landscape while maintaining the interdependence between state power and capital flows for mutual prosperity and security (Amineh & Yang 2014).

Conclusion

The theoretical exploration of the BRI, grounded in the question of state-society-market relations, the drivers of China's capitalist development, and the initiative's origins and impacts, illuminates the strategic depth of China's global engagement. Through the lens of geopolitical economy, the BRI is related as a strategic tool addressing overaccumulation and resource scarcity, contrasting with liberal market dynamics. Focusing on CWA, it explores China's use of the BRI for transnational economic expansion, positioning as a non-coercive strategy for global influence, diverging from Western colonial models. It scrutinizes China's state-society-market relations, its capitalist development drivers, and the BR"s geopolitical economic impacts, revealing a shift in regional alignments towards China. This shift indicates significant geopolitical and geo-economic changes, situating the BRI as a key element in China's strategy to reshape international relations and the global power balance, providing a critical foundation for further empirical analysis within this paper.

Diplomatic Background: BRI's Integration in Pakistan Through the China-Pakistan Economic Corridor (CPEC)

Over six decades, the longstanding and multifaceted bilateral relationship has blossomed between China and Pakistan. Politically, Pakistan is among the first countries, the third non-communist, and the first Muslim state that formally recognize the PRC. The recognition of the PRC by Pakistan took place on 4th January 1950, serving as a response to the willingness advocated by Mao Zedong to establish a diplomatic relationship "on the basis of mutual respect for sovereignty and territorial integrity, and equality and mutual benefit" (Ministry of Foreign Affairs, the People's Republic of China (MFAPRC), n.d.). The formal diplomatic relationship was established on 21 May 1951. The Sino-Pakistani bordering dispute was solved via the signing of the 1963 Boundary Agreement through peaceful negotiations (MFAPK, n.d.), which cleared the paths for the advancement of bilateral relations and laid a robust foundation for mutual trust building.

As the 21st century unfolded, the two countries have further deepened their partnership, with increased high-level interactions and enhanced political mutual trust.

Two vital diplomatic events emerged in 2013 and 2015, which boosted this partnership to a greater extent, in the name of achieving mutual prosperity, socio-economic development, and livelihood improvement. At the same time, this marked the turning point of BRI's integration into Pakistan via the form of CPEC.

In 2013, during Chinese Premier Li Keqiang's official visit to Pakistan, the cradle of the CPEC was proposed by the Chinese Premier. Subsequently, both countries issued the 'Joint Statement between the People's Republic of China and the Islamic Republic of Pakistan on Deepening the Comprehensive Strategic Cooperation Between the Two Countries'. The CPEC is mentioned in this joint statement:

> *The two sides agreed to jointly study and formulate a long-term plan for the China-Pakistan Economic Corridor on the basis of comprehensive deliberation. This effort aims to advance connectivity between China and Pakistan, facilitating substantial progress in investment, trade, and economic cooperation between the two nations. The decision has been made for the establishment of a joint working group, composed of the National Development and Reform Commission of China and the Planning Commission of Pakistan, to conduct research on interconnection-related projects.*[161]. (MFAPRC, 2013)

Subsequently, Pakistani Prime Minister Nawaz Sharif paid an official visit to China in July of the same year. It resulted in the issuance of a 'Common Outlook on Deepening China-Pakistan Strategic Cooperative Partnership in the New Era' (MFAPRC, 2013), where the framework of the Long-Term Plan for CPEC is highlighted again. The projects that initiated the CPEC involve the China-Pakistan Cross-border Fiber Optic Cable Project, the Karakoram Highway's upgrade and realignment, cooperation on solar energy and biomass energy, construction of industrial parks along the CPEC, the implementation of the Digital Television Terrestrial Multimedia Broadcasting (DTMB), the coordination the commercial operation of TD-LTE in Pakistan, and the enhancement of cooperation in the wireless broadband area (MFAPRC, 2013).

Meanwhile, a Memorandum of Understanding (MoU) was signed by both parties in July 2013. This MoU echoed the pursuit of enhancing economic regional integration indicated by the Joint Statement mentioned above, particularly in the domains of investment, energy, trade, and communication (Planning Commission Ministry of Planning, Development & Reform (PC), 2014).

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[161] Translated and adapted by the author from the original Chinese text: 双方同意，在充分论证的基础上，共同研究制订中巴经济走廊远景规划，推动中巴互联互通建设，促进中巴投资经贸合作取得更大发展。双方决定由中国国家发展和改革委员会和巴基斯坦计划委员会成立联合工作组，开展互联互通相关项目的研究 (MFAPRC, 2013). The original title is 'Joint Statement between the People's Republic of China and the Islamic Republic of Pakistan on Deepening Comprehensive Strategic Cooperation between the Two Countries' (中华人民共和国和巴基斯坦伊斯兰共和国关于深化两国全面战略合作的联合声明), published by the Ministry of Foreign Affairs, the People's Republic of China.

The following milestone took place in 2015 when CPEC was officially established in April 2015. Simultaneously, the cooperation between the two countries was enriched with a new interpretation, which was termed an ‘all-weather strategic partnership’. This terminology was introduced in the context of the Joint Statement issued by the PRC and the IRP, signifying the establishment of a comprehensive and enduring strategic cooperative partnership.

The CPEC is operated under the mode of ‘1+4’ cooperation, whereby CPEC is considered as the core, and four key areas of cooperation - Gwadar, Energy, Transport Infrastructure, and Industrial Cooperation– are prioritized (PSDP & People’s Republic of China National Development and Reform Commission (NDRC), 2017). The CPEC encompasses geopolitical and security/military significance.

For China, the MoU signed in 2013 has demonstrated China’s geopolitical ambition behind the CPEC via linkages between the Western Region of China and Pakistan and the conversion of the Gwadar port into an international free port. Xinjiang, serving as a pivotal determinant of CPEC, has been suffering from weak industrial base and constrained economic scale together with other western regions of China. CPEC traverses through Kashgar, China, and Gwadar port with a total length of over 3000 kilometers. The transportation infrastructure has been improved along the way from Kashgar to Gwadar, facilitating China-Pakistan economic and trade exchange on land.

In the dimension of transport and infrastructure, the construction of the ‘Dry Port near Havelian’ will enable access and traffic for goods between Pakistan and China. On top of Havelian Port’s establishment, the ‘Up-gradation and Dualization of ML-1’ will offer the most convenient and secure means of transporting oil from the Middle East to China (Zaafir, 2023). Meanwhile, Gwadar Port will also evolve into a crucial transshipment terminal for crude oil from the Middle East to China, thereby reducing travel costs for China. Besides the enhancement of China-Middle East connectivity, Gwadar Port also bridges China to Africa and Europe, where oil and gas transported from this corridor will facilitate China to meet its energy demand (Ministry of Planning Development & Reform Government of Pakistan (MoPD) & NDRC, 2017; Ali, 2020; Currie-Australia, 2020). In addition to the significance in the energy sector, the completed ‘Cross Border Optical Fiber Cable (Khunjerab - Rawalpindi)’ marks the first cross-border connection between China and Pakistan. This development is expected to enhance internet traffic from China to the Middle East, Africa, and Europe, offering shorter access routes for transit telecom traffic within these regions (EurAsian Times Desk, 2019).

Pakistan also embraces abundant geopolitical development via the CPEC. Due to Gwadar’s strategic geographical advantage, approximately 15-17 million barrels of oil are transported daily through the sea channels off the coast of Gwadar, constituting around one-third of the global seaborne oil trade (Ministry of Planning, Development & Special Initiatives (PSDP), n.d.). However, Gwadar has historically suffered from inadequate development due to resource shortages. Under the CPEC, 14 Gwardar projects have been planned to leverage the potential of both Gwardar port and the city. The construction of Gwadar International Airport, a cornerstone of CPEC, serves as a catalyst for regional and international trade and commerce. Furthermore, water scarcity, healthcare infrastructure, and power supply benefiting both the local population and project workers are being addressed. In the long term, these initiatives will alleviate constraints for foreign investments and trade activities. During this process, the right to development and sustainability have maintained a good balance through the ‘Gwadar Smart Environment Sanitation System and Landfill Project’, promoting long-term viability and fulfilling responsibility to mitigate climate change.

Besides the upgrade of Gwadar, the establishment of nine SZEs contributes to the enhancement of the transnational network between Pakistan and its neighbors, i.e.: China, India, Iran, Afghanistan, and the Arabian Sea. SZEs will also accelerate regional connectivity by providing development opportunities for local habitats, leading to a reduction of habitant influx towards more affluent regions and wealth regional disparity. Prime Minister Imran Khan has highlighted that the Rashakai SEZ could address local migration issues in Khyber Pakhtunkhwa, known for historical conflicts and limited development opportunities (Silk Road Briefing, 2021). Furthermore, the Dhabeji Special Economic Zone (DSEZ) is also equipped with geoeconomic importance. Through its convenient access to Port Qasim for efficient import of raw materials and export of finished goods, the inland transportation costs and time are minimalized (CPEC Secretariat & PSDP, n.d.a). DSEZ also has direct access to the National Highway, which facilitates the transportation of goods to inland areas and Central Asian nations, utilizing the National Trade Corridor (Sindh Economic Zones Management Company (SEZMC), n.d.). Therefore, together with 24 transport and infrastructure developments with the CPEC, this transnational network consisting of SZEs will be reinforced, with more efficient delivery of raw materials to SZEs and faster travel facilities, thus flourishing the business and trade across the country, as well as transcending them through national borders.

As for the military role encompassed by CPEC, China is prowling for the build-up of security and defense capacities in Pakistan. During the meeting between Chinese State Councilor and Defense Minister General Li Shangfu and Air Chief Marshal Zaheer Ahmed Baber Sidhu, Chief of the Air Staff of the Pakistani Air Force (PAF), General Li stressed that "...the military cooperation between China and Pakistan is delivering high-level performance, with close high-level exchanges and constantly improved cooperation mechanisms" (Ministry of National Defense of the People's Republic of China, 2023). Joint military drills have also been constantly held by China and Pakistan. What's more, in light of protecting Chinese overseas workers, a Special Security Division (SSD) was raised and launched by the Pakistan Army in January 2017 (Xinhua, 2017). Nevertheless, the operations carried out by the SSD can't fully tackle the security challenges. Therefore, it was reported that Chinese laborers have begun equipping themselves to ensure their own safety during maintenance activities at different sites along the CPEC (The Economic Times, 2021). In addition, military facilities have been included in some CPEC construction sites. In the camp of the 'KKH (Karakoram Highway) Phase II (Havelian - Thakot Section)' project, Pakistani special security forces and local security companies were in position, assisted by 10 security monitoring towers, 2 security inspection rooms, road hydraulic lifting baffles, and alarm systems[162] (China International Contractors Association (CHINCA, n.d.). Rashakai SEZ also provides "closed management with three tiers of security protection, including the military, police, and security guard and 24-hour surveillance facilities to ensure the security of investors" (Pakistan-China Business & Investment Forum (PCBIF), n.d.).

Bilateral Trade Relationship

Economically, the Sino-Pakistani trade and investment relationship has been established since 1950, and it has evolved significantly over the years.

Three bilateral agreements regarding strengthening trade ties have evolved the Sino-Pakistani trade relationship, motivated by the will to upgrade market access in the trade of goods and enhance trade liberalization. Starting in 2005, the negotiations on the Free Trade Area (FTA) were launched, and both sides reached the Free Trade Agreement in 2006 (Minister of Commerce People's Republic of China (MOFCOM), n.d.). In the wake of the growing importance of the Sino-Pakistani bilateral trade tie, the 'China-Pakistan Free Trade Area (FTA) Agreement on Trade in Services' was signed in 2009. During this year, China emerged, for the first time (since 2003), as one of the Top 5 import destinations for Pakistan based on data from World Integrated Trade

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[162] Translated and adapted by author. The original text is in Chinese: 营地周边设置10个安防监控塔、2个安检室、道路液压升降挡板以及报警系统等，并配备了巴方的特殊安全部队、边防军、警察、当地安保公司等多方安保力量，有效降低了营地的安全风险 (CHINCA), n.d.). The original title is 'China Road and Bridge Engineering Co., Ltd. Pakistan KKH Phase II (Haveliyan-Takot) Project Camp' (中国路桥工程有限责任公司巴基斯坦KKH二期（赫韦利扬-塔科特）项目营地), published by China International Contracting Engineering Chamber of Commerce.

Solution (WITS, n.d.). The second negotiation phase began in 2011 and concluded in 2019 with the signing of the Protocol of the Second Phase of the China-Pakistan FTA. Both sides consider this protocol "a vivid practice of advancing the construction of the Belt and Road Initiative" as well as a blueprint for establishing free trade zones in developing nations (MOFCOM, 2019).

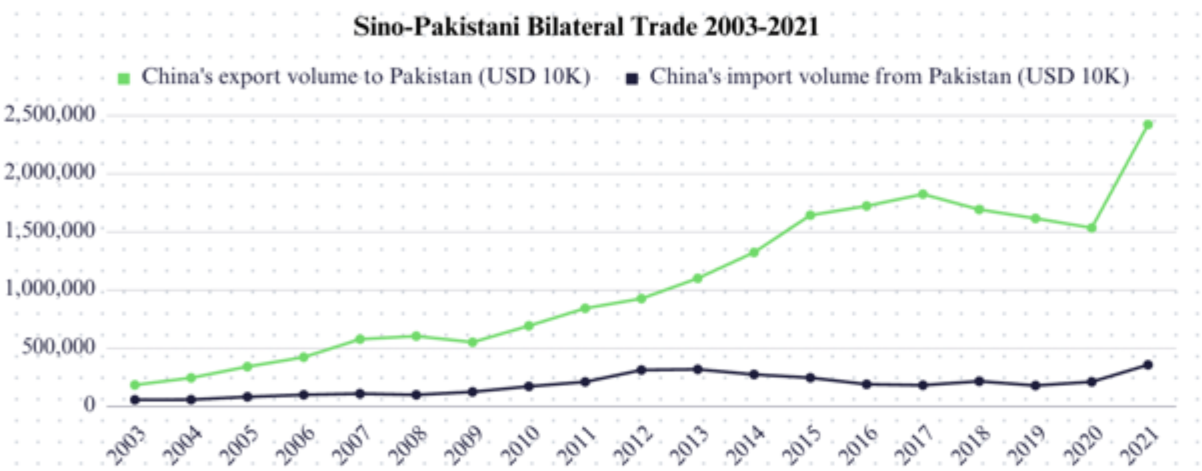
China's export volume to Pakistan data is collected and adapted from the National Bureau of Statistics of PRC (National Data, n.d.), which is further summarized in Appendix 1. Additionally, China's import volume from Pakistan data is retrieved from the WITS (WITS, n.d.) and presented in Appendix 1.

To visualize, China's export volume to Pakistan exhibited a consistent upward trend from 2003 to 2020 (see Figure 1). Notably, during the period of 2009 to 2017, and 2020 to 2021, the import flow experienced an unprecedented surge, propelling the Sino-Pakistan trade relationship to new heights.

In the context of China's import volume from Pakistan, China has consistently maintained its stable performance without notable fluctuations or disruptions. This is evident in China's sustained presence as one of Pakistan's top five exporting partners since 2009.

Subsequently, the trade exchange has been expanding dramatically over the years, which is largely due to the enhancement of China's export volume to Pakistan.

Figure 1: Sino-Pakistan Bilateral Export and Import 2003-2021



Source: this figure is generated by the author based on data from National Data (n.d.) and WITS (2003-2021).

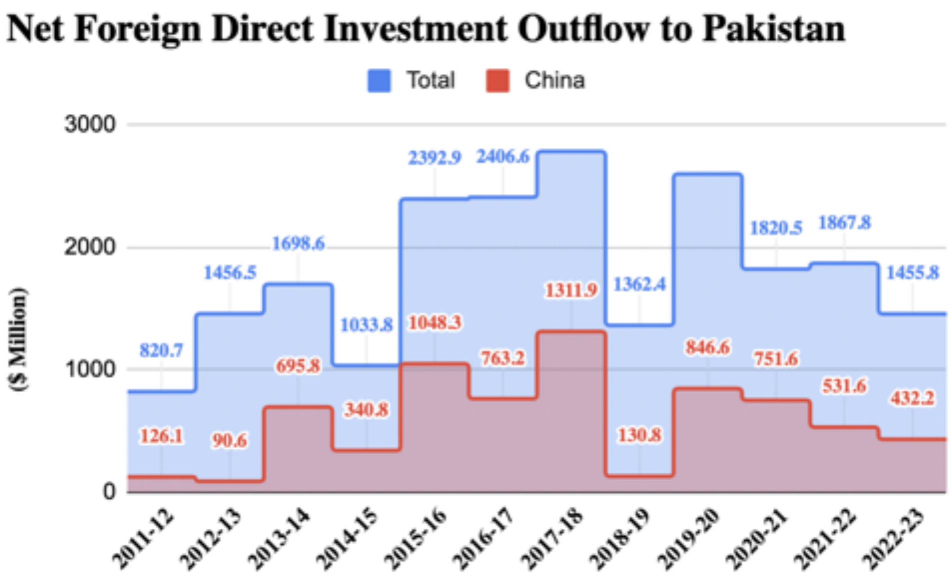
Chinese Investments Outflow to Pakistan

Regarding Chinese foreign direct investment (FDI) outflow to Pakistan, empirical data obtained from the Prime Minister's Office (see Appendix 2) reveals it over the past decade.

In contrast to bilateral trade data that consistently exhibit an ascending trajectory (see Figure 1), a cyclical fluctuation of approximately two years can be perceived regarding China's FDI (see Figure 2). Particularly, FDIs tend to exhibit a substantial surge in the first year, followed by a rapid decline in the subsequent year. The pinnacle of Chinese FDIs in Pakistan was observed in the fiscal year 2017-2018, totaling $110 million in net FDIs. Compared with other countries, China has consistently been the predominant source of Pakistani FDIs for seven consecutive years (Economic Cooperation Research Institute, 2022). This dominance can also be illustrated by the difference between the areas of the blue trapezoid and the red trapezoid in Figure 2, which visualizes the percentage of the total FDI equity inflows attributing to China ("%age with inflows' in Appendix 2). Moreover, The net Chinese direct investment outflow to Pakistan and the total net foreign direct investment outflow to Pakistan generally exhibit a comparable trend of fluctuations, with the exception of the fiscal years 2012-13, 16-17, and 21-22. On the one hand, this once again proves the significant proportion of net Chinese direct investment outflow accounts in Pakistan's total net foreign direct investment outflow. On the other hand, it might imply certain the influence of certain political reasons.

One of the factors that impacts and hinders Chinese FDI in Pakistan is the prevalence of terrorism and separatism in Pakistan. The political structure of Pakistan is characterized by centralization, provincial dominance (Eastern provinces), and appointment system. This political mechanism is deeply intertwined with unequal and unbalanced fiscal allocation, resulting in uneven resource distribution between the center and provinces, as well as among provinces (Huang & Yan, 2023). Previous scholarly research (see Li, 2023) has been carried out concerning the non-linear relationship between institutional risks in Pakistan and China's direct investment outflow to Pakistan. Facing terrorist threats, Li (2023) stressed the catalyst role that a friendly bilateral political relationship played in the case of Pakistan. Li (2023) observed that China's FDI in Pakistan could even exhibit the same inclination despite facing the institutional risks of Pakistan, under the condition of an increasingly friendly geo-economic political relationship.

Figure 2: Net Foreign Direct Investment Outflow to Pakistan[163]



Source: this figure is generated by the author based on data from Prime Minister Office, Board of Investment (Invest Pakistan). Retrieved (2023) from: https://invest.gov.pk/statistics

In regards to the labor force exported from China to Pakistan, two types of information are sorted, i.e., Chinese personnel deployed in foreign contracted projects[164] and in foreign labor service[165]. Defined by Art.2 Regulations on the Management of Overseas Contracting Projects (2008), the term 'foreign contracted project'[166] refers to the activities of Chinese enterprises or other entities (hereinafter referred to as units) undertaking construction projects abroad (hereinafter

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[163] The x-axis of the Figure 2 pertains to the fiscal year of Pakistan, which runs from 1st July till 30th June. The years in this paper, unless expressly indicated as being in fiscal years, are conventional calendar years.
[164] Translated by author, the original expression in Chinese is "中国对巴基斯坦承包工程派出人数" (National Data. (n.d.), published by National Bureau of Statistics.
[165] Translated by author, the original expression in Chinese is "中国对巴基斯坦劳务合作派出人数" (National Data. (n.d.), published by National Bureau of Statistics.
[166] Translated by author, the original expression in Chinese is '对外承包工程管理条例' (2008). The Regulations on the Management of Overseas Contracting Projects is passed by the 8th Executive Meeting of the State Council on May 7, 2008, and is implemented since September 1, 2008. It is published by the Minister of Commerce People's Republic of China.

referred to as projects)[167]. The term 'foreign labor service' is specified by Art. 2 Regulations on the Management of Foreign Labor (Cooperation) Service (2012)[168] as business activities that organize Chinese labor personnel to go to other countries or regions to work for foreign enterprises or institutions (hereinafter collectively referred to as foreign employers)[169].

Generally speaking, the amount of foreign labor engaged in contract-related projects substantially surpasses the number of personnel in labor service-related activities. Figure 3 is generated to portray the trends of Chinese personnel deployment, based on the data collected from National Data (n.d.) (See Appendix 3).

Pakistan has been one of the crucial markets for overseas project contracting, especially since the implementation of CPEC and Xi Jinping's visit in 2015 (MOFCOM) & China International Contracting Engineering Chamber of Commerce (CICECC), 2020). This echoes the dramatic rise in personnel from 2015 to 2017 (see Figure 3). Nevertheless, a sharp descent is observed from 2017 to 2019 (see Figure 3), which is also the era of sudden economic recession (Pakistan's fiscal year 2019) after five years of rapid economic growth. Concerns are raised constantly from the Chinese side regarding contracting projects in Pakistan, which can be summarized primarily in 4 aspects: instability of the political regime, currency exchange risk, Pakistan's incapabilities of meeting its debt obligations, and unfavorable tax environment, characterized by arbitrary enforcement of regulations, vague tax standards, and ever-changing tax policies, especially in the energy sector (MOFCOM & CICECC, 2020). What's more, terrorist attacks targeting Chinese labor in Pakistan have been continuously reported. The motives behind the attacks are not only linked to Pakistan's institutional risk, but it is also rooted in skepticism and doubts regarding Chinese investments or CPEC as a whole, resulting in a much more fierce form of protests (see AAMIR, 2023; Ebrahim, 2023). Subsequently, the strategy to fulfill corporate social responsibilities, thus promoting the image of Chinese overseas companies, is frequently proposed by the Chinese side.

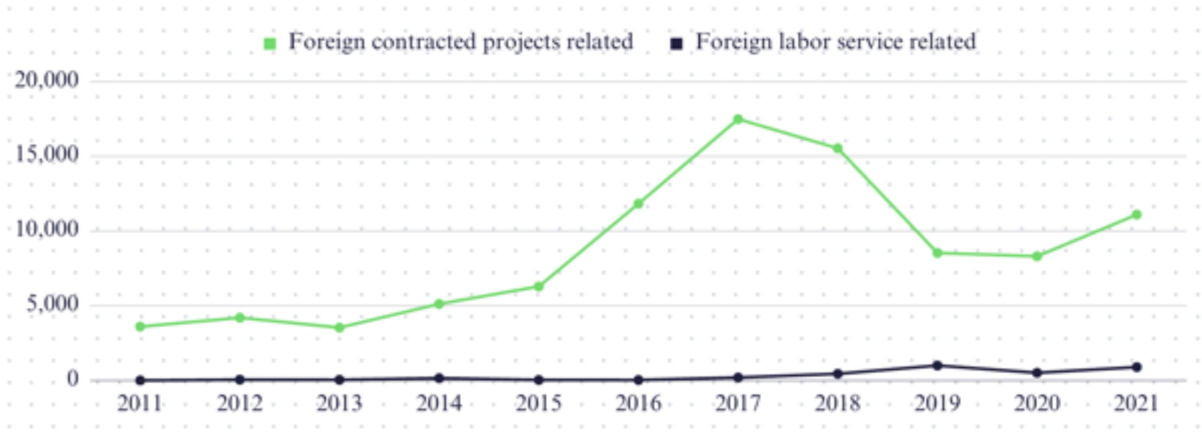
As for the Chinese overseas personnel in labor service-related activities, the summit appeared in 2019 when the number of laborers is roughly 143 times the number of laborers in 2011 (see National Data, n.d.). Concerns have also been raised regarding the protection of overseas labor rights and interests. Moreover, Chinese overseas labor can help to facilitate a friendly environment for people-to-people exchange, building profound bonds with Pakistani, and accelerating the China-Pakistan all-weather strategic cooperative partnership (Institute of International Trade and Economic Cooperation of the Ministry of Commerce et.al, 2022). Particularly, during the era of Coronavirus Disease 2019 (COVID-19), Chinese employees remaining at the post have impressed the Pakistani authorities and colleagues (The Nation, 2023).

[167] Translated and adapted by author, the original article in Chinese is: "本条例所称对外承包工程，是指中国的企业或者其他单位（以下统称单位）承包境外建设工程项目（以下简称工程项目）的活动" (2012).

[168] Translated by author, the original expression in Chinese is '对外劳务合作管理条例'. The regulations on the Management of Foreign Labor (Cooperation) Service is passed at the 203rd executive meeting of the State Council of the People's Republic of China held on May 16th, 2012, and implemented from August 1st, 2012 onwards. It is published by The Central People's Government of the People's Republic of China.

[169] Translated and adapted by author, the original article in Chinese is: " 本条例所称对外劳务合作，是指组织劳务人员赴其他国家或者地区为国外的企业或者机构（以下统称国外雇主）工作的经营性活动" (2012).

Figure 3: Chinese Personnel Deployment: Foreign Contracted Projects Related and Foreign Labor Service Related



Source: this figure is generated by the author from National Data.

Chinese Contributions in Finance to Pakistan

This section intends to provide an overview of Foreign Economics Assistance (FEA) received by Pakistan from China. As definition applied by the Policy Analysis & Development Wing Ministry of Economic Affairs Government of Pakistan (PADW, MoEA, GoP), FEA is referred to as government aid designed to promote the economic development and welfare of developing countries, whereas loans and credits for military purposes are excluded (The Organization for Economic Cooperation and Development (OECD), n.d.).

FEA reports present crucial information concerning financing details of social-economic and infrastructure development projects in Pakistan. The data analyzed in this section is retrieved from currently available FEA reports (from FY 2006-2007 till 2021-2022) published for each financial year of Pakistan by PADW, MoEA, and GoP, which is a secondary database. The original data is "obtained from the Debt Management and Financial Analysis System (DMFAS) Database managed by the Debt Recording and Reporting Center, MoEA" (MoEA, 2022). To further nuance, the data primarily used by this research is Source, Donor Wise Disbursement of FEA. Disbursement is defined as the total amount of funds received from development partners of the Pakistan government (MoEA, 2022). A table is created based on available FEA reports from FY 2006-2007 to FY 2021-2022 (See Appendix 4). 'Bilateral China' refers to the proportion of Chinese assistance amongst total FEAs that Pakistan recived bilaterally.

In Appendix 4, China SAFE Deposits stand as deposits from the State Administration of Foreign Exchange (SAFE), acting as "deposit to repay deposit received from a friendly country" (MoFA, p.11, 2021). SAFE, functions as "the foreign exchange management arm of the People's Bank of China (PBoC)" (Liu, p.5, 2023), without delivering commercial banking services. Furthermore, PBoC exclusively serves as the central bank of China. The commercial banking service of PBoC is distributed by the State Council of China into four independent but state-owned banks, i.e., the Industrial and Commercial Bank of China (ICBC), the Bank of China (BoC), the Agricultural Bank of China (ABC), and the China Construction Bank (CCB) (Liu, 2023). It is also worth mentioning that the detailed information of each donor was not presented during FY 2021-2022, FY 2021-2020, and FY 2019-2020. Therefore, related data is marked with N/A in Appendix 4.

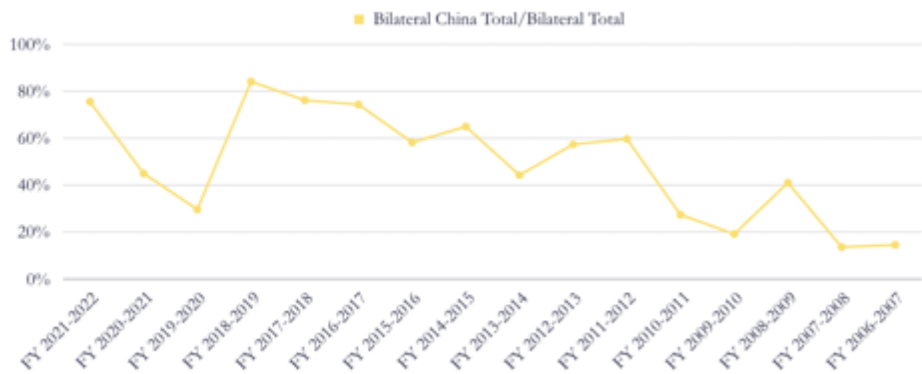
Overall, the vast majority of Chinese financial contributions are in the form of grants, rather than loans. Bilaterally, over sixteen years, China has contributed 14,048.18 million US dollars to Pakistan, constituting approximately 56.33% of the total bilateral FEA received by Pakistan. China has maintained its dominant position as the largest contributor to Pakistan, except in FY 2019-2020 (China is the second largest bilateral contributor after Saudi Arabia), FY 2010-2011 (China is the second largest bilateral contributor after the USA), as well as in FY 2009-2010 (China is the third largest bilateral contributor after the USA and Saudi Arabia), FY 2007-2008 (China is the third largest bilateral contributor after Saudi Arabia and the UK) and FY 2006-2007 (China is the third largest bilateral contributor after the USA and the UK).

To offer a clearer illustration of trends and variations, the basis of Appendix 4, Figures 4, 5, and 6 are generated.

Figure 4: Trends in Bilateral China and Bilateral Total Contributions From FY 2006-2007 to FY 2021-2022

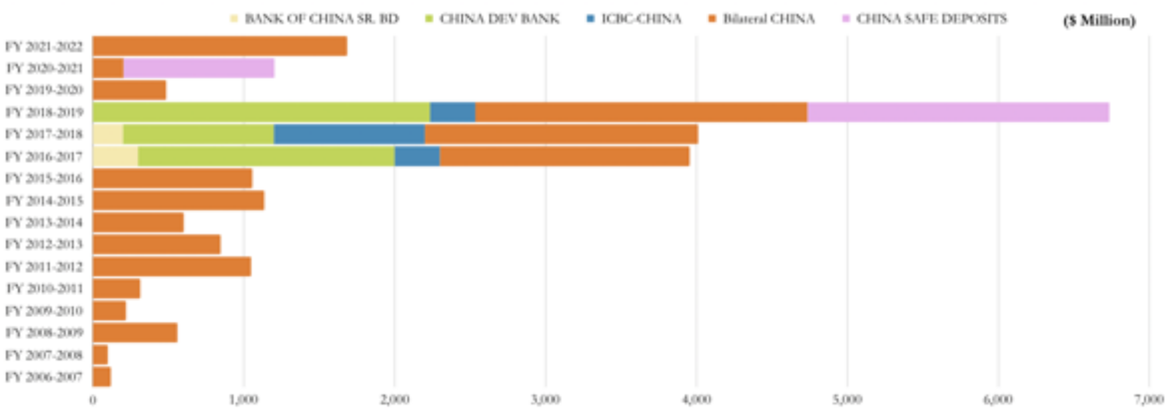
Source: this figure is generated by author based on data tracked from Policy Analysis & Development Wing Ministry of Economic Affairs Government of Pakistan.

Figure 5: Proportional Chinese Contribution in Bilateral Context From FY 2006-2007 to FY 2021-2022



Source: this figure is generated by author based on data tracked from Policy Analysis & Development Wing Ministry of Economic Affairs Government of Pakistan.

Figure 6: Compositions of Chinese Contributions From FY 2006-2007 to FY 2021-2022



Source: this figure is generated by the author based on data from Policy Analysis & Development Wing Ministry of Economic Affairs Government of Pakistan.

Firstly, Figure 4 demonstrates the synchronization of changes in bilateral contributions from China and the total bilateral contributions, implying the notable dominance possessed by China. This dominance is further illustrated in Figure 5. Though with fluctuations, from FY 2006-2007 to FY 2021-2022, the influence from China is ascending. A sharp decline of approximately 54% appears during FY 2019-2020 compared with FY 2018-2019. Nevertheless, with the arrival of FY 2020-2021, Chinese influence surged abruptly, even accelerating more dramatically during the second following financial year, i.e.: 2021-2022. Combined with Figure 4, even though Chinese contributions account for nearly 45% of the total contribution during FY 2020-2021, the number of Chinese contributions decreased, as well as the total bilateral contributions, compared to the previous financial year. These turbanlances among 2020-2022 echo the economic recession and economic recovery process caused by the Covid-19 pandemic. The peak of Chinese contributions to Pakistan appears during FY 2018-2019.

In order to examine the compositions of Chinese contributions in general, which take the contributions from Chinese banks and SAFE deposits into consideration, Figure 6 is completed. Nevertheless, due to the accessibility of data during FY 2021-2022, FY 2021-2020, and FY 2019-2020, Figure 6 is only responsible for the trends portrayed in the rest of the financial years.

From Figure 6, the dynamic initiatives of both the China Development Bank (CDB) and the ICBC are noteworthy. Additionally, it is during FY 2015-2016 that Chinese banks started to integrate into the development of Pakitan. This involvement echoes the benchmark that took place in the year 2015 when CPEC was officially established (which is mentioned in the previous section: *Diplomatic Background: BRI's Integration in Pakistan Through the China-Pakistan Economic Corridor (CPEC)*).

Transnationalization of Chinese Economy Along the CPEC

Method and Data

This is a theory-oriented research with descriptive analyses, which centers around the theory of geopolitical economy.

On top of the theory of geopolitical economy, both quantitative and qualitative approaches have been incorporated into the analysis of Chinese investments outflows in Pakistan along the CPEC. The mapping of Chinese companies' data are processed through the computer software 'Gephi' and 'QGIS'. The quantitative data retrieved regarding Chinese companies' participation in the 4 sectors (energy, transport and infrastructure, Gwadar, industrial cooperation/SEZs) and 7 provinces of Pakistan are visualized in Figure 7, 8, 9 together with qualitative analyses.

In general, the data regarding the CPEC projects invested by China is collected and displayed in 2 tables (see Appendices 5 and 6), which is retrieved from the official website of CPEC.

The information displayed regarding the CPEC Project Overview by Sector I (Appendix 5) and II (Appendix 6) is directly downloaded and compressed from the official website of the CPEC, which provides an overall landscape of CPEC projects. The former (Appendix 5) combines the information of Sectors I to V: i.e.: I). energy, II). transport and infrastructure, III). Gwadar, IV)industrial cooperation/Spcecial Economic Zones (SZEs), V). social and economic development under the CPEC, while the latter (Appendix 6) targets the PSDP projects by directly merging three forms: "PSDP 2016-2017", "PSDP 2017-2018", and "PSDP 2018-2019" downloaded from the website.

To further nuance, two reductions will be made to narrow the research scope and avoid unnecessary repetitions.

Appendix 6 tends to encompass different stages of one project. Therefore, its categorization is so detailed that doesn't match the research goal and is likely to generate confusion. For example, "Karachi - Lahore Motorway (Land Acquisition) (CPEC) Sukkur-Hyderabad (CSDP S#78)", "Comprehensive Feasibility Study for Upgradation/Rehabilitation of Mainline (ML-I) and New Dry Port at Havelian (Buldher) District Haripur under (CPEC)" (CSDP S#615), and "Up-gradation of Pakistan Railway's existing Mainline-1 (ML-I) and establishment of Dry port near Havelian (2018- 22) Phase-1 (CPEC) (CSDP S#642)" are listed as three projects. Nevertheless, these three projects represent different phases of the project "Up-gradation and Dualization of ML-1 and establishment of Dry Port near Havelian (#T12)" included in the 'transport and infrastructure' sector of Appendix 5. As for the rest of the projects in Appendix 6 that are not involved in Appendix 5, the information is tough to trace. Consequently, the research focus will be applied to the projects involved in Appendix 5.

To refine the research scope more accurately, sector V in Appendix 5 will be excluded. On the one hand, the projects in sector V exhibit the same content that has been counted in the previous four sectors. For instance, the project "Gwadar Vocational and Technical Project (S17)" is already mentioned in Sector III as "Pak-China Technical and Vocational Institute at Gwadar (G3)". On the other hand, the rest of the content tends to be vague, making it impossible to be traced. For instance, the project "Drinking Water Equipment (#S15)", and "Medical Equipment and Materials (S12)."

Ultimately, the research will be centered around the previous four sectors (energy, transport, and infrastructure, Gwadar, industrial cooperation/SEZs) covered in Appendix 5.

For the sake of gathering data from four sectors, the use of primary resources, especially the official documents or contracts of each project published by related government institutions, is always prioritized. Apart from this, news reports are also scrutinized since they sometimes publish their personal communications with officials regarding the most recent updates. To summerize, the main resources retrieved are listed in Appendix 9.

Chinese Companies' Involvement Along the CPEC

To begin with, ten companies are filtered out due to their public inaccessibility, where the basic information regarding their ownership, management, products or services, and financial and legal status are missing. Subsequently, 130 companies have been outlined (see Appendix 7), including their ownerships.

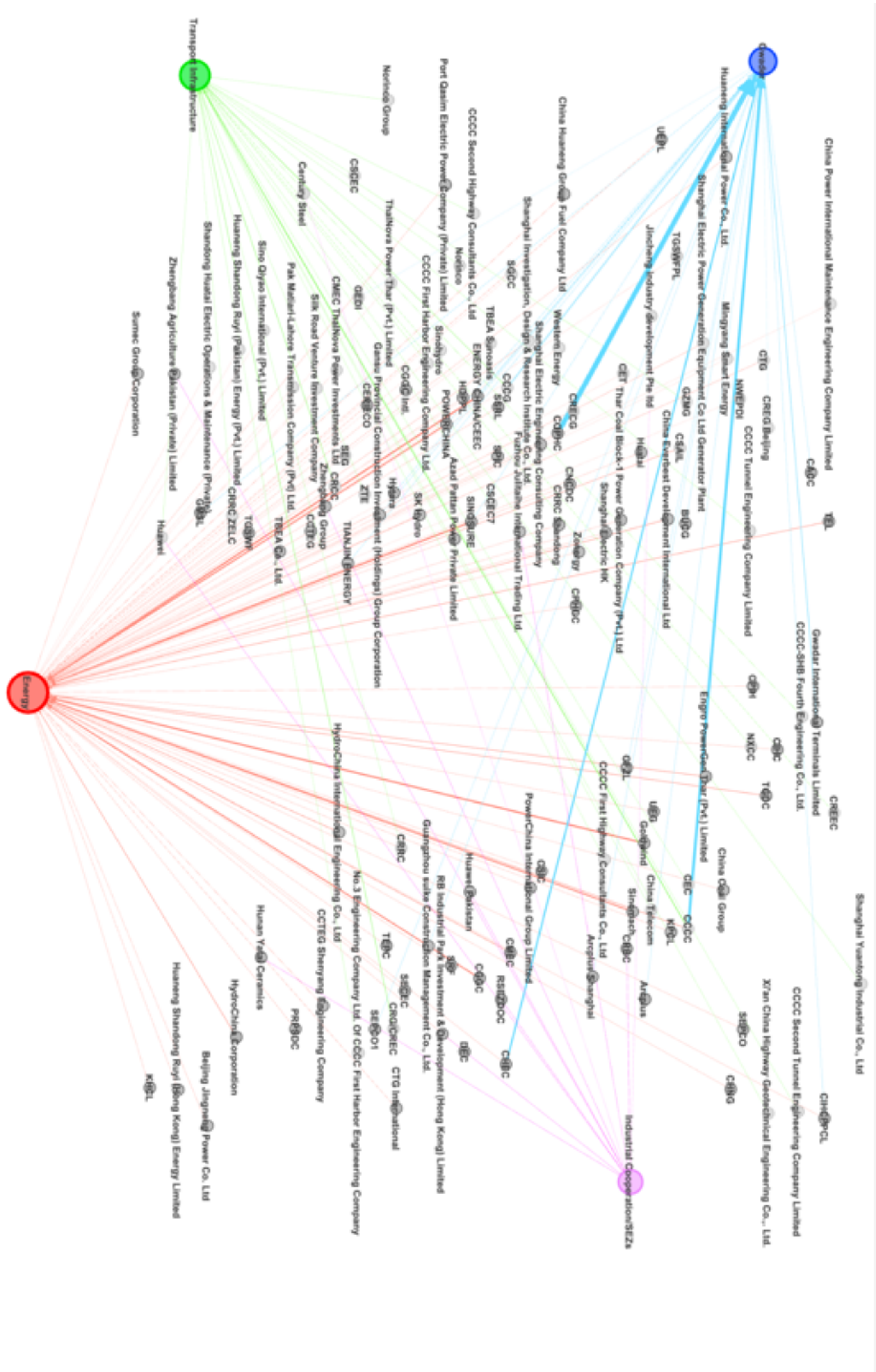
The 'direct involvement' is characterized as companies directly entering into agreements under the supervision and approval of Pakistani authorities in the forms of being executors, equity holders, Engineering, Procurement, and Construction (EPC) contractors, Operations and Maintenance (O&M) contractors, or in charge of construction, etc. The companies indirectly involved are the parent entities of the companies directly engaged in the investment, which may also include those operating behind intermediaries or investment vehicles, facilitating the investment as per their agreement. Within the scope of indirect participation of Chinese companies, the Special Purpose Vehicle (SPV)/Project Company is also considered. A SPV is defined as a separate legal entity created for a specific objective (Corporate Finance Institute, 2023). As for the companies behind the SPVs in the forms of partnerships or joint ventures, they are considered indirect contractors.

Among these Chinese companies, it is noteworthy to mention China Overseas Ports Holding Company Ltd (COPHC), together with its three subsidiaries Gwadar International Terminals Ltd. (GITL), Gwadar Marine Services Ltd. (GMSL), and Gwadar Free Zone Company Ltd. (COPHC, n.d.). The command of Gwadar Port and Gwadar Free Zone was taken over by the COPHC for 40 years since 2013. Starting with the universally acknowledged strategic significance of Gwadar port, the Pakistani authorities envisage the COPHC to advance this 'region's most strategically well-located port' into a hub of maritime trade for the whole region, especially within landlocked Central Asia (National Electrical Power Regulatory Authority, 2020). On the contrary to the enormous obligation and responsibilities carried by COPHC, there is a scarcity of information regarding COPHC's ownership, management, finance, and functioning in reality. The Pakistani media characterizes COPHC as 'mysterious' in a negative tone (see BR Research, 2018). BR Research (2018) claimed this mystery by illustrating the lack of COPHC's background information, COPHC's failure to submit Annual Accounts, and absence in International Reports. Notwithstanding three years have passed, the insufficiency of data and transparency haven't altered a lot. It seems that either the company doesn't issue the yearbooks/annual reports, or they are not accessible to the public. In addition, the only record on the official website of the Security and Exchange Commission of Pakistan (SECP) remains to be the signing of a Memorandum of Understanding (MoU) in 2016 for establishing a facilitation center in Gwadar Free Zone (SECP, n.d.).

All the reports concerning the profile of this company across the entire internet are repetitive, which solely identify the COPHC as an emerging, fast-growing company established in Hong Kong without further illustrations concerning the structure and stakeholders of this company. The ownership of this COPHC also seems vague, and clues can only be traced from media reports and one Chinese third-party database named Qi Cha Cha, rather than from the official website of this company or government websites. Ebrahim (2017) mentioned the COPHC as a state-run company, and it is shown on Qichacha's (2023) website that the COPHC is a state-owned holding. Qichacha (2023) also indicates that the shareholder information and corporate's annual reports are not found, possibly due to the reasons that the source of information disclosure has not been disclosed, there are differences in disclosure forms, and there is a time lag in data retrieval.

In this research, 'company involvement' within each sector is taken as a unit and defined by the cumulative frequency of their participation, indicating the depth of their engagement within a given sector. To visualize the sectoral 'involvements' of 130 companies in these four scrutinized sectors, i.e., energy, Gwadar, transport and infrastructure, and industrial cooperation/SEZs, Figure 7 is accomplished as the visualization of Appendix 7. The degree of corporate involvement is depicted through the thickness of edges, quantified by the quantity of projects in which a given company participates. Both direct and indirect participation are collectively considered as a general form of involvement. Their weight differences are not encompassed. Nevertheless, direct and indirect participation are not merged together. For example, CCCC is involved both indirectly and directly in the energy project 300MW 'Coal-Fired Power Project at Gwadar (#E16)'. In this case, they are summed up as 'two involvements'.

Figure 7: Sectoral Chinese Company Involvements Along the CPEC



Source: this figure is generated by the author with computer software 'Gephi', based on data in Appendix 7. The 4 colored circles represent 4 sectors (energy, transport and infrastructure, Gwadar, industrial cooperation/SEZs) investigated. The smaller gray circles represent 130 Chinese companies included in this research.

It is striking to see that the vast majority of the companies are only involved in one project, which is reflected in the widely distributed thin divergences in Figure 7 from different companies to four sectors. It suggests that most companies' scope of project involvement is not substantial. Beyond this, the most representative Chinese companies along the CPEC are COPHC and CCCC, demonstrating a notable presence through '15 involvements' and '13 involvements', respectively. Four companies exhibit a moderate level of engagement, including CCCG, which is marked by '8 involvements', alongside ENERGY CHINA/CEEC China, SINOSURE, and CHEC, which are marked by '6 involvements'. Lastly, another set of four companies manifest a medium-low degree of engagement, involving Goldwind, and POWERCHINA, each is related to '5 involvements', as well as CGGC and Sinomach, associated with '4 involvements.'

Among these 10 companies, apart from the mysterious ownership of COPHC, CCCC (majority state-owned and CCCC's parent, China Communications Construction Group (CCCG), is fully state-owned) and Goldwind, the rest of 7 enterprises are state-owned. Although Goldwind is the only private company here, it has been constantly enjoying support from the central government as well as active local backing from the regional government of Xinjiang (Forbes, 2015). On the one hand, this implies the significant role played by Chinese State-owned Enterprises (SOEs) in Chinese outward FDI. On the other hand, Chinese SOEs' heavy integration into CPEC can also be reflected, implying the use of SOEs as instruments to promote Chinese foreign policy. Additionally, It is not difficult to understand the substantial role played by COPHC since it is the operator of the Gwadar port and the developer of the Gwadar Free Zone (see NEPRA, 2020), thus penetrating every dimension of CPEC projects in Gwadar. As for CCCC & CCCG, CCCC is a subsidiary of the CCCG (Fitch Ratings, 2021). The former is majority state-owned, contributing to a great proportion of CCCG's revenue, profit, debt, cash, and assets; the latter is completely state-owned. This suggests the leading and overarching influence delivered by the CCCG along the whole CPEC. In other words, CCCG has demonstrated its notable capability in delivering and expanding Chinese global impact, safeguarding access to strategic resources and markets.

The Spatial Distribution of these 10 representative Chinese Companies are summerized in Appendix 8.

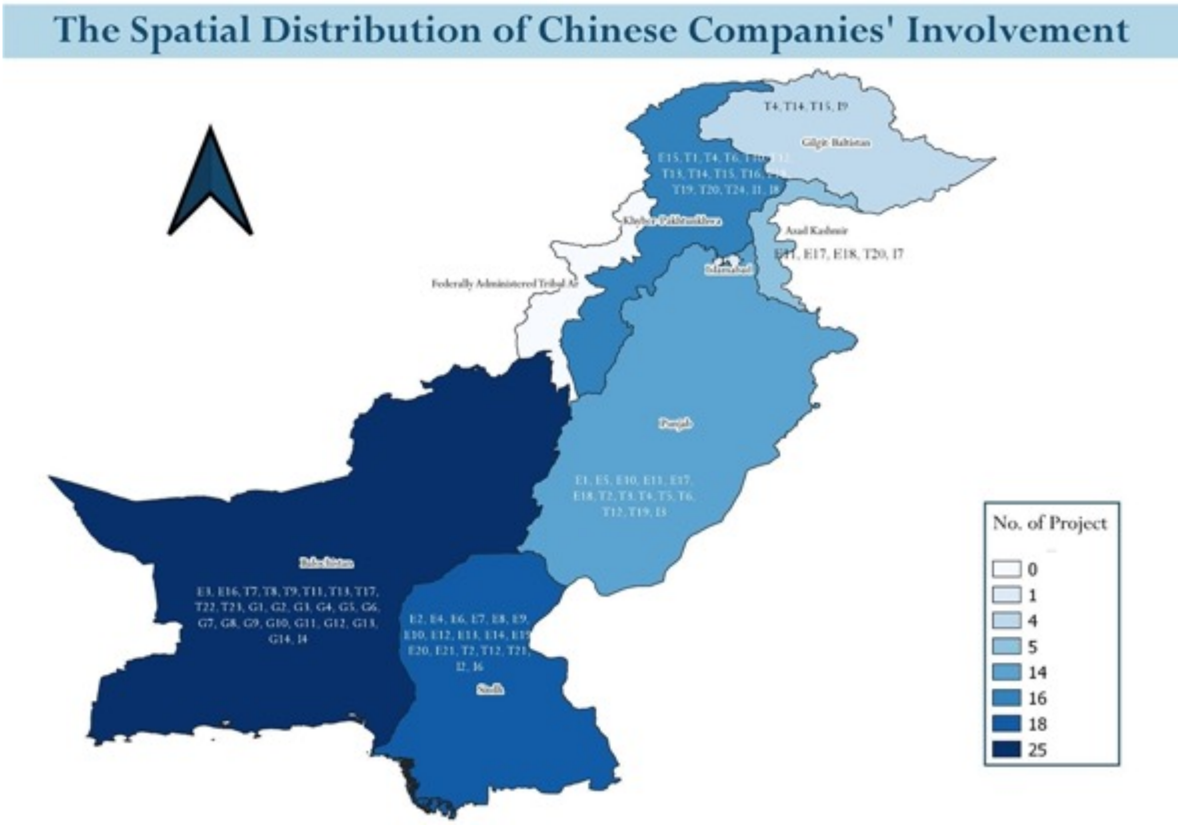
Sectorally, the hierarchy of company engagement is delineated as follows: The energy sector holds the highest precedence (accounting for approximately 55.45% of the total involvements), followed by the Gwadar sector (24.69%), then the Infrastructure and Transport sector (14.69%), and finally, the SEZs sector (5.21%). The effort in the energy sector contributed by companies is notable, accounting for more than half of the 'involvements'.

In the context of the CPEC, energy is constantly emphasized in the 'CPEC Long-term Plan' and 'Pakistan 2025 One Nation One Vision' policy documents. It constitutes one of the four key components within the '1+4' cooperation framework, which also encompasses Gwadar, transport infrastructure, and industrial cooperation. Furthermore, the CPEC energy projects are perceived as 'a backbone of the energy strategy to overcome the energy power crisis in Pakistan' (PC, 2014). Since the country's inception in 1947, the complex energy challenges in Pakistan have been consistently observed. These challenges have been compounded and exacerbated by factors such as political reluctance to address the issue, inadequate energy supplies from foreign sources, and domestic mismanagement over the years (Wolf, 2021). Despite facing acute energy deficiency, Pakistan possesses substantial untapped energy resources and significant potential for renewable energy (Grainger & Zhang, 2017).

Moreover, it is crucial to highlight that this measurement still possesses shortages and may not be complete, which is primarily concerning the data of SZEs. Firstly, no single SZE has achieved full construction. Instead, they are either in the process of being constructed or are in the planning stage for future development. Further to this, up to date, the official records of investors of SZEs registered under the Pakistani authorities are missing. Therefore, the Chinese companies involved in the SZEs aforementioned above are discerned mainly through news reports. This delineates a fragmented process that could lead to significant deviations or discrepancies from the actual facts. Secondly, the data regarding supporting facilities for the economic zone is also quite lacking. The information regarding supporting facilities is broadly generalized in summary speeches, lacking specifications of the entities' participation, including contractors, subcontractors, suppliers, investors, and developers. This absence of clarity renders it difficult to determine the extent and nature of Chinese involvement in these facilities. For example, in the case of Rashakai SEZ, it is described as: "Rashakai SEZ provides various services and facilities for zone enterprises, including 210MW of electricity and 30MMCFD of gas. The electricity and gas have been connected to the zero point, and the grid station and gas station will be put into operation by the end of 2022" (PCBIF, n.d.). Regarding the investment details of grid station and gas station is not accessible.

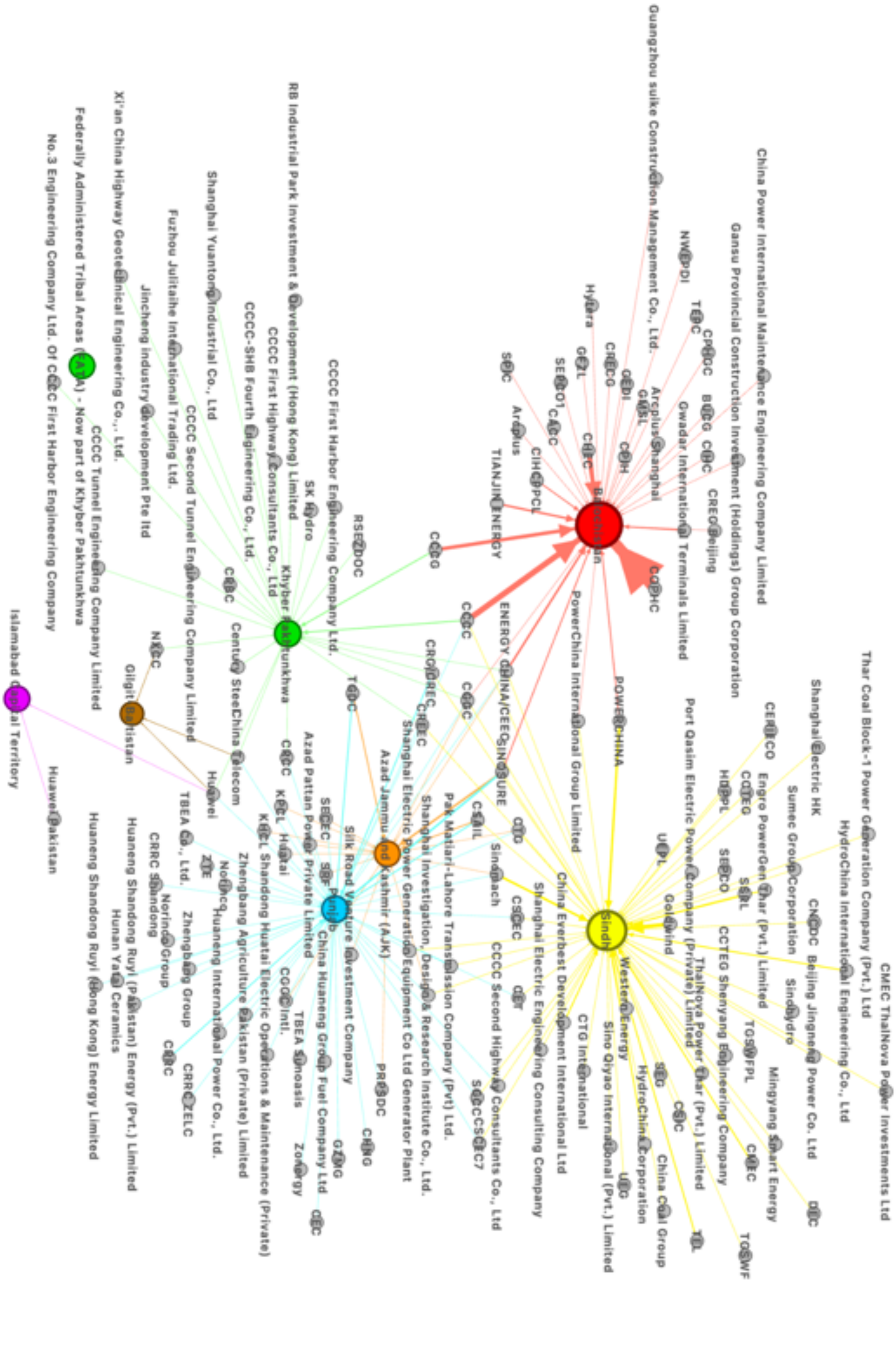
To further scrutinize the geographical patterns of Chinese companies in Pakistan along the CPEC, Figures 8 and 12 are generated, based on the location provided in Appendix 5.

Figure 8: The Spatial Distribution of Chinese Involvement by Projects



Source: this figure is generated by author with computer software 'QGIS', based on data concerning the geographical locations of each project, which is retrieved (2023) from: https://cpec.gov.pk/

Figure 9: The Spatial Distribution of Chinese Involvement by Companies



Source: this figure is generated by author with computer software ‘Gephi’, based on data in Appendix 7. The 7 colored circles represent 7 provinces of Pakistan (Balochistan, Sindh, Punjab, Khyber Pakhtunkhwa (KP), Azad Jammu and Kashmir (AJK), Gilgit-Baltistan and Islamabad

Capital Territory) investigated. The smaller gray circles represent 130 Chinese companies included in this research.

Figure 9 reflects the geographical disparity of CPEC investments by projects. This provincial density is ranked from the top to down as Balochistan> Sindh> Punjab> KP> AJK> Gilgit-Baltistan> Islamabad Capital Territory (> Federally Administered Tribal Areas (FATA), which is part of Khyber Pakhtunkhwa[170])

Substantial progress in Balochistan has been undergone under the CPEC, primarily attributed to the development of Gwadar ports and Gwadar Free Zone. Through this strategy, the change might be facilitated to the historical unprivileged status of Balochistan compared with Eastern provinces such as Punjab. Balochistan has long been confronting the vicious cycle of security crisis and economic distress, i.e., the more turbulent the country is, the harder it is to achieve economic development; the harder it is to boost the economy forward, the higher the chance that terrorism and separatism arise due to discontent and hostile of local habitats (Huang & Yan, 2023). On top of this, the commitment has also been to local employment and community, in the sense that 90 percent of manpower is hired from the local market of Gwadar and Balochistan (Khan, 2023). Subsequently, this commitment suggests a more sustainable understanding of China's drastic investment via CPEC, contrary to Wolf's (2021) skepticism that considers Chinese investment as a threat to local industries and the labor force. On top of this, the Sino-Pakistani military relation is boosted during this process. The Special Security Division of 12,000 personnel, headed by a senior military official of the rank of a Major General, comprising nine Army battalions and six wings of paramilitary forces (Rangers and Frontier Corps), is established concerning the security of Chinese overseas works.

Similar to Balochistan, facing a scarcity of resources, KB has also been suffering from the vicious cycle of security crises and economic hardship (Huang & Yan, 2023). Its transport and infrastructure have been heavily invested via the CPEC, which involves an all-around advancement of highways, rapid transit systems, railways, and motorways, improving regional connectivity and alleviating traffic burden.

Despite the fact that considerable effort has been displayed in Western provinces, the majority of energy projects, including green energy projects, are initiated and planned in the Eastern provinces, in particular, in the Southeastern coastal plain region–Sindh.

In contrast to the disproportionate allocation of energy projects throughout Pakistan, the establishment and development of Industrial Cooperation/SEZs has illustrated a relatively equal distribution across the entire territory. It is perceptible that at least one SZE has or will be constructed in each province, which helps to convert the geographical potential of each province into economic opportunities. This transformation process will also bring out spill-over effects, effectively integrating resources, cultivating competitive industrial clusters, and increasing exports, thereby helping Pakistan achieve sustainable development (Gilani, 2023). On top of that, the equal distribution of SEZs further signifies the ambition to comprehensively upgrade the transnational networks formulated by Pakistan and its neighboring countries. On the one hand, abundant economic development and opportunities to thrive can be brought by SZEs. On the other hand, tensions and security challenges arise from Pakistan and its neighbors, including Afghanistan, Iran, and India. Table 1 is generated to demonstrate the transnational outlook behind SZEs. Scholars have also stressed this feature:

> To fully exploit benefits from export opportunities through the SEZs, Pakistan needs to have workable relationships with the neighbouring countries, especially in Central

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[170] FATA (Federally Administered Tribal Areas) has merged with KP (Khyber-Pakhtunkhwa) and the Twenty-fifth Amendment to the Constitution has passed on on May 24, 2018 (Tribune, 2018).

Asia. This will allow for greater market access and open up new vistas for Pakistani products. The success of economic zones also depends on the security and socio-economic situation of the region; thus, it is essential to maintain peaceful relationships with the immediate neighbors, including India, Afghanistan, and Iran. (Aslam. et al, 2019)

Table 1: Transnational Geographical Networks Behind SZEs

#	Name of SZEs	Location	Transnational Geographical Networks
I1	Rashakai Special Economic Zone (RSEZ)	Nowshera, Khyber Pakhtunkhwa(KP)	1. Jammu and Kashmir, **India**: To the southeast, KP shares a border with the Jammu and Kashmir in India. 2. Xinjiang, **China**: To the north and northeast, KP shares a border with the Xinjiang Autonomous Region of China.
I2	Dhabeji Special Economic Zone (DSEZ)	Thatta, Sindh	**1. India**: To the East, Sindh borders India. **2. Arabian Sea**: To the south, Sindh is bordered by the Arabian Sea.
I3	Allama Iqbal Industrial City	Faisalabad, Punjab	1. **India**: To the south, southeast, north, northeast, tPunjab shares a border with India.
I4	Bostan Special Economic Zone	Balochistan	1. **Afghanistan**: To the northwest, Balochistan shares a border with. 2. **Iran**: To the west, Balochistan shares a border with. 3. **Arabian Sea:** To the south, Balochistan has a long coastline along the Arabian Sea.
I5	ICT Model Industrial Zone	Islamabad	
I6	Industrial Park on Pakistan Steel Mill Land	Port Qasim Near Karachi	Situated on the **Arabian Sea**
I7	Mirpur Industrial Zone	Mirpur, Azad Jammu Kashmir (AJK)	AJK borders the **Indian** union territory of Jammu and Kashmir
I8	Mohmand Marble City	Mohmad Agency, KP	1. Jammu and Kashmir, **India**: To the southeast, KP shares a border with the Jammu and Kashmir in India. 2. Xinjiang, **China**: To the north and northeast, KP shares a border with the Xinjiang Autonomous Region of China.
I9	Moqpondass Special Economic Zone	Gilgit-Baltistan	1. **Afghanistan**: GB borders Afghanistan to the north. 2. **Xinjiang**, China: To the north and northeast, Gilgit-Baltistan shares a border with the Xinjiang.

Source: the data concerning the location of SZEs are collected from the official website of the CPEC, retrieved (2023) from: https://cpec.gov.pk/special-economic-zones-projects. The 'transnational geographical networks' in this table are completed by author.

Challenges Confronting Chinese Investors

In general, significant risks for Chinese investors are perceived in the following five dimensions: 1. Natural/environmental risks; 2. Logistical, technical, and infrastructure risks; 3. Bureaucratic processes and regulatory risks; 4. Financing risks; 5. Safety and security risks.

Natural/Environmental Risks

Northern Pakistan is characterized by its rugged and challenging terrain, constituting some of the world's highest peaks, including the Himalayas and the Karakoram Range. This area encompasses the administrative regions of Gilgit-Baltistan, Khyber Pakhtunkhwa (KP), Azad Jammu and Kashmir (AJK). Therefore, Chinese investors face formidable challenges due to landslides, avalanches, as well as unpredictable weather. This risk triggered by the harsh local natural environment is especially prominent in projects: KKH (Karakoram Highway) Phase II (Havelian - Thakot Section) (#T1), Cross Border Optical Fiber Cable Khunjrab - Rawalpindi (#T4), Realignment Of KKH Phase-I Thakot - Raikot Section (#T15), and Peshawar-Karachi Motorway (Multan-Sukkur Section) (#T2). #15 is Even regarded as "the Highest Paved International Road and 'Eighth Wonder of the World" (Dangerous Roads, n.d.)

Avoiding damaging historical cultural sites is the second notable natural/environmental risk. United Nations Educational, Scientific and Cultural Organization (UNESCO) has expressed concerns about the project Orange Line Metro Train - Lahore (#T3), regarding it as a serious threat to Fort and Shalamar Gardens in Lahore, together with potential visual and noise pollution generated through its construction (UNESCO, 2017; UNESCO, 2018). In addition, during the engineering, procurement, and construction of KKH Phase II (Havelian - Thakot Section) (#T1), great attention has been paid to minimizing ecological impact and addressing the sensitivities of endangered species like the Marco Polo sheep (CHINCA, 2018). The solutions include noise disturbance avoidance and minimizing nighttime activities, which is achieved through the engagement of the local monitoring agency and adherence strictly to local standards (Embassy of the People's Republic of China in the Islamic Republic of Pakistan, 2018).

Additionally, fishermen's concerns regarding their future livelihood have become the dominant impediment during the Development of Port and Free Zone (#G1). The pessimistic outlook of fishermen has been conveyed by the report, suggesting that "In fact, other than the local fisherfolk, it seems everybody else is benefiting" (Ebrahim, 2017). Fishermen have been plagued by restricted access to Gwadar jetty upon completion, fishing sustainability, potential displacement, societal marginalization, and loss of income.

Concerning ten coal projects in the energy sectors (#E1, #E2, #E3, #E4, #E12, #E13, #E14, #E16, #E19, #G8), protests arise in response to grievances about air pollution, health issues, contamination of groundwater, threats to ecology and the toxic impacts thereof.

Lastly, regional water scarcity has also been reported to impact the development of the Gwadar Smart Port City Master Plan (#G2) and the Development of the Port and Free Zone (#G1)

Logistical, Technical, and Infrastructure Risks

Related impediments have been constantly perceived in the sector of transport & infrastructure and Gwadar. For example, in the construction of KKH (Karakoram Highway) Phase II (Havelian - Thakot Section) (#T1) and Peshawar-Karachi Motorway (Multan-Sukkur Section) (#T2), local resource scarcity has led to the reliances on transportation materials and pieces of machinery, resulting significant time wastage (China Society for International Economic Cooperation, 2016). Furthermore, delays occur due to poor road conditions and unpredictable weather, escalating the risks from the natural environment to financial risks. Similarly, this risk escalation has been observed during the Up-gradation and Dualization of ML-1 and the establishment of the Dry Port near Havelian (#T12) due to technical challenges and design faults (Abbas, 2022). Besides this, another technical issue stemming from different engineering and transport standards between

China and Pakistan also influences the construction efficiency of the Karachi Circular Railway (#T21) (Janjua & Asif, 2018).

In the Gwadar sector, similar impediments emerged in projects such as the Gwadar Smart Port City Master Plan (#G2), New Gwadar International Airport (#G5), and the Development of Port and Free Zone (#G1). Chinese companies have been tackling major issues such as underdeveloped local infrastructure, lack of industrial development, and scarcity of electricity to fulfill their responsibilities and avoid further delays.

Bureaucratic Processes and Regulatory Risks

Similar to the aforementioned logistical, technical, and infrastructure risks, bureaucratic processes and regulatory risks also prevail in the sector of transport & infrastructure and Gwadar. Moreover, it is intricately connected to financial risks, owning to the possible delays caused by prolonged bureaucratic processes or social instability and disturbances.

The pending approval of the No Objection Certificate (NOC) has resulted in a delay of DTMB-A (Digitalize the existing three sites of PTV) (#T19), hindering technical teams to carry out crucial activities involving installation, commissioning, and integration (Haider, 2023). Furthermore, the miscommunication between local and Pakistan authorities has led to compensation disputes and abuse of labor in projects of Orange Line Metro Train - Lahore (#T3), and Up-gradation and Dualization of ML-1, and the establishment of Dry Port near Havelian (#T12) (Bibi & Raza, 2023). In other words, this ignorance of local laborers' working conditions reflects the ineffectiveness of Pakistani governance, which will slow down the construction process.

Besides the infringement of labor rights, inhabitants' resettlements and post-construction urban planning remain challenging, which invovlves the resettlement issue, together with unfair land compensation rates, could potentially lead to the formation of slum settlements. As for problematic post-construction urban planning, it is associated with financial issues, i.e.: without proper planning, current land use patterns might not be conducive enough to support efficient transit systems, leading to difficulty in recovering costs and resulting in a further inability to meet debt obligations for the Pakistan government. What's worse, problems of strikes and death of labors also emerged during the establishment of #T3 (Devdiscourse, 2020). In these circumstances, the reputation of Chinese companies might be damaged, further exacerbating the security challenges confronted by Chinese investors.

On top of this, the issue of inconsistency and uncertainty in the project evaluation and decision-making from Pakistan is also perplexing. For instance, Pakistan's inability to prepare the required feasibility study in time has caused the shifting inclusion and exclusion of the Quetta Mass Transit project (#T23) project at different Joint Cooperation Committee (JCC) meetings.

In the sector of Gwadar, regional administrative fragmentation exists. Therefore, the failure of proper funds disbursement has deteriorated the local investment environment, which is notable in projects 1.2 MGD Desalination Plant (#G9), Gwadar Smart Environment Sanitation System and Landfill Project (#G14), and Gwadar Smart Environment Sanitation System and Landfill Project (G8) (Kaur & Malhi, 2023). Problems in land acquisition and insufficient environmental approvals by the Balochistan government are apparent in the 300MW Coal-Fired Power Project at Gwadar (#G8) (Ahad, 2023). Also, dissatisfaction with compensation is constantly raised by fishermen in projects such as Gwadar Eastbay Expressway (#G4) (Ebrahim, 2021).

Lastly, the infamously high level of corruption has enhanced the hesitation from the Chinese side. In 2017, China temporarily halted the release of funds for projects Realignment Of KKH Phase-I Thakot - Raikot Section (#T15), Dera Ismail Khan-Zhob Road (#T13), and Khuzdar-Basima Road (#T8) (Raza, 2017; Times of India, 2017).

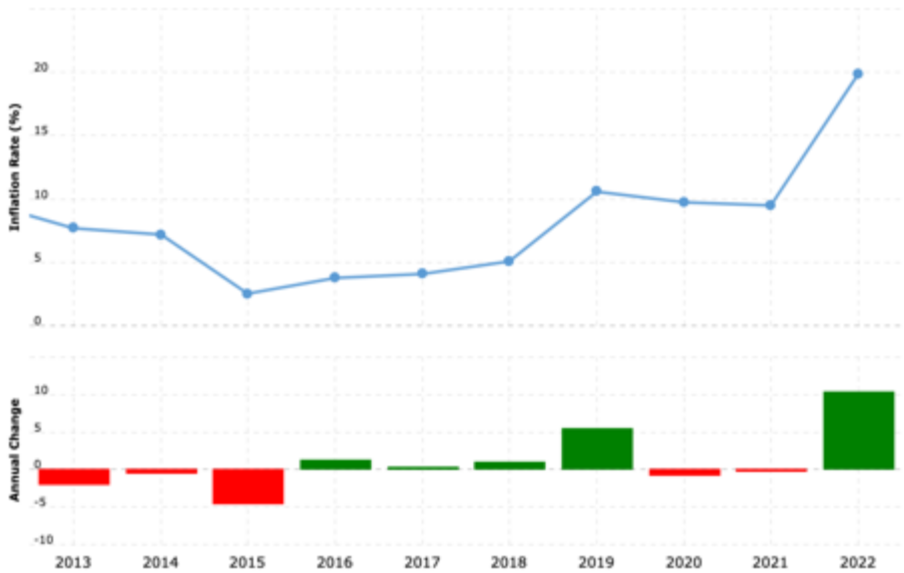
Financing Risks

Against the background of insufficient political stability within the federal government and local government, issues related to tax and fiscal are prominent.

There are two striking challenges embedded in all transportation and infrastructure sectors: 1. The threat to the anticipated cash flows, which will disrupt repayment and result in a cash flow hiatus. Moreover, these threats are mainly caused by consistent project delays due to potential political instability, policy changes, and a high inflation rate. 2. The risk connected with exchange rate fluctuations, which reflect Pakistan's imbalance in international payments and limited capacity to generate foreign exchange from exports. Additionally, the overall financial risk will be intensified during global economic downturns, as Pakistan heavily depends on international capital inflows to offset project deficits.

Figure 10 demonstrates Pakistan's inflation rate from 2013 to 2024. According to this graph, the economic volatility or instability of Pakistan is notable, resulting in uncertainty for businesses and investment decisions. In particular, during 2021-2022, the inflation rate surged substantially, which might stem in global economic recession brought by Covid-19.

Figure 10: Pakistan Inflation Rate 2013-2024



Source: Macro Trends (n.d.) with data retrieved from the World Bank.

Figure 11: Pakistani Rupee to United States Dollar 2006-2023

Source: GoogleFinance, retrieved on Nov 23, 12:20:00 PM UTC.

As illustrated by GoogleFinance in Figure 11, a persistent decline is evident, indicating a significant devaluation of the Pakistani Rupee (PR). The value of the Pakistani Rupee (PR) in May 2006 was 477% higher than its current value. Financial inviability occurs along the CPEC, such as in projects Orange Line Metro Train - Lahore (#T3) and Quetta Mass Transit project (#T23), where controversy and skepticism exist concerning whether Pakistan can eventually pay back the loans.

To mitigate the inflation challenge, Chinese companies in Gwadar have been demanding permissions or projects to settle in Chinese currency Yuan, instead of the US dollar, which is recognized by scholars as "a feasible mode of hedging against exchange rate fluctuations" (Adnan & Fayyaz, 2018). Additionally, this strategy has expanded beyond the realm of CPEC. The approval from the Pakistan Central Bank in regards to the use of Yuan in bilateral trade and investment activities was issued in 2018 (ICBC, 2018). Recently, a momentum of internationalization of the Yuan has been achieved through the lauch of the Yuan-clearing bank in Pakistan. This lauch not only signals the significance of strategic cooperation between China and Pakistan via CPEC, it also fosters more all-encompassing bilateral economic ties (Zhang, 2023).

Apart from threats from inflation and devaluation of PR, delays in projects have been frequently mentioned. For instance, due to the incapability to complete on time, doubling cost has been generated in the Up-gradation and Dualization of ML-1 and the establishment of Dry Port near Havelian (#T12) (Abrar, 2023). On top of this, due to this rising cost, the government led by Imran Khan's Pakistan Tehreek-e-Insaf (PTI) has been unsuccessful in securing the approval from both the International Monetary Fund (IMF) and the Chinese government to commence the project (Zaafir, 2023). Therefore, even though project #12 has been proven by the Executive Committee of National Economic Council (ECNEC) and Central Development Working Party (CDWP) in 2020, it is still in-pipeline until today. Subsequent to these incidents, the Gwadar Eastbay Expressway (G4) and Hakla-D.I Khan Motorway (T6) projects have experienced delays, exceeding the initially set timelines by three years and two years, respectively (Chaudhry, 2021; Ebrahim, 2021).

Safety and Security Risks

Pakistan is officially bordered by four neighboring countries: India to the east (2,912 km), Iran to the west (909 km), Afghanistan to the northwest (2,430 km), and China to the northeast (523 km) (Consulate General of Pakistan Los Angelos, n.d.). Additionally, the Arabian Sea is located in the South of Pakistan, serving as an important trade route. Together with the Karachi Port (Sindh), Port Qasim (Sindh), and Gwadar Port (Balochistan), Gulf trade connectivity is strengthened through the Arabian Sea. Among the four bordering countries, border disputes and tensions mainly occur on the Pakistan-Afghanistan border and the Pakistan-Indian border. Nevertheless, the out-migration of people and illicit flow of goods to Pakistan from Afghanistan have become geographically centralized in Afghanistan's southwestern region, which borders both Pakistan and Iran (Mir et.al., 2022).

Geopolitically, Pakistan has deeply intertwined with the Pashtun borderlands in the Afghanistan wars, leading to the destabilization of the borderlands, as well as impact on tribal culture, social networks, the local economy, and the role of religion. Confrontations and insecurity in Afghanistan have adversely affected trading interdependences. Security repercussions in Afghanistan might also cause resilient influence. India-Pakistan border disputes can be traced back to the 1947 partition of British India, which ended in the funding of Pakistan and India. The dispute over the sovereignty of Jammu and Kashmir has been a major source of tension, which has triggered multiple wars and conflicts. Moreover, this dispute has constantly caused India's reservations and concerns about the corridor, claiming that CPEC infringes on India's sovereignty and territorial integrity. In practice, the project Up-gradation and Dualization of ML-1 and establishment of Dry Port near Havelian (#T12), situated close to the disputed area, remain unsigned due to unresolved safety and security concerns during the 11th JCC (Haider, 2023). Furthermore, there's no update during the most recent 12th JCC as well.

Consequently, surrounding bordering tensions and cross-bordering terrorism are worth considering.

Gwadar is one of the most critical locations confronting severe security challenges under the CPEC. Over the years, there have been countless reports regarding attacks targetting Chinese nationals, despite the establishment of the Pakistan Navy's special 'Task Force-88' (TF-88) for safeguarding the maritime security of Gwadar port and related sea lanes against both conventional and non-traditional threats (Dawn, 2016). This risk is related to the longstanding resource tension and right of development conflict between Balochistan and Punjab, which is mentioned earlier in the section *Direct and Indirect Involvement of Chinese Companies Along the CPEC.* The marginalization of Balochistan contrasts distinctly with the domination of Punjab, leading to a lack of public trust from Balochistan citizens regarding development projects. Similarly, the project Awaran - Khuzdar Road Section (M-8) (#T17) has also been experiencing security issues stemming from developmental disparity.

Criticism regarding local governance also arises from citizens, complaining about officials prioritizing personal benefits over the development and well-being of the province and the Baloch people (Farid, 2022). Furthermore, the problem of terrorism and separatism has been addressed in the section *Chinese Investments Outflow to Pakistan.*

Besides the security issues mentioned above regarding Gwadar, India remains particularly skeptical about using the Gwadar port, expressing worries over its potential military applications. Despite denial from both the Chinese (see Bhaya, 2018) and Pakistan sides (see Blanchard, 2018), India maintains its skepticism, accelerating Pakistan-India tension, and leading to greater security concerns.

In addition to issues from regional disparity above, opposition from Western provinces can extend into other regions. For instance, spanning across the provinces of Sindh and Punjab, the project Peshawar-Karachi Motorway (Multan-Sukkur Section) (#T2) project has received confrontations from the West, claiming it is a deprivation of western provinces' development rights (China Society for International Economic Cooperation, 2016). The central government's limited control capacity aggravates these regional disputes. Therefore, the consensus is missing concerning the share of CPEC benefits. Additionally, project #T2 has been impacted by border-related challenges occurring between northwest Pakistan and Afghanistan (China Society for International Economic Cooperation, 2016), in addition to the influence of terrorist forces from East Pakistan and India. Influences from foreign forces, together with local bandit activities, have further deteriorated regional security.

To sum up, five substantial risks for Chinese investments range from risks deeply intertwined with natural/environmental to geopolitical and security risks. Additionally, these various types of risks are not segregated. Instead, they interact with one another, exacerbating the overall impact. The predominant pattern identified among these diverse risks parameters that delays can stem from various sources, including natural/environmental factors, logistical challenges, technical and infrastructure issues, bureaucratic processes, regulatory hurdles, as well as safety and security concerns. Ultimately, these factors contribute to financial losses.

Geopolitical Reflection and Conclusion

It is imperative to underscore that the limitation exists in this research concerning each project's financing data. Firstly, the detailed systematic official resources from both governments that display loan/grant data on a project-specific basis are missing. In particular, on the Chinese side, it is barely impossible to find publicly accessible data regarding Chinese foreign investment outflow to Pakistan, needless to say, on a project-specific basis.

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Appendices

Appendix 1: Sino-Pakistan Bilateral Export and Import 2003-2021

	2021	2020	2019	2018
China's export volume to Pakistan (USD 10K)	2424040	1535767	1616692	1693332
China's import volume from Pakistan (USD 10K)	358448	212487	180613	217209

	2017	2016	2015	2014	2013	2012	2011	2010	2009
China's export volume to Pakistan (USD 10K)	1825079	1723446	1644189	1324448	1101960	927539	843971	693760	552833
China's import volume from Pakistan (USD 10K)	183322	191259	247476	275387	319684	313825	211862	173102	126001

	2008	2007	2006	2005	2004	2003
China's export volume to Pakistan (USD 10K)	605107	578905	423937	342766	246579	185499
China's import volume from Pakistan (USD 10K)	100680	110422	100721	83317	59475	57494

Source: China's export volume to Pakistan data is collected and adapted from the National Bureau of Statistics of PRC (National Data). China's import volume from Pakistan data is retrieved from the World Integrated Trade Solution (WITS).

Appendix 2: Net Foreign Direct Investment Outflow to Pakistan ($ million)

FY PK	China	Total	%age with Inflows
2011-12	126.1	820.7	15.36%
2012-13	90.6	1,456.50	6.22%
2013-14	695.8	1,698.60	40.96%
2014-15	340.8	1,033.80	32.97%
2015-16	1,048.30	2,392.90	43.81%
2016-17	763.2	2,406.60	31.71%
2017-18	1,311.90	2,780.30	47.19%
2018-19	130.8	1,362.40	9.60%
2019-20	846.6	2,597.50	32.59%
2020-21	751.6	1,820.50	41.29%
2021-22	531.6	1,867.80	28.46%
2022-23	432.2	1,455.80	29.69%

Source: the authtor collected and adapted from Prime Minister Office, Board of Investment (Invest Pakistan), n.d. Retrieved (2023) from: https://invest.gov.pk/statistics

Appendix 3: Chinese personnel deployment: foreign contracted projects related and foreign labor service related

	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011
Chinese personnel deployed for international contract projects in Pakistan	11102	8313	8537	15540	17493	11830	6292	5122	3541	4204	3606
Chinese labor subcontracting in Pakistan	896	517	1002	449	200	33	36	156	45	54	7

Source: the author collected and adapted from the National Data.

Appendix 4: Chinese Commitments in Finance to Pakistan From FY 2006-2007 to FY 2021-2022

	BANK OF CHINA SR. BD Grant	BANK OF CHINA SR. BD Loan	CHINA DEV BANK Grant	CHINA DEV BANK Loan	ICBC-CHINA Grant	ICBC-CHINA Loan	Bilateral CHINA Grant	Bilateral CHINA Loan	Bilateral CHINA	Bilateral Total	Bilateral China Total/Bilateral Total	CHINA SAFE DEPOSITS
FY 2021-2022	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.685,00	2.231,00	75,53%	N/A
FY 2020-2021	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	204,00	454,00	44,93%	1.000,00
FY 2019-2020	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	487,00	1.644,00	29,62%	0,00
FY 2018-2019	0,00	0,00	0,00	2.234,45	0,00	300,00	0,00	2.201,02	2.201,02	2.618,21	84,07%	2.000,00
FY 2017-2018	0,00	200,00	0,00	1.000,00	0,00	1.000,00	0,00	1.810,57	1.810,57	2.376,98	76,17%	0,00
FY 2016-2017	0,00	300,00	0,00	1.700,00	0,00	300,00	0,00	1.654,59	1.654,59	2.225,56	74,34%	0,00
FY 2015-2016	0,00	0,00	0,00	0,00	0,00	0,00	14,73	1.041,81	1.056,53	1.815,39	58,20%	0,00
FY 2014-2015	0,00	0,00	0,00	0,00	0,00	0,00	47,72	1.088,85	1.136,57	1.750,94	64,91%	0,00
FY 2013-2014	0,00	0,00	0,00	0,00	0,00	0,00	7,90	594,45	602,35	1.360,86	44,26%	0,00
FY 2012-2013	0,00	0,00	0,00	0,00	0,00	0,00	3,22	843,44	846,55	1.476,07	57,35%	0,00
FY 2011-2012	0,00	0,00	0,00	0,00	0,00	0,00	6,33	1.042,19	1.048,52	1.757,49	59,66%	0,00
FY 2010-2011	0,00	0,00	0,00	0,00	0,00	0,00	20,61	293,61	314,22	1.148,47	27,36%	0,00
FY 2009-2010	0,00	0,00	0,00	0,00	0,00	0,00	8,50	212,25	220,74	1.152,94	19,15%	0,00
FY 2008-2009	0,00	0,00	0,00	0,00	0,00	0,00	11,23	550,12	561,35	1.369,84	40,98%	0,00
FY 2007-2008	0,00	0,00	0,00	0,00	0,00	0,00	0,40	99,78	100,18	735,92	13,61%	0,00
FY 2006-2007	0,00	0,00	0,00	0,00	0,00	0,00	0,00	118,99	118,99	819,86	14,51%	0,00
Total	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14.048,18	24.937,53	56,33%	N/A

Source: The arthur collected and adapted from Annual FEA reports from FY 2006-2007 to FY 2021-2022, which are published by Policy Analysis & Development Wing Ministry of Economic Affairs Government of Pakistan from 2007 to 2022.

Appendix 5: CPEC Project Overview by Sector I

CPEC Project Overview by Sector I											
Project Sector	**Status**	**#**	**##**	**Project Name**	**Location**	**Province**	**Executing Company / Sponsors**	**Coordinating Ministry**	**Proposing Agency**	**Implementing Agency**	**Supervising Agency**
Energy	**Completed**	1	E1	1320MW Sahiwal Coal-fired Power Plant	Qadarabad, Sahiwal	Punjab	Huaneng Shandong Rui Group, China	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB) / Punjab Power Development Board (PPDB)
		2	E2	1320MW Coal-fired Power Plant at Port Qasim Karachi	Port Qasim	Sindh	Port Qasim Electric Power Company (Private) Limited	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB)
		3	E3	1320MW China Hub Coal Power Project, Hub Balochistan	Hub, Balochistan	Balochistan	China Power Hub Generation Company (Private) Limited	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB)
		4	E4	660MW Engro Thar Coal Power Project	Thar-Block-II, Sindh	Sindh	Engro Power Gen Thar Ltd., China Machinery Engineering Corporation (CMEC), HBL and LIBERTY	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB)
		5	E5	1000MW Quaid-e-Azam Solar Park (Bahawalpur)	Bahawalpur, Punjab	Punjab	Zonergy	Ministry of Energy (Power Division)			Punjab Power Development Board (PPDB) / Alternative Energy Development Board (AEDB)
		6	E6	50 MW Hydro China Dawood Wind Farm, Gharo, Thatta	Bhanbore, Gharo, District Thatta	Sindh	Hydrochina Dawood Power Pvt. Limited (HDPPL)	Ministry of Energy (Power Division)			Alternative Energy Development Board (AEDB)
		7	E7	100MW UEP Wind Farm, Jhimpir, Thatta	Jhimpir, District Thatta	Sindh	UEP Wind Power Pvt. Limited (UEPL)	Ministry of Energy (Power Division)			Alternative Energy Development Board (AEDB)
		8	E8	50MW Sachal Wind Farm ,Jhimpir, Thatta	Jhimpir, District Thatta	Sindh	Sachal Energy Development Pvt. Limited (SEDPL)	Ministry of Energy (Power Division)			Alternative Energy Development Board (AEDB)
		9	E9	100MW Three Gorges Second and Third Wind Power Project	Jhimpir, District Thatta	Sindh	Three Gorges Second Wind Farm Pakistan Ltd. (TGSWF) & Three Gorges Third Wind Farm Pakistan Pvt. Ltd. (TGTWF)	Ministry of Energy (Power Division)			Alternative Energy Development Board (AEDB)
		10	E10	Matiari to Lahore ±660 KV HVDC Transmission Line Project	Matiari to Lahore	Sindh and Punjab	China Electric Power Equipment and Technology Co.Ltd.(CET) / State Grid Corporation of China (SGCC)	Ministry of Energy (Power Division)			National Transmission & Despatch Company (NTDC)
		11	E11	720MW Karot Hydropower Project, AJK/Punjab	River Jehlum	AT the dual boundary of District Rawalpindi, Punjab & District Kotli, AJK, River Jhelum	Karot Power Company Ltd. (KPCL)/ CSAIL/ CTGI /CTG (China Three Gorges)	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB)
		12	E12	330MW HUBCO Thar Coal Power Project (Thar Energy)	Thar Block - II	Sindh	HUBCO, FFC, China Machinery Engineering Corporation (CMEC)	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB)
		13	E13	1320MW SSRL Thar Coal Block-I 7.8 mtpa & Power Plant (2×660MW) (Shanghai Electric)	Thar-Block-I	Sindh	Shanghai Electric Power Company Limited / CCTEG and SSRL	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB)
		14	E14	330MW HUBCO ThalNova Thar Coal Power Project	Thar Block - II	Sindh	HUBCO, FFC, China Machinery Engineering Corporation (CMEC)	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB)
	Under Construction	15	E15	884MW Suki Kinari Hydropower Project, KP	River Kunhar (a tributary of River Jhelum)	District Mansehra, KPK	Suki Kinari Hydro (Pvt) Ltd / China Gezhouba Group Company Ltd	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB)
		16	E16	300MW Coal-Fired Power Project at Gwadar	Gwadar	Balochistan	China Communications Construction Company (CCCC)	Ministry of Energy (Power Division)			Gwadar Port Authority (GPA) / Gwadar Development Authority (GDA)
	Under Consideration	17	E17	1124MW Kohala Hydropower Project, AJK	Jhelum River near Muzaffarabad		CTG/CWEI (China Three Gorges) / (CWE Investment Crop)	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB)
		18	E18	700.7MW Azad Pattan Hydropower Project, AJK/Punjab	Jhelum River		Laraib Energy / China Gezhouba Group Company	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB)
		19	E19	1320 MW Thar Mine Mouth Oracle Power Plant & surface mine	Thar Block-VI	Sindh	M/s Oracle Coalfields SEPCO and Yanzhou Coal	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB)
		20	E20	50MW Cacho Wind Power Project	Jhampir, District Thatta	Sindh	Cacho Wind Energy Pvt. Ltd	Ministry of Energy (Power Division)			Alternative Energy Development Board (AEDB)
		21	E21	50MW Western Energy (Pvt.) Ltd. Wind Power Project	Jhampir, District Thatta	Sindh	Western Energy (Pvt.) Ltd	Ministry of Energy (Power Division)			Alternative Energy Development Board (AEDB)
Transport Infrastructure Projects Under CPEC	**Completed**	22	T1	KKH Phase II (Havelian - Thakot Section)	(Havelian-Thakot) Khyber Pakhtunkhwa	Khyber Pakhtunkhwa	M/s China Communications Construction Company Ltd		Ministry of Communications	National Highway Authority	Ministry of Communications, Government of Pakistan
		23	T2	Peshawar-Karachi Motorway (Multan-Sukkur Section)	Province of Punjab and Sindh	Punjab and Sindh	M/s China State Construction Engineering Corporation		Ministry of Communications	National Highway Authority	Ministry of Communications, Government of Pakistan
		24	T3	Orange Line Metro Train - Lahore	Lahore	Punjab					
		25	T4	Cross Border Optical Fiber Cable (Khunjrab - Rawalpindi)	Gilgit Baltistan, Khyber Pakhtunkhwa, Punjab	Gilgit Baltistan, Khyber Pakhtunkhwa, Punjab					
		26	T5	Pilot Project of Digital Terrestrial Multimedia Broadcast (DTMB)	Murree	Punjab					

		27	T6	Hakla - D.I Khan Motorway			M/o Communications/NHA					
		28	T7	Zhob - Quetta (Kuchlak) (N-50)	Zhob and Quetta	Balochistan	National Highway Authority					Ministry of Communications, Government of Pakistan
		29	T8	Khuzdar-Basima Road (N-30)	Khuzdar	Baluchistan	National Highway Authority				been taken up through PSDP	Ministry of Communications, Government of Pakistan
	Under Construction	30	T9	Hoshab - Awaran Road Section (M-8)	Hoshab and Awaran	Balochistan						
		31	T10	KKH Alternate Route Shandur - Chitral Road	Khyber Pakhtunkhwa (KP)							
		32	T11	Nokundi-Mashkhel Road		Balochistan						
		33	T12	Up-gradation and Dualization of ML-1 and establishment of Dry Port near Havelian	Karachi to Peshawar via Hyderabad, Nawabshah, Rohri, Rahimyar Khan, Bahawalpur, Khanewal, Sahiwal, Lahore, Gujranwala, Rawalpindi, Peshawar	Punjab				Ministry of Railways	Pakistan Railways	International Supervising Agency will be hired through competitive bidding
		34	T13	Up-gradation of D.I. Khan (Yarik) - Zhob, N-50 Phase-I		Khyber Pakhtunkhwa - Balochistan	National Highway Authority					Ministry of Communications, Government of Pakistan
	In-Pipeline	35	T14	KKH Alternative Route Gilgit-Shandur Road	Gilgit Baltistan, Khyber Pakhtunkhwa							
		36	T15	Realignment of KKH Phase-I Thakot - Raikot Section	Gilgit Baltistan, Khyber Pakhtunkhwa							
		37	T16	Peshawar - D.I.Khan Motorway		Khyber Pakhtunkhwa (KP)						

		38	T17	Awaran - Khuzdar Road Section (M-8)		Balochistan					
		39	T18	Dir Expressway		Khyber Pakhtunkhwa (KP)					
		40	T19	DTMB-A (Digitalize the existing three sites of PTV)	Murree, Cherat, Kala Shah Kaku						
	Long Term	41	T20	Mirpur-Muzaffarabad-Mansehra Road		Azad Jammu and Kashmir, Khyber Pakhtunkhwa					
		42	T21	Karachi Circular Railway		Sindh					
		43	T22	Mashkhel - Pangur Road		Balochistan					
		44	T23	Quetta Mass Transit		Balochistan					
		45	T24	Greater Peshawar Region Mass Transit		Khyber Pakhtunkhwa (KP)					
Gwadar	**Completed**	46	G1	Development of Port and Free Zone	Gwadar district	Balochistan	Gwadar Port Authority		Gwadar Port Authority, MoMA		Ministry of Maritime Affairs, Government of Pakistan
		47	G2	Gwadar Smart Port City Master Plan	Gwadar district	Balochistan					
		48	G3	Pak-China Technical and Vocational Institute at Gwadar	Gwadar district	Balochistan	Gwadar Port Authority				GPA/Ministry of Maritime Affairs
		49	G4	Gwadar Eastbay Expressway	Gwadar district	Balochistan	The contracting company on the basis of EPC Or any Financial Framework Agreement under CPEC		Gwadar Port Authority and Ministry of Maritime Affair		Ministry of Maritime Affairs, Government of Pakistan
		50	G5	New Gwadar International Airport	Gurandani, 26 KM east of Gwadar City	Balochistan	Civil Aviation Authority			Aviation Division	
	Under Construction	51	G6	Necessary facilities of fresh water treatment, water supply and distribution	Gwadar district	Balochistan				Gwadar Development Authority	Gwadar Development Authority, P&D Dept. Govt. of Balochistan and Ministry of Planning, Development, and Special Initiatives.
		52	G7	Pak-China Friendship Hospital	Gwadar district	Balochistan	Gwadar Development Authority		proposed under the GDA Business Plan (Federal PSDP)		P&D Dept., Government of Balochistan and Ministry of Planning, Development and Special Initiatives.
		53	G8	300MW Coal-Fired Power Project at Gwadar	Gwadar	Balochistan	China Communications Construction Company (CCCC)	Ministry of Energy (Power Division)			Private Power and Infrastructure Board (PPIB)
		54	G9	1.2 MGD Desalination Plant	Gwadar district	Balochistan	The contracting company on the basis of EPC from CIDCA will be hired		Gwadar Port Authority, MoMA		Ministry of Maritime Affairs, Government of Pakistan
		55	G10	5 MGD Water Desalination Plant Gwadar		Balochistan				Implementation Agency: GoB/GDA	
	In-Pipeline	56	G11	Construction of Breakwaters	Gwadar district	Balochistan	The contracting company on the basis of EPC Or any Financial Framework Agreement under CPEC		Gwadar Port Authority, MoMA		Ministry of Maritime Affairs, Government of Pakistan
		57	G12	Dredging of berthing areas & channels	Gwadar district	Balochistan	The contracting company on the basis of open tendering Or any Financial Framework Agreement under CPEC		Gwadar Port Authority, MoMA		Ministry of Maritime Affairs, Government of Pakistan
		58	G13	Fish Landing Jetty and Fishermen Boat Making Industry on West bay		Balochistan				GoB/GDA	
		59	G14	Gwadar Smart Environment Sanitation System and Landfill Project		Balochistan				GoB/GDA	
Industrial Cooperation/SEZs		60	I1	Rashakai Special Economic Zone	Nowshera, Khyber Pakhtunkhwa(KP)		CRBC in joint venture with KPEZDMC			An SPV Company of these two firms named Rashakai Special Economic Zone Development and Operations Company (RSEZDOC)	

	Under Construction	61	I2	Dhabeji Special Economic Zone	Thatta	Sindh					
		62	I3	Allama Iqbal Industrial City	Faisalabad	Punjab	Faisalabad Industrial Estate & Management Company (FIEDMC) is the developing body of Allama Iqbal SEZ.				
		63	I4	Bostan Special Economic Zone	District Pishin bordered with Quetta, Balochistan	Balochistan					
	In-Pipeline Projects	64	I5	ICT Model Industrial Zone	Islamabad						
		65	I6	Industrial Park on Pakistan Steel Mill Land	Port Qasim Near Karachi						
		66	I7	Mirpur Industrial Zone	Mirpur, Azad Jammu Kashmir (AJK)						
		67	I8	Mohmand Marble City	Mohmad Agency, KP						
		68	I9	Moqpondass Special Economic Zone	Gilgit-Baltistan						
Social And Economic Development Under CPEC		69	S1	Vaccine storage and transportation equipment							
	Completed	70	S2	Poverty Alleviation Training							
		71	S3	Emergency relief supplies for enhancing NDMA, disaster preparedness capacity							
		72	S4	Pakistan Vocational and Technical Education Capacity build-up project							
		73	S5	Pakistan Vocational Schools equipment Upgrading and Renovation Project							
	Under Construction	74	S6	China-Pakistan Joint Agricultural Technology Laboratory							
		75	S7	Provision of Agricultural equipment and tools							
		76	S8	Smart Classroom for Higher education							
		77	S9	Maintenance and renovation for 50 schools in newly merged districts							
		78	S10	Solar-powered lighting equipment							
		79	S11	Overseas student scholarship							
		80	S12	Medical equipment and materials							
		81	S13	Gwadar hospital project							

		82	S14	Brightness journey in Pakistan							
		83	S15	Drinking water equipment							
		84	S16	Gwadar Desalination Plant							
		85	S17	Gwadar Vocational and Technical Project							
	In-Pipeline	86	S18	China-Pakistan Joint Agricultural demonstrations							
		87	S19	Bacterial grass (JunCao) Technology Training and promotion project							
		88	S20	Pakistan Agricultural Vocational Training							
		89	S21	Provision of teaching equipment for primary and secondary schools							
		90	S22	Burn Centres							
		91	S23	China-Pak joint telemedicine network							
		92	S24	Medical emergency center in Balochistan							
		93	S25	Rural poverty reduction joint research project							
		94	S26	Cooperative Project with Pak-Austria Fachhochule: Institute of Applied Sciences and Technology							
		95	S27	Punjab-Tianjin University of Technology Project							

Source: the data is collected and adapted from the official website of the CPEC, retrieved (2023) from: https://cpec.gov.pk/

Appendix 6: CPEC Project Overview by Sector II

CPEC Project Overview by Sector II					
Title and Name	**#**	**Approval Status**		**PSDP S#**	**Project Name**
CPEC & Related Projects Under Public Sector Development Program (PSDP) 2018-2019	1	ECNEC	12.02.2015	8	New Gwadar International Airport, Gwadar
	2	CDWP	19.03.2018	11	Establishment of Project Management Unit (PMU) on China Pakistan Economic Corridor Industrial Cooperation Development Project (CPEC-ICDP)
	3	ECNEC	12.04.2017	96	Construction of 02 Lane Highway from Basima to Khuzdar (Length 106 km)
	4	ECNEC	22.08.2016	63	Construction of BurhanHavelian Expressway (E-35) 29.1 Km (Revised)
	5	ECNEC	19.12.2015	67	Construction of KKH Phase-II Havelian-Thakot (118.057 KM) Part of China Pakistan Economic Corridor (CPEC)- Revised
	6	ECNEC	07.11.2016	68	Construction of Motorway from Burhan - Hakla on M-I to Dera Ismail Khan
	7	ECNEC	12.04.2017	97	Dualization & Improvement of Existing N-50 from Yarik - Sagu - Zhob including Zhob Bypass (210 km)
	8	ECNEC	10.07.2017	77	Improvement, Upgradation and Widening of Jaglot - Skardu Road (S-1, 167 km) Revised
	9	ECNEC	03.07.2014	78	Karachi - Lahore Motorway (Land Acquisition) (CPEC) Sukkur-Hyderabad
	10	ECNEC	14.11.2015	80	Lahore-Multan Motorway (M-3 section) of Karachi - Lahore Motorway
	11	ECNEC	7.11.2016	81	Land Acquisition , Affected properties compensation and relocation of utilities for construction of Burhan/Hakla to D.I. Khan Motorway
	12	ECNEC	07.03.2018	84	Land Acquisition and Resettlement for China-Pak Economic Corridor (CPEC) - Islamabad-Raikot Section (Phase-I), Havelian-Thakot (120.12 km)
	13	ECNEC	17.12.2015	88	Peshawar Karachi Motorway (PKM) Project Construction of Sukkur-Multan Section (392 km) (Revised)
	14	ECNEC	07-03-2018	102	Improvement and widening of Chitral-Booni-Mastuj-Shandur (CPEC)
	15	CDWP	19.05.2015	121	Construction / Black Topping of Access Road from Makran Coastal Highway to New Gwadar International Airport (CPEC)
	16	CDWP	30.03.2015	140	Necessary Facilities of Fresh Water Treatment, Water Supply and Distribution Gwadar (CPEC)
	17	CDWP	29.11.2017	146	5 MGD RO Sea Water Desalination Plant at Gwadar (CPEC)
	18	CDWP	29.03.2018	149	Gwadar Smart Environmental and Sanitation System and Landfill (CPEC)
	19	ECNEC	13.01.2014	370	Construction of Cross – Border Optical Fiber Cable (OFC) System Between China and Pakistan For International Connectivity of Voice / Data Traffic.
	20	CDWP	17.01.2017	373	Expansion and Upgradation of NGMS (3G/4G) Services and Seamless Coverage along KKH (in Support of CPEC) in Gilgit Baltistan
	21	ECNEC	12.01.2015	485	Construction of Eastbay Expressway (CPEC)
	22	DDWP	29.12.2015	487	Establishment of CPEC Support Unit (CSU) for Projects and Activities in GPA
	23	CDWP	30.03.2016	488	Feasibility Study for Construction of Break Water (CPEC)
	24	CDWP	19.10.2014	489	Pak-China Technical & Vocational Institute at Gwadar (CPEC)

	25	CDWP		604	Pak-China Year of Friendly Exchanges Programme (CPEC)
	26	CDWP	06.01.2015	614	China-Pakistan Economic Corridor Support Project (CPECSP) at Ministry of Railways
	27	CDWP	25.06.2014	615	Comprehensive Feasibility Study for Upgradation/Rehabilitation of Mainline (ML-I) and New Dry Port at Havelian (Buldher) District Haripur under (CPEC)
	28	CDWP	17.01.2017	636	Updation of Feasibility Studies up-gradation of existing Railway Link from Rohri to Kohi-Taftan via Quetta including the realignment of Sibi-Spezand Section (1022 Kms) and Feasibility Study of Rail Link from Quetta to Kotla Jam (538 Kms)-ML-III.
	29	CDWP		642	Up-gradation of Pakistan Railway's existing Mainline-1 (ML-I) and establishment of Dry port near Havelian (2018- 22) Phase-1 (CPEC)
	30	DDWP	23.02.2017	651	Purchase of Land for Establishing Directorate of Transit Trade at Gilgit for CPEC Trade Facilitation
	31	DDWP	29.06.2017	658	Construction of Office for Zonal Office (IR) at Mansehra (CPEC)
	32			609	Completion of CPEC and other Projects
CPEC & Related Projects Under Public Sector Development Program (PSDP) 2017-2018	33	ECNEC	12.01.2015	10	New Gwadar International Airport (NGIA) (CPEC)
	34	ECNEC	07.03.2017	77	Basima - Khuzdar (106 km) N30 CPEC
	35	CDWP	03.07.2014	86	Construction of BurhanHavelian Expressway (E-35) 59.1 Km
	36	ECNEC	22.04.2016	92	Construction of Hakla on M-I to Yarik D.I.Khan Motorway (CPEC)
	37	ECNEC	12.04.2017	113	Dualization of Yarik - Mughalkot - Zhob section of N50 (210 km) CPEC Western Alignment including Zhob Bypass and Land Acquisition
	38	NHC	25.03.1999 (RUP)	114	Gwadar - Turbat - Hoshab Section (200Km) of Gawadar - Ratodero Road (892 Km) M-8 including Khuzdar - Shahdadkot - Ratodero (143 km) - (Gwadar, Turbat, Khuzdar in Balochistan and Kamber, Shahdadkot & Larkana in Sindh)
	39			117	Improvement and Widening of Jaglot - Skardu Road (S-1, 167 km) - Land Acquisition (CPEC)
	40	ECNEC	03.11.2010	118	Improvement and Widening of Jaglot - Skardu Road (S-1, 167 km) (CPEC)
	41	ECNEC	14.11.2015	124	Lahore-Abdul Hakeem Section (230 km) (PKM)
	42	ECNEC	22.04.2016	125	Land Acquisition , Affected properties compensation for construction of Burhan-Hakla to D.I. Khan Motorway
	43	ECNEC	19.12.2015	128	Multan - Sukkur Section (387 km) Credit Financing (90:10) (PKM)
	44	ECNEC	10.04.2015	137	Rehabilitation of D.I Khan Mughal Kot 50 km Section N50 (FERP Phase-II)
	45	UnApproved		140	Sukkur - Hyderabad Section (296 km)
	46	ECNEC	19.12.2015	141	Thakot to Havelian 118 KM (Construction) (Phase-I) (CPEC)
	47	ECNEC	04.12.2014	142	Thakot to Havelian 118 KM (Land) (Phase-I) (CPEC)
	48	ECNEC	06.09.2007	144	Widening & Improvement of N85, Hoshab - Nag - Basima - Surab Road (459 Km) (Khuzdar,Panjgur)
	49	ECNEC	21.01.2010	146	Zhob Mughal Kot 81 Km N-50 (NHDSIP, ADB

	50	UnApproved		154	Gilgit-Shandoor-Chitral Chakdara Road (CPEC)
	51	UnApproved		157	Mirpur - Mangla - Muzaffarabad - Mansehra Road (CPEC)
	52	CDWP	30.03.2015	204	Necessary Facilities of Fresh Water Treatment, Water Supply and Distribution Gwadar (CPEC)
	53	UnApproved		360	Establishment of National Institutes of Applied Technologies and Specialized Research Centers to support CPEC Initiatives
	54	UnApproved		452	Infrastructure Development of Export Processing Zone at Gawadar (CPEC)
	55	ECNEC	09.12.2010	483	Construction of Cross – Border Optical Fiber Cable (OFC) System Between China and Pakistan For International Connectivity of Voice / Data Traffic
	56	CDWP	17.01.2017	494	Expansion and Upgradation of NGMS (3G/4G) Services and Seamless Coverage along KKH (in Support of CPEC) in GB
	57	UnApproved		727	CPEC Institute, Gwadar
	58	UnApproved		731	Pak-China Year of Friendly Exchanges Programme (CPEC)
	59	ECNEC	12.01.2015	739	Construction of Eastbay Expressway (CPEC)
	60	DDWP	29.12.2015	741	Establishment of CPEC Support Unit (CSU) for Projects and Activities in GPA
	61	CDWP	30.03.2016	744	Feasibility Study for Construction of Break Water (CPEC)
	62	CDWP	19.10.2014	745	Pak-China Technical & Vocational Institute at Gwadar (CPEC)
	63	UnApproved		750	Capital Dredging of Berthing areas & channel for Additional Terminals (CPEC)
	64	UnApproved		752	Land Acquisition as per Gwadar Port Master Plan
	65	CDWP	06.01.2015	760	China Pakistan Economic Corridor (CPEC) Support Project at Ministry of Railways
	66	CDWP	25.06.2014	761	Comprehensive Feasibility Study for Upgradation/Rehabilitation of Mainline 1 (ML-I) and New Dry Port at Havelian (Balder) Distt. Haripur under China-Pak Economic Corridor (CPEC)
	67	CDWP	31.08.2015	764	Doubling / Improvement of Existing Track from Port Qasim to Bin Qasim Station (CPEC)
	68	CDWP	29.11.2013	767	(i) PC-II for Feasibility Study to Connect Gwadar with Karachi (ii) Feasibility Study from Gwadar to Besima and from Besima to Jacobabad via Khuzdar (CPEC)
	69	ECNEC	12.04.2017	768	Preliminary Design / Drawings for Upgradation/ Rehabilitation of Main line (ML-1) and establishment of Dryport near Havelian under the China Pakistan Economic Corridor (CPEC) and hiring of Design / Drawings Vetting Consultants
	70	UnApproved		791	Feasibility study for Rail Link from Havelian to Pak China Border (682 K.M) (CPEC)
	71	CDWP	17.01.2017	792	Feasibility Study for Upgradation and Extension of ML-III in connection with CPEC
	72			794	Rehabilitation/Up-gradation of ML-I including Acquisition of land for new Dryport at Buldhair, District Haripur (CPEC)
	73	DDWP	23.02.2017	805	Purchase of Land for Establishing Directorate of Transit Trade at Gilgit for CPEC Trade Facilitation
	74	CDWP	21.12.2015	931	Construction of 132 KV(AIS) Grid Station at Deep Sea Port Gwadar and the associated 132-KV D/C Transmission line.
CPEC & Related Projects Under Public Sector Development Program (PSDP) 2016-2017	75	ECNEC	12.01.2015	8	New Gwadar International Airport (NGIA) (CPEC)

	76	ECNEC	22.04.2016	74	Construction of Burhan-Hakla on M-I to D.I. Khan Motorway (CPEC)
	77	NHC	25.03.1999	75	Gwadar - Turbat - Hoshab Section (200Km) of Gawadar - Ratodero Road (892 Km) M-8 including Khuzdar - Shahdadkot - Ratodero (143 km) - (Gwadar, Turbat, Khuzdar in Balochistan and Kamber, Shahdadkot & Larkana in Sindh)
	78	ECNEC	06.09.2007	76	Widening & Improvement of N-85, Hoshab - Nag - Basima - Surab Road (459 Km) (Khuzdar,Panjgur)
	79	ECNEC	21.01.2010	77	Zhob Mughal Kot 81 Km N-50 (NHDSIP, ADB)
	80	ECNEC	10.04.2015	78	Rehabilitation of D.I Khan Mughal Kot 50 km Section N50 (FERP Phase-II)
	81	ECNEC	22.04.2016	79	Land Acquisition, Affected Properties Compensation for Construction of Burhan - Hakla to D.I. Khan Motorway
	82	CDWP	03.07.2014	80	Construction of BurhanHavelian Expressway (E-35) 59.1 Km
	83	ECNEC	19.12.2015	81	Thakot to Havelian 118 KM (Construction) (Phase-I) (CPEC)
	84	ECNEC	04.12.2014	82	Thakot to Havelian 118 KM (Land) (Phase-I) (CPEC)
	85	ECNEC	14.11.2015	98	Lahore-Abdul Hakeem Section (230 km) (PKM)
	86	ECNEC	19.12.2015	99	Multan - Sukkur Section (387 km) Credit Financing (90:10) (PKM)
	87	UnApproved		100	Sukkur - Hyderabad Section (296 km) (PKM)
	88	ECNEC	26-05-2011	108	Basima - Khuzdar (110 km) N30 CPEC

	89	UnApproved		127	Dualization of Yarik - Mughalkot - Zhob Section of N-50 (245 km) CPEC Western Alignment including Zhob Bypass and Land Acquisition
	90	CDWP	19.05.2015	170	Construction / Black Topping of Access Road from Makran Coastal Highway to New Gwadar International Airport (CPEC)
	91	CDWP	30.03.2015	173	Necessary Facilities of Fresh Water Treatment, Water Supply and Distribution Gwadar (CPEC)
	92	ECNEC	01.12.2010	410	Construction of Cross – Border OFC System Between China and Pakistan For International Connectivity of Voice / Data Traffic (SCO) (CPEC Related)
	93	UnApproved		421	Provision of Seamless GSM Coverage along KKH for Proposed Gawadar - Kashighar Economic Corridor in Gilgit Baltistan (SCO) (CPEC Related)
	94			488	Provision for CPEC Related Security Projects
	95	UnApproved		624	Pak-China Year of Friendly Exchanges Programme (CPEC)
	96	ECNEC	12.01.2015	632	Construction of Eastbay Expressway (CPEC)
	97	UnApproved		640	Capital Dredging of Berthing Areas & Channel for Additional Terminal (CPEC)
	98	DDWP	29.12.2015	641	Establishment of CPEC Support Unit (CSU) for projects and Activities in GPA
	99	CDWP	30.03.2016	642	Feasibility Study for Construction of Break Waters (CPEC)
	100	UnApproved		643	Infrastructure Development for EPZA and GIEDA, Gwadar (CPEC)
	101	CDWP	19.10.2014	644	Pak-China Technical & Vocational Institute at Gwadar (CPEC)

	102	UnApproved		646	Up-gradation of Existing 50 Bed Hospital to 300 Beds, Gwadar (CPEC)
	103	CDWP	29.11.2013	683	(i) PC-II for Feasibility Study to Connect Gwadar with Karachi . (ii) Gwadar to Jacobabad via Basima under CPEC
	104	CDWP	06.01.2015	684	China Pakistan Economic Corridor (CPEC) Support Project at Ministry of Railways
	105	CDWP	25.06.2014	685	Comprehensive Feasibility Study for Upgradation/Rehabilitation of Mainline 1 (ML-I) and New Dry Port at Havelian (Buldhair) District Haripur under China-Pak Economic Corridor (CPEC)
	106	CDWP	31.08.2015	686	Doubling / Improvement of Existing Track from Port Qasim to Bin Qasim Station (CPEC)
	107	CDWP	14.01.2016	687	Feasibility Studies for Updation of Existing Main Line-II (ML-II) and Upgradation & Extension of ML-III in connection with CPEC (Revised)
	108	UnApproved		688	Feasibility study for Rail Link from Havelian to Pak China Border (682 K.M) (CPEC)
	109	UnApproved		689	Rehabilitation / Upgradation of ML-I including Acquisition of Land for New Dry Port at Buldhair, District Haripur (CPEC)
	110	CDWP	01.03.2008	807	132 KV Sub Stations at Deep Sea Port Gwadar (QESCO)
	111	CDWP	01.03.2008	808	132 KV Sub Stations at Down Town, Gwadar
	112	UnApproved		898	Pre-Feasibility - Installation of 300 MW Coal Fired Power Plant at Gwadar (CPEC)

Source: the data is collected and adapted from the official website of the CPEC, retrieved (2023) from: https://cpec.gov.pk/cpec-psdp-funded-projects

Appendix 7: Direct and Indirect Involvement of 130 Chinese Companies Along the CPEC

Direct and Indirect Involvement of Chinese Companies Along the CPEC							
#	Company	Abbreviations	Ownership and Parents	References	Directly Related Projects	Indirectly Related Projects	References
C1	Huaneng Shandong Ruyi (Pakistan) Energy (Pvt.) Limited	Huaneng Shandong Ruyi (Pakistan) Energy (Pvt.) Limited	private, wholly owned subsidiary of Huaneng Shandong Ruyi (Hong Kong) Energy Limited	(PACRA, 2022)	E1		(Ahmed, 2016) (Ahmed, 2019)
C2	Huaneng Shandong Ruyi (Hong Kong) Energy Limited	Huaneng Shandong Ruyi (Hong Kong) Energy Limited	Private company	(Hong Kong Company Directory, n. d.)		E1	(Ali, 2022) (Auditor General of Pakistan, 2017)
C3	Shandong Huatai Electric Operations & Maintenance (Private)	Shandong Huatai Electric Operations & Maintenance (Private)	Private, 40% owned by China Huaneng Group Company Limited	(Aekci Corporation, 2023)	E1		(Ayang, 2023)
C4	China Huaneng Group Company Limited	CHNG	state-owned Chinese Company	(CHNG, n.d.)		E1	(Azad Pattan Power, n.d.)
C5	China Huaneng Group Fuel Company Ltd	China Huaneng Group Fuel Company Ltd	Equity: 50% hold by Huaneng Group Company , 50% hold by Huaneng International Power Co., Ltd.	(CHNG, n.d.a)	E1		(Azad Pattan Power, n.d.a)
C6	Huaneng International Power Co., Ltd.	Huaneng International Power Co., Ltd.	owned by China Huaneng Group Co., Ltd	(CHNG, n.d.b)		E1	(Azad Pattan Power, n.d.)
C7	CRRC SHANDONG CO., LTD. (previous name: Jinan Railway Vehicles Equipment Co., Ltd.) (hereafter CRRC Shandong)	CRRC Shandong	wholly-owned subsidiaries of China CRRC Corporation Limited	(CRRC Shandong, n.d.)	E1		(Business Recorder, 2016)
C8	China CRRC Corporation Limited	CRRC	state-owned	(Fitch Ratings, 2020)		E1, T3	(Business Recorder, 2018)
C9	Shanghai Electric Power Generation Equipment Co Ltd Generator Plant	Shanghai Electric Power Generation Equipment Co Ltd Generator Plant	a joint venture established with Siemens (Germany).		E1, E13		(Business Recorder, 2022)
C10	Port Qasim Electric Power Company (Private) Limited	Port Qasim Electric Power Company (Private) Limited	Sinohydro Resources Limited hold 51% equity	(NEPRA, 2015) (NEPRA, 2014)	E2		(Centre for Aviation, 2023) (China Coal, 2019)
C11	Sinohydro Resources Limited	Sinohydro	State-owned; a subsidiary of Power Construction Corporation of China	(Static.sse, 2022)		E2	(China Coal Technology & Engineering Group (CCTEG), 2019)
C12	Power Construction Corporation of China	POWERCHINA	State-owned	(Globaldata, n.d.)	E16	E2, G8, E6, E19	
C13	China Power Hub Generation Company (CPHGC)	CPHGC	a joint venture company formed by two sponsors, China based company China Power International Holding Ltd (CPIH) and Pakistan based company The Hub Power Company Limited (HUBCO).; China Power International Holding Limited has a 74% ownership stake	(NEPRA, 2015) (Embassy of the People's Republic of China in the Islamic Republic of Pakistan, 2018)	E3		(China Daily, 2016) (China Economic Net, 2022)
C14	China Power International Holding Limited	PowerChina International Group Limited	wholly-owned subsidiary of State Power Investment Corporation	(China Power International Holding, n.d.)		E3	(China Hua

C15	State Power Investment Corporation	SPIC	State-owned	(Fitch Ratings, 2022)		E3
C16	Northwest Electric Power Design Institute Co. Ltd. (NWEPDI)	NWEPDI	a wholly-owned subsidiary company of China Energy Engineering Group Co., Ltd.(ENERGY CHINA)	(Informa Markets, n.d.)	E3	
C17	China Energy Engineering Group Co., Ltd.(ENERGY CHINA/CEEC)	ENERGY CHINA/CEEC	State-owned	(CEEC, n.d.)		E3, E7, E15, E16, E18, G8
C18	China Energy Engineering Group Tianjin Electric Construction Company	TIANJIN ENERGY	a wholly-owned subsidiary of China Energy Engineering Group Co., Ltd., (ENERGY CHINA)	(China Energy and Engineering Group, 2019)	E3	
C19	China Power International Maintenance Engineering Company Limited	China Power International Maintenance Engineering Company Limited	subsidiary of State Power Investment Corporation ("SPIC")	(HUBCO, 2021)	E3	
C20	Engro PowerGen Thar (Pvt.) Limited	Engro PowerGen Thar (Pvt.) Limited	Private, 35% equity shared by China Machinery Engineering Corporation (CMEC)	(Engro Energy, n.d.)	E4, E12	
C21	China Machinery Engineering Corporation (CMEC)	CMEC	a subsidiary of China National Machinery Industry Corporation (Sinomach)	(CMEC, n.d.)	E14	E4
C22	China National Machinery Industry Corporation (Sinomach)	Sinomach	State-owned	(Sinomach, n.d.)	E11	E4, E9, E14
C23	TBEA Xinjiang Sunoasis Company Ltd (TBEA Sunoasis)	TBEA Sunoasis	a subsidiary of TBEA Co., Ltd.	(Sunoasis, n.d.)	E5	
C24	TBEA Co., Ltd.	TBEA Co., Ltd.	Private	(Ding, 2018)		E5
C25	Zonergy Company Limited	Zonergy	state-owned	(CHEN, 2021)	E5	
C26	HydroChina Dawood Power (Private) Limited (HDPPL)	HDPPL	Private, HydroChina Corporation acquired majority shares	(Embassy of the People's Republic of China in the Islamic Republic of Pakistan, 2018)	E6	
C27	HydroChina International Engineering Co., Ltd	HydroChina International Engineering Co., Ltd	state-owned; a subsidiary of China Hydropower Engineering Consulting Group	(Chincold, 2009)	E8	E6
C28	China Hydropower Engineering Consulting Group (HydroChina Corporation)	HydroChina Corporation	state-owned; a subdiary of PowerChina		E6, E8	
C29	Mingyang Smart Energy Group Co., Ltd (old name: Guangdong's China Ming Yang Wind Power Group)	Mingyang Smart Energy	non-state-owned	(Gwy, 2023)	E6	
C30	UEP Wind Power Pvt. Limited (UEPL)	UEPL	Private, equity share: United Energy Group Co., Ltd. (1%)	(Embassy of the People's Republic of China in the Islamic Republic of Pakistan, 2018)	E7	
C31	United Energy Group Co., Ltd	UEG	a Hong Kong listed company but controlled by Zhang Hongwei, a majority shareholder in mainland China, who owns 71.7% of the company.	(UEG, n.d.)		E7
C32	China Gezhouba Group Company Limited (CGGC)	CGGC	wholly owned by China Energy Engineering Group Co., Ltd (CEEC)	(Fitch Ratings, 2020)	E7, E15, E16, E18	
C33	Xinjiang Goldwind Science & Technology Co., Ltd. (Goldwind)	Goldwind	not a state-owned enterprise (SOE), but the company long has enjoyed central government support as well as the active backing of the regional Xinjiang government.	(Forbes, 2015)	E7, E8, E9, E20, E21	
C34	China Export & Credit Insurance Corporation (SINOSURE)	SINOSURE	state-owned	(Fitch Ratings, 2023)	E8, E11, E16, E17, E18, G8	
C35	Three Gorges Second Wind Farm Pakistan Ltd. (TGSWFPL)	TGSWFPL	invested by China Three Gorges South Asia Investment Limited (CSAIL)	(East Wind Power Net, 2017)	E9	
C36	China Three Gorges South Asia Investment Limited (CSAIL)	CSAIL	the subsidiary of China Three Gorges International Corporation and wholly subsidiary of CTG	(CTGI, n.d.) (CHINCA, n.d.)	E17	E9, E11
C37	China Three Gorges International Corporation	CTG International	the subsidiary of China Three Gorges Corporation	(CTGI, n.d.a)		E9
C38	China Three Gorges Corporation	CTG	wholly State-owned company, previously named China Three Gorges Project Development Co. Ltd	(CTGI, n.d.b) (CTGI, n.d.c)		E9, E17
C39	Shanghai Investigation Design & Research Institute Co. Ltd	Shanghai Investigation, Design & Research Institute Co., Ltd.	subsidiary of China Three Gorges Corporation	(SIDRI, n.d.)	E9, E11	
C40	Sumec Group Corporation Company Limited	Sumec Group Corporation	member of China National Machinery Industry Corporation (SINOMACH)	(Sumec, n.d.)	E9	
C41	Three Gorges Third Wind Farm Pakistan Ltd. (TGSWF)	TGSWF	invested China Three Gorges South Asia Investment Limited, CSAIL	(China Daily, 2016)	E9	
C42	Pak Matiari-Lahore Transmission Company (Pvt) Ltd.	Pak Matiari-Lahore Transmission Company (Pvt) Ltd.	wholly-owned subsidiary of China Electric Power Equipment & Technology Co. Ltd (CET)	(Pak Matiari-Lahore Transmission Company (Pvt) Ltd., n.d.)	E10	
C43	China Electric Power Equipment & Technology Co. Ltd (CET)	CET	wholly owned subsidiary of State Grid Corporation of China (SGCC)			E10
C44	State Grid Corporation of China (SGCC)	SGCC	state-owned	(Yidaiyilu, n.d.)		E10
C45	Karot Power Company Ltd. (KPCL)	KPCL	majority (93%) owned by China Three Gorges South Asia Investment Limited (CSAIL), Silk Road Venture Investment Company (7%)	(NEPRA, 2015)	E11	
C46	Silk Road Venture Investment Company	Silk Road Venture Investment Company	Privately Held	(PitchBook, n.d.)		E11
C47	Yangtze Three Gorges Technology and Economy Development Company (TGDC)	TGDC	wholly-owned subsidiary of China Three Gorges Corporation	(TGDC, n.d.)	E11, E17	
C48	Shanghai Donghua Engineering Consulting Company (SECEC)	SECEC	state-owned	(Idjob88, n.d.)	E11	
C49	Thar Energy Limited (TEL)	TEL	China Everbest Development has 10% ownership through CMEC in TEL	(PACRA, 2023)	E12, E14	

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(Guangzhou

C50	China Everbest Development International Ltd	China Everbest Development International Ltd	Private company limited by shares registered in Hong Kong	(Hong Kong Companies Directory, n. d.)		E12, E14
C51	Thar Coal Block-1 Power Generation Company (Pvt.) Ltd	Thar Coal Block-1 Power Generation Company (Pvt.) Ltd	a subsidiary of the Shanghai Electric Power Company Limited in Pakistan	(Thar Coal Block-1 Power Generation Company (PVT) Ltd., n.d.)	E13	
C52	Shanghai Electric Hongkong Co. Ltd (Abbr. Shanghai Electric HK)	Shanghai Electric HK	subsidiary wholly owned by Shanghai Electric Group Co., Ltd. (SEG)	(Shanghai Electric, n.d.)	E13	
C53	Shanghai Electric Group Co., Ltd. (SEG)	SEG	Owned by the Shanghai municipality	(Fitch Ratings, 2020) (Nikkei Inc, n.d.)		E13
C54	China Coal Technology & Engineering Group Corp (CCTEG) Shenyang Engineering Company	CCTEG Shenyang Engineering Company	subsidiary of CCTEG	(CCTEG, n.d.)	E13	
C55	China Coal Technology & Engineering Group (CCTEG)	CCTEG	State-owned	(China Daily, 2019)		E13
C56	Sino-Sindh Resources (SSRL)	SSRL	SSRL accepted Shanghai Electric as its controlling shareholder.	(Ns Energy, n.d.)	E13	
C57	Dongfang Electric Corporation	DEC	state-owned	(Market Screener, n.d.)	E13	
C58	Shanghai Electric Engineering Consulting Company	Shanghai Electric Engineering Consulting Company			E13	
C59	ThalNova Power Thar (Pvt.) Limited	ThalNova Power Thar (Pvt.) Limited	Thal Energy Ltd holds 25%, (Thal Energy Ltd (China Everbest Development has 10% ownership through CMEC in TEL) China Everbest Development International Ltd invested through CMEC ThalNova Power Investments Ltd 10%	(PACRA, 2022)	E14	
C60	CMEC ThalNova Power Investments Ltd	CMEC ThalNova Power Investments Ltd	CMEC ThalNova Power Investments Limited is a Dubai based entity and is a wholly-owned subsidiary of China Machinery Engineering Corporation which forms part of the China National Machinery Industry Corporation (Sinomach)	(Farooq, 2018)	E14	
C61	China East Resource Import & Export Corporation	CERIECO	wholly state-owned company with independent legal status.	(CERIECO, n.d.)	E14	
C62	Suki Kinari Hydro (Private) Limited.	SK Hydro	20% equity shared by China Gezhouba Group Company Limited (CGGC) (20%).	(Pakistan Today, 2023)	E15	
C63	CIHC Pak Power Company Limited (CIHCPPCL)	CIHCPPCL	Private; CCCC Industrial Investment Holding Company (CIHC) shares 75.5% equity; Tianjin Energy Investment Group Company Limited shares 24.5% equity	(NEPRA, 2015) (NEPRA, 2018)	E16, G8	
C64	CCCC Industrial Investment Holding Company (CIHC)	CIHC	subsidiary of CCCC (can't access the official website of CCCC so far, as well as the 2022 annual report)		E16	
C65	China Communications construction company Ltd. (CCCC)	CCCC	majority state-owned; CCCC's parent, China Communications Construction Group (CCCG), is fully owned by the state	(Fitch Ratings, 2021) (QCC, 2023)	E16, G4, G8, T24	E16, G2, G3, G5, G8, G9, G12, T1, T2
C66	China Communications Construction Group (CCCG)	CCCG	State-owned	(Fitch Ratings, 2021)	G8	E16, G2, G4, G5, G8, T1, T24
C67	Tianjin Energy Investment Group Company Limited (TIANJIN ENERGY)	TIANJIN ENERGY	State-owned	(Tianjin Energy Group, n.d.)	E16, G8	
C68	China Overseas Ports Holding Company Ltd (COPHC)	COPHC	state-run	(Ebrahim, 2017)	E16, G1, G2, G3, G4, G5, G6, G7, G8, G9, G10, G11, G12, G13, G14	
C69	China Harbour Engineering Company (CHEC)	CHEC	a subsidiary of China Communications Construction Company Ltd (CCCC)	(CHEC, n.d.)	E16, G3, G8, G9, G10, G12	
C70	Kohala Hydro Company (Pvt.) Limited (KHCL)	KHCL	subsidiary of China Three Gorges Corporation (the CTG), owned by an intermediate subsidiary of CTG called China Three Gorges South Asia Investment Limited (the "CSAIL"), the equity share is 70%; China Silk Road Fund (SRF), accounts for 15% ownership	(NEPRA, 2017)	E17	
C71	Silk Road Fund Co., Ltd (SRF)	SRF	state-owned	(Crunchbase, n.d.)	E17	
C72	Azad Pattan Power Private Limited	Azad Pattan Power Private Limited	private limited company, China Gezhouba Group Co., Ltd. (CGGC) holds eighty percent (80%) of equity	(Azad Pattan Power, n.d.)	E18	
C73	China Gezhouba Group International Engineering Co. Limited	CGGC Intl.	wholly-owned subsidiary of China Gezhouba Group Co., Ltd.	(Development Aid, n.d.)	E18	
C74	Pearl River Planning Surveying and Designing Co. Limited, China	PRPSDC	state-owned	(Devex, n.d.)	E18	
C75	Huatai Insurance Agency & Consultant Service Limited	Huatai	state-holding sino-foreign joint venture	(Huatai, n.d.)	E18	
C76	China National Coal Development Company (CNCDC)	CNCDC	wholly-owned subsidiary of China National Coal Group	(CNCDC, n.d.)	E19	
C77	China National Coal Group Corporation (abbreviation as China Coal Group)	China Coal Group	State-owned	(China Coal Group, n.d.)		E19
C78	Shangdong Electric Power Construction Corp. (SEPCO)	SEPOC	wholly owned subsidiary of POWERCHINA	(SEPOC, n.d.)	E19	
C79	PowerChina International Group Limited	PowerChina International Group Limited	MEMBER ENTERPRISES of PowerChina	(Powerchina, n.d.)	E19	
C80	Beijing Jingneng Power Co. Ltd	Beijing Jingneng Power Co. Ltd	China-based	(Financial Times, n.d.)	E19	
C81	Western Energy (Pvt.) Ltd	Western Energy	The China Shipbuilding Industry Cooperation (CSIC) through its Shanghai Pilot Free Trade Zone Well Energy Technology Co., Ltd (Shanghai Well) holds 40% equity	(NEPRA, 2017)	E21	
C82	China Shipbuilding Industry Corporation (CSIC)	CSIC	state-owned	(CSIC, n.d.)	E21	

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C83	Sino Qiyao International (Pvt.) Limited	Sino Qiyao International (Pvt.) Limited	affiliated with SMDERI	(NEPRA, 2017)	E21	
C84	Hytera	Hytera	partly state-owned manufacturer	(Scmp, 2022)	G5	
C85	Beijing Urban Construction Group	BUCG	state-owned	(Xinhua, 2018)	G5	
C86	China Railway Beijing Engineering Group	CREG Beijing	subsidiary of China Railway Engineering Corporation (CRECG)	(CRECG, n.d.)	G5	
C87	China Railway Engineering Corporation (CRECG)	CRECG	state-owned	(Sovereign Wealth Fund Institute, n. d.)		G5
C88	China Airport Construction Group (CACC) Co., Ltd	CACC	partly state-holding, biggest state-holder: China Communications Construction Company Limited	(QCC, 2023)	G5	
C89	Gansu Provincial Construction Investment (Holdings) Group Corporation	Gansu Provincial Construction Investment (Holdings) Group Corporation	state-owned enterprises directly under the Gansu Provincial Government	(China-Africa Business Council, n.d.)	G7	
C90	China Energy Engineering Group Guangdong Electric Power Design Institute Co. Ltd (GEDI for short)	GEDI	China Energy Engineering Group Co., Ltd. holds 100% of the shares	(CEDC & CHINA ENERGY ENGINEERING CORPORATION LIMITED, 2022)	G8	
C91	SEPCO1 Electric Power Construction Corporation (SEPCO1)	SEPCO1	State-owned; enterprise of Power Construction Corporation of China	(SEPCO1, n.d.)	G8	
C92	Arcplus Institute of Shanghai Architectural Design & Research(Co., Ltd.)	Arcplus Shanghai	Affiliated to Arcplus Group PLC (Arcplus)	(Skyscrapercenter, n.d.)	G9	
C93	Arcplus Group PLC (Arcplus)	Arcplus	owned by Shanghai State-Owned Assets Supervision & Administration (54.38 %)	(Marketscreener, n.d.)		G9
C94	Guangzhou suike Construction Management Co., Ltd.	Guangzhou suike Construction Management Co., Ltd.	private	(QCC, 2023)	G9	
C95	Gwadar International Terminals Limited	Gwadar International Terminals Limited	subsidiary of China Overseas Ports Holding Company Pakistan (Pvt.) Ltd.	(COPHC, n.d.)	G1, G9	
C96	Gwadar Free Zone Company Limited	GFZL	subsidiary of China Overseas Ports Holding Company Pakistan (Pvt.) Ltd.	(COPHC, n.d.)	G1	
C97	Gwadar Marine Services Limited	GMSL	subsidiary of China Overseas Ports Holding Company Pakistan (Pvt.) Ltd.	(COPHC, n.d.)	G1	
C98	Rashakai Special Economic Zone Development and Operations Company (RSEZDOC)	RSEZDOC	China Road and Bridge Corporation (CRBC) through its subsidiary RB Industrial Investment and Development (Hongkong) owns 91% of the shares	(NEPRA, 2022)	I1	
C99	RB Industrial Park Investment & Development (Hong Kong) Limited	RB Industrial Park Investment & Development (Hong Kong) Limited	Private company limited by shares registered in Hong Kong; subsidiary of CRBC	(HK Company Directory, n.d.)	I1	
C100	China Road and Bridge Corporation (CRBC)	CRBC	wholly-owned subsidiary of China Communications Construction Company Limited (CCCC)	(CRBC, n.d.)		I1
C101	Century Steel (Private) Limited	Century Steel	invested by Jincheng industry development Pte ltd; owned by FUZHOU JULITAIHE INTERNATIONAL TRADE LIMITED COMPANY	(Century Steel, n.d.) (Liyuan Stainless Steel, 2021)	I1	
C102	Jincheng industry development Pte ltd	Jincheng industry development Pte ltd	Exempt Private Limited Company	(The Grid, n.d.)		I1
C103	FUZHOU JULITAIHE INTERNATIONAL TRADE LIMITED COMPANY	Fuzhou Julitaihe International Trading Ltd.	private	(QCC, 2023)		I1
C104	Zhengbang Agriculture Pakistan (Private) Limited	Zhengbang Agriculture Pakistan (Private) Limited	subdiary of Zhengbang Group Corporation Limited	(Anhui Agricultural University, 2020)	I3	
C105	Zhengbang Group	Zhengbang Group	private	(Zhengbang, n.d.)		I3
C106	Hunan Yatai Ceramics	Hunan Yatai Ceramics	private	(The People's Government of Yueyang County, 2023)	I3	
C107	Huawei Technology Pakistan	Huawei Pakistan	private; Branch of Huawei Technologies Co., Ltd.	(Huawei, n.d.)	I5	
C108	Huawei Technologies Co., Ltd	Huawei	private	(Huawei, n.d.)	T4	I5
C109	China Telecom Corporation Limited	China Telecom	State-owned	(Sovereign Wealth Fund Institute, n. d.)	T4	
C110	ZTE Corporation	ZTE	not owned or controlled by the Chinese government or any entities affiliated with the Chinese government. Some Chinese state-owned entities are shareholders in ZTE.	(ZTE, n.d.)	T5	
C111	No.3 Engineering Company Ltd. Of CCCC First Harbor Engineering Company	No.3 Engineering Company Ltd. Of CCCC First Harbor Engineering Company	state-owned; wholly-owned subsidiary of CCCC First Harbor Engineering Company Ltd.; affiliated to China Communications Construction Co (CCCC).	(China Daily, 2018)	T1	
C112	CCCC First Harbor Engineering Company Ltd.	CCCC First Harbor Engineering Company Ltd.	state-owned; wholly-owned subsidiary of China Communications Construction Co.	(CCCC First Harbor Engineering Company, n.d.)		T1
C113	CCCC-SHB Fourth Engineering Co., Ltd.	CCCC-SHB Fourth Engineering Co., Ltd.	state-owned; Wholly owned by CCCC	(CCCC-SHB Fourth Engineering Corporation, n.d.)	T1	
C114	Xi'an China Highway Geotechnical Engineering Co., Ltd.	Xi'an China Highway Geotechnical Engineering Co., Ltd.	wholly-owned subsidiary of CCCC FIRST HIGHWAY CONSULTANTS CO.LTD (referred to as "CCCCC First Highway")		T1	
C115	CCCC FIRST HIGHWAY CONSULTANTS CO.LTD	CCCC First Highway Consultants Co., Ltd	subsidiary of CCCC			T1

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C116	CCCC Second Tunnel Engineering Company Limited (not sure about the translation because the official website is not accessible)	CCCC Second Tunnel Engineering Company Limited	wholly-owned subsidiary of CCCC Tunnel Engineering Company Limited		T1		
C117	CCCC Tunnel Engineering Company Limited	CCCC Tunnel Engineering Company Limited	state-owned; wholly-owned subsidiary of CCCC	(CCCC Tunnel Engineering Company, n.d.)		T1	
C118	Shanghai Yuantong Industrial Co., Ltd	Shanghai Yuantong Industrial Co., Ltd	private	(QCC, 2023)	T1		
C119	Ningxia Communications Construction Co. Ltd (NXCC)	NXCC	Mixed-ownership enterprises	(NXCC, n.d.)	T14		
C120	China North Industries Corporation (Norinco)	Norinco	State-owned; subsidiary of China North Industries Group Corporation Limited (Norinco Group)	(Chambre de Commerce et d'Industrie de Chine en France, n.d.)	T3		
C121	China North Industries Group Corporation Limited (Norinco Group)	Norinco Group	State-owned	(Sovereign Wealth Fund Institute, n. d.)		T3	
C122	Guangzhou Metro Group Co., Ltd. (GZMG)	GZMG	state-owned	(Fitch Ratings, 2019)	T3		
C123	CRRC Zhuzhou Locomotive Co., Ltd. (CRRC ZELC)	CRRC ZELC	state-owned; subsidiary of CRRC Corporation Limited	(CRRCGC, n.d.)	T3		
C124	China Railway Engineering Consulting Group Co., Ltd. (CEC)	CEC	public & private mix ownership reform;subsidiary of the China Railway Group Limited (CRG)	(CREC, n.d.)	T3		
C125	China Railway Group Limited (CRG) or (CREC)	CRG/CREC	state-owned	(China Daily, 2019) (CRECG, 2019) (Sovereign Wealth Fund Institute, n. d.)		T3, T12	
C126	China Railway Construction Corporation Limited (CRCC)	CRCC	state-owned;	(The World Bank, 2019)	T3, T24		
C127	China Railway Eryuan Engineering Group Co., Ltd. (CREEC)	CREEC	enterprise of China Railway Group Ltd.	(Devex, n.d.)	T12		
C128	China State Construction Engineering Corporation Ltd. (CSCEC)	CSCEC	state-owned company; a subsidiary of China State Construction Engineering Corporation	(China Chamber of Commerce to the EU, n.d.)	T2		
C129	China Construction Seventh Engineering Division Corp., Ltd. (CSCEC7)	CSCEC7	an enterprise of China State Construction Engineering Corporation Ltd.	(China Construction Seventh Engineering Division Corp., Ltd., 2023)	T2		
C130	CCCC SECOND HIGHWAY CONSULTANTS CO.,LTD.	CCCC Second Highway Consultants Co., Ltd	the solely-invested subsidiary of the China Communications Construction Company Ltd	(CCCC Second Highway Consultants Co., Ltd, n.d.)	T2		

Source: the data is collected and adapted based on 'references' listed in this table.

Appendix 8: The Spatial Distribution of 10 Representative Chinese Companies Involvement

Name of Company	Ownership	Spatial Distribution
China Overseas Ports Holding Company Ltd (COPHC)	state-run	15 involvement in Balochistan
China Communications construction company Ltd. (CCCC)	majority state-owned; subsidiary of CCCG	9 involvements in Balochistan; 2 involvements in Khyber Pakhtunkhwa; 1 involvement in Punjab; 1 involvement in Sindh
China Communications Construction Group (CCCG)	State-owned	6 involvements in Khyber Pakhtunkhwa; 2 involvements in Balochistan
China Energy Engineering Group Co., Ltd.(ENERGY CHINA/CEEC)	State-owned	3 involvements in Balochistan; 2 involvements in Punjab; 1 involvements in Khyber Pakhtunkhwa; ; 1 involvement in Sindh; 1 involvement in Azad Jammu and Kashmir (AJK)
China Export & Credit Insurance Corporation (SINOSURE)	state-owned	3 involvement in Azad Jammu and Kashmir (AJK); 3 involvements in Punjab; 1 involvement in Sindh; 2 involvements in Balochistan
China Harbour Engineering Company (CHEC)	stateowned, a subsidiary of CCCC	6 involvement in Balochistan
Xinjiang Goldwind Science & Technology Co., Ltd. (Goldwind)	non-SOE	5 involvements in Sindh
Power Construction Corporation of China (POWERCHINA)	State-owned	3 involvement in Balochistan; 2 involvements in Sindh
China Gezhouba Group Company Limited (CGGC)	stateowned, wholly owned by CEEC	1 involvements in Balochistan; 1 involvements in Punjab; 1 involvements in Khyber Pakhtunkhwa; ; 1 involvement in Sindh; 1 involvement in Azad Jammu and Kashmir (AJK)
China National Machinery Industry Corporation (Sinomach)	State-owned	3 involvements in Sindh; 2involvements in Punjab

Source: the data is retrieved based on the 'reference' column in Appendix 7.

Appendix 9: The Sources and Applications of the Major Data

Data	Sources	Section
Sino-Pakistan Bilateral Export and Import 2003-2021	National Bureau of Statistics (PK); World Integrated Trade Solution	Bilateral Trade Relationship; Figure 1; Appendix 1
Net Foreign Direct Investment Outflow to Pakistan	Prime Minister Office, Board of Investment (Invest Pakistan)	Chinese Investments Outflow to Pakistan; Figure 2; Appendix 2
Chinese Personnel Deployment: Foreign Contracted Projects Related and Foreign Labor Service Related	National Bureau of Statistics (CN)	Chinese Investments Outflow to Pakistan; Figure 3; Appendix 3
Trends in Bilateral China and Bilateral Total Contributions From FY 2006-2007 to FY 2021-2022	Policy Analysis & Development Wing Ministry of Economic Affairs Government of Pakistan	Chinese Investments Outflow to Pakistan; Figures 4; Appendix 4
Proportional Chinese Contribution in Bilateral Context From FY 2006-2007 to FY 2021-2022	Policy Analysis & Development Wing Ministry of Economic Affairs Government of Pakistan	Chinese Investments Outflow to Pakistan; Figure 5; Appendix 4
Compositions of Chinese Contributions From FY 2006-2007 to FY 2021-2022	Policy Analysis & Development Wing Ministry of Economic Affairs Government of Pakistan	Chinese Investments Outflow to Pakistan; Figure 6; Appendix 4
CPEC Project Overview by Sector	CPEC Secretariat at MoPD&SI	Method and Data; Appendix 5, 6
Direct and Indirect Involvement of 130 Chinese Companies Along the CPEC	Main resources: NEPRA (PK); Xinhua (CN), The People's Daily (CN); Official website of project companies/SPVs; Official website/annual reports/yearbook of Companies (Both PK and CN); Embassy of the People's Republic of China in the Islamic Republic of Pakistan; Business Recorder; Fitch Ratings; Gwadar Today (PK); Dawn (PK).	Method and Data; Appendix 7; Appendix 8
Pakistan Inflation Rate 2013-2024	World Bank	Figure 10
Pakistani Rupee to United States Dollar 2006-2023	GoogleFinance	Figure 11

Source: this table is generated by the author.

11- Africa's role in the European supply chain of hydrogen: the cases of Egypt and Morocco

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Africa's role in the European supply chain of hydrogen: the cases of Egypt and Morocco

Introduction

The Paris Agreement on Climate Change requires the European Union (EU) to reduce its greenhouse gas emissions by at least 40% of its 1990 level and to expand the share of renewable energy to 32% by 2030. The European aim is to be climate-neutral by 2050. *Green* hydrogen, i.e. hydrogen being produced from renewable energy sources, is to play a significant role in the European energy transition. Electrification is a major pillar of Europe's climate ambitions, but it is not an effective substitute for fossil fuels in certain sectors, such as the chemical and steel industry, or long-haul transportation. Green hydrogen can fill the gap. Under the 2022 RePowerEU plan, a response to the energy market disruptions caused by the Russian invasion of Ukraine, the European Commission emphasized the role of green hydrogen in Europe's future energy mix by quadrupling the 2021 hydrogen targets from 5 million tonnes (MT) by 2030 to 20 MT. Half of this amount of hydrogen needs to be imported. Even with a drastic expansion of the installed capacity of electrolyzers, the EU can produce only 10 MT of green hydrogen in the near future (Schmidt and Maggiore, 2020). By 2050, the EU may have to import 60 MT of green hydrogen (Enerdata, 2022).

In this context, the EU has great interest in North Africa, its "Southern Neighbourhood," because of its proximity and potential for renewable energy production (European Commission, 2020a). The region has abundant solar and wind resources and large parts of desert land available, making it suitable for the production of renewable energy. Egypt and Morocco have already started generating solar and wind energies and they are developing facilities for green hydrogen production. Egypt is a traditional energy exporter and is looking for a response to the intensifying global climate emergencies and frequent energy security issues. Morocco is an energy importer and embraces renewable energy and green hydrogen for its energy transition and as a route to reduce its dependence on foreign energy supplies. Even the option of turning the country into an energy exporter looms.

Green hydrogen is a 'Power-to-X (PtX) product. PtX stands for the different trajectories to transform renewable electricity (power) into material and energy sources for further use in the transport, energy, and chemical sectors. The 'X' symbolizes either storable chemical energy carriers, synthetic fuels for the transport sector, reducing agents in steel production, or raw materials for the chemicals industry (Terrapon-Pfaff, 2021). In terms of industrial policy, PtX is relevant in that it refers to industrial upgrading, in this case, the renewable industry sector moving up the value chain. Producing and exporting renewable electricity is one step. For emerging economies, the second step is more attractive: adding value to this 'raw' product by transforming it into hydrogen or a derivative such as ammonia.

This paper addresses the question as to what extent Morocco and Egypt can benefit from the EU strategy of securing sufficient green hydrogen supply needed for the European energy transition in the next decades. We first explain the various European energy funding and investment policies that have been used to reach out to Morocco and Egypt in respect of future hydrogen deliveries. The second section deals with the energy transition and build-up of a green hydrogen value chain in Morocco and Egypt. We address the main institutional changes in both countries, followed by the investments in three stages of the green hydrogen value chain: desalination installations, electrolyzing capacity, and storage and transportation. Section three addresses the potential impacts of green hydrogen investments in both countries. The paper ends with a conclusion.

European Union looking for external hydrogen supplies
The Global Gateway Initiative (GGI) is one of the central vehicles the EU is using to, among other things, source green hydrogen from North Africa. Since many African countries have joined the Chinese Belt and Road Initiative (BRI) and received considerable Chinese funding and private investments for the much-needed infrastructure development, the EU is looking for a proper response that would make up for the lost ground ceded to China. The EU-Africa Global Gateway involves an investment package of EUR 150 billion in support of Africa's green, inclusive, and digital transformation (European Commission, 2019). The European approach is to operate as 'Team Europe' i.e., through concerted actions by the EU, EU member states and their implementing agencies, and EU financial institutions. The projects should take place as public-private partnerships (PPPs), including Team Europe partners, European private companies, and companies and institutions from the countries where the projects are initiated.

The Africa-Europe Green Energy Initiative is the energy component of the GGI in Africa. The initiative is to support Africa's energy transition by increasing renewable energy capacity and increasing access to energy for the African population. It will work on regional electricity interconnections and market integration, on energy transition partnerships, and promote opportunities for cooperation on clean hydrogen in Africa (AEEP, 2022a). Green hydrogen offers opportunities for Africa post-COVID economic recovery and could become a promising export commodity (AEEP, 2022b).

The initiative should also help the EU achieve carbon neutrality by 2050. Europe needs green hydrogen that can be produced at competitive prices in Africa. The then European Commission's Vice President Frans Timmermans, the driving force behind the European Green Deal, pointed out that Africa and Europe are "sister continents" with a future that is interlinked. He stated that Europe wants African countries to be the leaders in green hydrogen production. This would allow Africa to transform its traditional role as an exporter of raw materials to one that exports high-value-added green hydrogen and green derivatives. Europe is offering plenty of market opportunities (Kurmayer, 2022).

EU aiming at hydrogen supplies from Morocco
The EU established a Green Partnership with Morocco in October 2022. It was the first of its kind. The Partnership forms "the external dimension of the European Green Deal" and intends to combat climate change, foster the energy transition, and promote a green and blue economy (European Commission, 2022b). In a follow-up of the Green Partnership, in June 2023, a delegation of four **European Union** Directorates-General visited Morocco to strengthen political dialogue with institutional partners and the private sector in Morocco. Among other things, the dialogue focused on support for the transition towards a decarbonized economy. Delegates from both sides laid the groundwork for close cooperation in promising sectors such as renewable energies and green hydrogen, in line with the EU Global Gateway strategy. One decade earlier, in 2012, Morocco had already signed the German Moroccan Energy Partnership (PAREMA), aiming at the development of a renewable energy industry in Morocco, including the production of green hydrogen for domestic purposes and export to Germany (Green Hydrogen Organization, 2023). Germany has been spearheading Europe's quest for foreign green hydrogen. It adopted a National Hydrogen Strategy in 2020, and two years later, the Federal Ministry for Economic Affairs and Climate Action provided funding of EUR 900 million to the H2Global Foundation. The organization is supported by over 50 German companies and aims to create supply and demand markets for green hydrogen and PtX products in Europe and globally (H2Global Stiftung, 2023). Apart from Morocco, Germany has concluded bilateral deals with a number of potential green hydrogen supplier

countries in Africa, including Namibia and Tunisia, and has dedicated hydrogen diplomacy offices linked to its embassies in Angola and Nigeria (Irena 2022: 79)
Morocco has also formed bilateral hydrogen partnerships with the Netherlands, Portugal, and Finland (Quitzow et al., 2023) and discussed the option of joining the H2Med pipeline network with Italy and Spain. H2Med should become the EU hydrogen backbone connecting Portugal, Spain, France and Germany (Rahhou, 2023a).
France is reaching out to Morocco too, but with a different approach. France has a well-established nuclear industry and is building a hydrogen industry on its nuclear capabilities. Organizations from France and eight other EU member states have recently proposed to the European Commission to allow "low-carbon" hydrogen, produced from nuclear energy or fossil gas with carbon capture and storage, as a form of renewable or green hydrogen. This proposal is highly controversial in Europe. Nuclear-based hydrogen would compete with countries such as Germany, Italy and Spain, which develop hydrogen based on renewable energy because nuclear energy is presently cheaper and not clean in respect of its nuclear waste. The proposal would also promote competition with the Moroccan renewable industry. The EU (under the European Commission's new Delegated Act, 2023 Feb) does not allow green hydrogen to be produced with nuclear power, but the Commission is considering separate rulings on "low-carbon" hydrogen by the end of 2024 (Savickas, 2023). Meanwhile, the hydrogen task team of France's largest employers' federation, Mouvement des Entreprises de France (MEDEF), visited Morocco in 2023 to examine cooperation opportunities in low-carbon hydrogen development (Dokso, 2023).

EU aiming at hydrogen supplies from Egypt
In November 2022, during the Climate Change conference COP27, the EU and Egypt formed the EU-Egypt Renewable Hydrogen partnership. In a Joint Statement, the Egyptian and EU Presidents said the energy partnership is essential for the EU and "will serve as a central block in building an EU-Mediterranean Renewable Hydrogen Partnership." Both parties view renewable hydrogen as a crucial contributor to reducing emissions and ensuring energy security while representing an opportunity for industrial cooperation, sustainable economic growth, and job creation. The partnership entails creating an EU-Egypt Hydrogen Coordination Group and involves a Business Forum with representatives from industry, regulators, financial institutions, and experts. They should also contribute to the establishment of a framework for a global rules-based market for hydrogen-based solutions, including harmonized safety and environmental standards (European Commission, 2022a).
The hydrogen partnership entails a contribution of EUR 35 million from the *European Bank for Reconstruction and Development* (EBRD) to support Egypt's Energy Wealth Initiative. The Initiative was created by the Egyptian Government and the EBRD to accelerate the implementation of Egypt's new 2050 climate change strategy, launched in May 2022. The aim is to close 5 Gigawatt (GW) of inefficient gas-based power generation capacity - about 5% of the country's total electricity supply-, and facilitate investments in 10 GW of new renewable energy capacity. The investment forms part of the EU's Economic and Investment Plan for the Southern Neighbourhood (European Commission, 2022a).
Next to the partnership with the EU, Egypt has formed a bilateral agreement with one individual EU member state, Germany (Quitzow et al., 2023). In November 2022, the governments of the two countries signed two Joint Declarations of Intent. One of them concerns Egyptian LNG deliveries. The other specifically aims to help Egypt build up a green hydrogen value chain and should enable Germany "to cover some of its need for green hydrogen from Egyptian Exports" (BMZ, 2022). The cooperation between Egypt and Germany on energy has a longer history. Since 2008, the Egyptian-German Joint Committee on Renewable Energy, Energy Efficiency and Environmental Protection (JCEE) has been a

platform for high-level policy coordination on several aspects of the electricity sector, among them renewable energy and efficiency (GIZ, 2021).

Morocco and Egypt developing a national green hydrogen strategy

Renewable energy in Morocco

Morocco's government understood its potential for wind and solar power early in the first decade of this century and has developed an ambitious strategy. The country prioritized renewable energy in its National Energy Strategy in 2010. By 2030, 52% of installed electricity production capacity should come from renewable energy sources, a share significantly higher than the 38% of renewable installed capacity available in 2021 (Bozier et al, 2022).

In a drive to add more value to renewable electricity, the Moroccan government began to focus on the PtX options and founded, in 2019, a National Hydrogen Commission that published a National Roadmap for green hydrogen. The Moroccan vision is to produce green hydrogen to meet both domestic demand and serve foreign markets, particularly in Europe. The intention is to build a national green hydrogen industry to substitute the 2 million tonnes of ammonia, a derivative of hydrogen, that is imported annually (Bozier et al, 2022).

The cost of generating renewable electricity in Morocco is not the lowest in the world; Chile and Saudi Arabia have better sun and wind conditions. Morocco's prices are competitive however, and its proximity to major end markets in Europe is key, although the country shares this benefit with other Middle East North African (MENA) countries, such as Egypt (Bozier et al, 2022).

Morocco aim to make green energy a core determinant of its economic attractiveness. An accelerated transition to a low-carbon, competitive economy would drive sustainable production methods and attract foreign investors looking for opportunities in green economy sectors (SCDM, 2021). This aim is embraced at the top level of Morocco's administration. Recently, King Mohammed VI ordered the development of the 'Morocco Offer', an overall plan covering the entire hydrogen value chain that sets the administrative, legal, and institutional conditions to attract foreign investors that will generate and export green hydrogen at competitive prices (Dokso, 2023).

A central pillar of Morocco's renewable energy value chain is the state-owned enterprise MASEN, which forms the bridge with the private sector. MASEN pre-develops renewable energy sites carries through the procurement process, acts as the government entity borrowing concessional finance from development finance institutions and commercial lenders, and co-invests on behalf of the government (van Wijk and Wouters, 2020). Law no. 13-09, adopted in 2015, liberalized the renewable energy sector and allowed private companies to enter the sector and export through the national grid (Fuente Cobo, 2023). In 2021, IRESEN presented a Green H2 Maroc platform to develop a green H2 industry cluster. The platform is devoted to the R&D demonstration of PtX projects that have a high value-added, such as methanol and ammonia (Bozier et al., 2022; Berahab and Zarkik, 2022).

Renewable energy strategy of Egypt

Egypt understood the potential of renewable energy decades ago. Already back in 1960, Egyptian Chemical Industries (KIMA) produced green ammonia by using hydroelectricity from the adjacent Aswan dam (Esily et al., 2022). While the facility turned to natural gas for cost reasons in 2019, President Abdel Fattah al-Sisi brought green hydrogen back to the spotlights two years later. Ever since, a series of foreign companies announced plans for the production and export of green hydrogen, bringing Egypt's electricity Minister even designating 2022 as "the year of green hydrogen" (Fouad, 2022).

In 2023, the Egyptian government created the National Council for Green Hydrogen and its Derivatives. The council should stimulate green investment and ensure the country's regional and international competitiveness. The council will also monitor the implementation of the National Strategy for Green Hydrogen and review legislation and regulations relevant to green hydrogen and its derivatives. One of Egypt's climate ambitions is increasing the share of renewables in its national energy mix from 20% in 2022 to 42% by 2035. A part of it will be used for green hydrogen, which is supposed to play an important role in the decarbonization of Egypt's economy. Presently, the most important industries in the country use grey hydrogen produced from natural gas (Habib and Ouki, 2021). Egypt aims to produce low-cost green hydrogen and capture 8 per cent of the global hydrogen market (Anonymous 2023).

Green hydrogen projects are planned in or near the Suez Canal Economic Zone (SCZONE). From here, hydrogen can be exported and a hydrogen-based vessel refuelling infrastructure may be developed in the future (Parkes, 2023). The government has also allocated land in the Matrouh Governorate bordering the Mediterranean Sea: 60 hectares for renewable energy projects and 300 hectares for green hydrogen and green ammonia production facilities (Hydrogen Central, 2023).

Developing a hydrogen value chain

The governments of both Morocco and Egypt are committed to building up a green hydrogen value chain in their respective countries. The chain begins with the generation of renewable energy, specifically solar and wind energies. For practical purposes, this study leaves out the details of the many projects that are being planned or developed in the two countries in this area. However, if all wind and solar power projects under some form of development indeed materialize, the increase in renewable energy production in this decade will be six-fold for Egypt (from 3.6 GW to 21 GW) and nine-fold for Morocco (from 2 GW to 18 GW) (Table 1). The green hydrogen value chain is discussed below and includes three different stages: desalination, electrolysis, and storage and transportation. Table 1 displays the main projects per stage of the chain in Egypt and Morocco.

Water desalination

The principal source of green hydrogen is freshwater. Producing hydrogen through electrolysis requires about 20-30 liters of water: 9 liters for electrolysis and the rest for purification and cooling. This amount of water does not exceed the water requirements of fossil fuel-based ('grey') hydrogen production (Ramirez et al., 2023) and is also not more than needed to produce certain fossil fuels (Hydrogen Europe, 2020). Nevertheless, these water requirements form an immediate challenge to the hydrogen ambitions of Egypt and Morocco. Both countries are among the most water-scarce countries in the MENA region. Egypt is facing an annual water deficit of around seven billion cubic meters, and could run out of water by 2025 (UNICEF, 2021), while water availability in Morocco declined by 75% in the period 1960-2020 (Cutrone et al., 2023). Hence, green hydrogen production requires a substantial capacity expansion to desalinate seawater. Table 1 displays the current and projected desalination capacity in both countries.

Electrolysis

The production of green hydrogen through solar-driven electrolysis could be highly valuable to the Egyptian and Moroccan economies. Whereas the generation of electricity by solar panels or wind turbines is already economically viable, the production of green hydrogen and derivatives implies value addition to a 'raw' material. It is particularly

this potential of these 'power-to-X' opportunities that is stressed in many green energy publications that foresee great futures for Egypt and Morocco as leaders in green hydrogen production and export. At present, however, such production is still in its infancy (Berhabab and Zarkik, 2022; Fouad, 2022). The projects displayed in Table 1 indicate that most of the present projects in Egypt and Morocco are being considered or in some stage of development.

Storage and transport
Green hydrogen produced in North Africa can best be transported to Europe as gas via the existing albeit refurbished natural gas pipelines (Van Wijk and Wouters, 2021). However, such a pipeline network is yet to be built and involves considerable investment. Alternatively, green hydrogen could be shipped in liquid form, but this is controversial. Hydrogen maritime export requires specialized vessels, which do not yet exist. The only demonstration vessel recently suffered from a fire due to a valve malfunction in the gas combustion (IEA, 2023). Further, liquifying hydrogen requires the cooling of the hydrogen molecules to -253°C. This process is energy-intensive and consumes 25-35% of the initial quantity of hydrogen. The maritime transport of ammonia, a hydrogen derivative, may be a better option. Ammonia liquefies at -33° C, is less prone to leakage, and benefits from existing dedicated infrastructure (loading, unloading, storage) (Enerdata 2022).

Table 1. Development of a hydrogen value chain in Egypt and Morocco

Egypt	Morocco
Renewable energy generation	
* Egypt has 42 operational solar power projects that generate a total 2 GW of energy. Another 21 projects are under some form of development, which will produce 7.5 GW.* * Egypt has 1.6 GW of wind power farms in operation, with new projects under development that will produce another 13.5 GW.** * More solar and wind power projects have been announced.	* Morocco has 9 operational solar power projects that generate a total 0.7 GW of energy. Another 21 projects are under some form of development, which will produce 13.5 GW.* * Morocco has 1.2 GW of wind power farms in operation, with new projects under development that will produce another 4.5 GW.** * More solar and wind power projects have been announced.
Desalination	
* In 2020, as the government expressed its commitment to provide a contribution of USD 2.8 billion to raise its desalination capacity (Schneider, 2022). * Egypt plans to build four desalination plants. Funding comes from the Egyptian government and the Sovereign Fund of Egypt for Investment and Development, and from the EBRD and the International Finance Corporation (IFC) (Zgheib, 2023).	* Presently, the country has nine desalination plants with a capacity of 147 million m^3 of water per year. The 2020-2050 Water National Plan outlines Morocco's plans to increase desalination production to 1 billion m^3 of water by 2030 (Cutrone et al., 2023). * In 2022, the government announced the development of three new seawater desalination projects in El Jadida, Safi and in the Oriental region. Another 20 new seawater desalination plants are required to meet the water target by 2030 (Magnoum, 2023). * A PPP involving the Spanish company Abengoa recently completed a large desalination plant in Agadir, southern Morocco. The USD 346 million desalination plant can produce up to 400,000m^3 of

	desalinated water per day (Gihub, 2019). * A new tender for building a desalination plant near Casablanca has attracted bids from at least six international consortia from various parts of the world (Takouleu, 2022).
Electrolysis	
* Mid 2023, Egypt has built-up a portfolio of 25 Memorunda of Understandings (MoUs) involving foreign companies considering investment in green hydrogen or derivatives. Nine of them aim at feasibility studies. The far majority of the MoUs (18/25) consider projects to be located in the SCZONE, while 10 of the total of MoUs explicitly target at green ammonia exports. Three of the MoUs explicitly focus on local markets of green ammonia (RVO, 2023). The foreign companies involved in the MoUs include, for example, Siemens and Thyssenkrupp (Germany); Eni (Italy); EDF Renewables, Electricite de France, and TotalEnergies (France); DEME Group, FLUXYS, Port of Antwerp (Belgium); Maersk (Denmark); Globaleq (UK/Norway); AMEA (UAE), and Fortescue Future Industries (Australia). The project pipeline involves a total investment of USD 83 billion and, if realized, would produce up to 15 million tonnes of green ammonia and e-methane. However, few of these MoUs or framework agreements have reached the final decision moment (Parkes, 2023). * One of the most widely publicized MoUs concerns the founding of Egypt Green SPV by a consortium involving Scatec (Norway), Orascom Construction (Egypt), and Fertiglobe, an ammonia producer jointly owned by OCI N.V. and Abu Dhabi National Oil Company (ADNOC). Egypt Green SPV is a new green hydrogen plant in the SCZONE near Ain Sokhna, under development since 2021. The facility will have a 100 Megawatt (MW) electrolysis capacity powered by 260 MW of solar and wind energy. This electrolyzer will be able to generate 15,000 tonnes of green hydrogen per year (Takouleu, 2022). The Egypt Green SPV project is in an advanced stage of development. It did already receive permission to obtain renewable energy from existing solar and wind power stations, which is considered to be an exception. The project deal was reportedly pushed through to give the government a “flagship” project up and running by the time the Climate Change conference COP27 in Egypt in 2022 (Fouad, 2022). * In 2022, the EBRD loaned USD 80 million to Egypt	* In 2022, IRESEN and the UM6P completed Morocco’s first micro-pilot (20kW) green hydrogen production system (Anouar, 2022). * The first large scale green hydrogen project in Morocco, *Power-to-X project,* is a collaboration of MASEN, the Moroccan Agency for Sustainable Energy, and the German government and includes the building of a 100 MW renewable energy plant to produce green hydrogen via electrolysis. The start of the plant is scheduled for 2025 (Bozier et al., 2022). * The Hevo Ammonia Maroc project is a project of the Ireland-based company Fusion Fuel Green and Consolidated Contractors Company, an engineering and construction firm based in Greece. The project involves the development of a green ammonia and hydrogen plant using innovative HEVO electrolyzers. The construction started in 2022. Estimated costs are USD 850 million. When fully developed in 2026, the project, representing 600 MW of electrolyzer capacity, can produce 183,000 tonnes of green ammonia (Global Data, 2022). * A Moroccan-German partnership is developing a pilot project to produce 4 tonnes of green ammonia daily. The project partners include the OPC group, the Moroccan SOE in phosphate and fertilizers, IRESEN, Morocco’s UM6P, and the German Fraunhofer institute (Berhabab and Zarkik, 2022; Bozier et al., 2022). * In 2023, an international partnership agreed to establish a 1 MW polymer electrolyte membrane (PEM) electrolyzer system to test and produce green hydrogen. The three parties involved are **Chariot Green Hydrogen, a subsidiary of Africa-focused energy group Chariot, Oort Energy, a UK-based manufacturer of green hydrogen systems, and the UM6P (**Čučuk, 2023). * The French company Total Eren announced in 2022 that it will invest approximately USD 10 billion in a project that will produce green hydrogen and green ammonia in the region of Guelmim-Oued Noun. The hybrid project combines wind and solar

Green Hydrogen S.A.E to develop the country's first green hydrogen facility.	energy, and is to generate more than 10 GW. The plant is expected to be operational by 2027 (Baldessin et al., 2022). * Two Italian companies, the oil and gas services multinational Saipem and Alboran Hydrogen, agreed in 2021 to start joint operations in Morocco, including the construction of five green hydrogen plants that can produce green ammonia (Tanchum, 2023). * **In 2022, t**he Dutch company Proton Ventures **and the** Mohammed VI Polytechnic University **signed an agreement for the turnkey** construction of **a new g**reen **a**mmonia **p**ilot **plant. The unit is located** at the chemical complex **of the Moroccan** OCP Group in Jorf Lasfar **and is meant to serve as a training location for both university and OPC staff and students**. **The unit will have the capacity to produce 1,460 tonnes of** green ammonia per day (Proton Ventures, 2022). * In 2022, the Moroccan renewable energy developer Gaia Energy and the Israeli company H2Pro agreed to partner in the construction of a 10-20 MW green hydrogen project using H2Pro electrolyzer technology. It is a demo project in Morocco, with Gaia Energy exploring the use of the same technology for a giga-scale hydrogen project elsewhere in Morocco (Gaia Energy, 2022). * In 2023, three organizations signed a MoU to develop a green hydrogen and green ammonia plant in Morocco: the Chinese energy engineering company Energy China International Construction Group, the Saudi conglomerate Ajlan Brothers, and Morocco's Gaia Energy. The plant will use both solar and wind energy and has the capacity to produce 1.4 Mt of green ammonia per year. The project, located on a coastal area of southern Morocco, will serve both Moroccan and European markets (Enerdata, 2023). * The Polish company Green Capital is considering developing a large 8 GW green hydrogen project in Dakhla (Rahhou, 2023b).
Storage and export	
* The 'SoutH$_2$ Corridor' is a 3300 km long hydrogen pipeline from North Africa to Germany via Italy and Austria. The pipeline will transport green hydrogen from Egypt, Algeria, and Tunisia to Central Europe. The project, funded by the EU, forms part of the European Hydrogen Backbone. Over 70% of the pipeline consists of repurposed natural gas pipe. When operational by 2030, the pipeline could deliver more than 40% of the REPowerEU hydrogen import target (SoutH$_2$corridor, 2023).	* Presently, no suitable pipeline connection exists for transporting hydrogen from Morocco to Europe. * One option is to connect Morocco to H2Med, one pillar of the intended European hydrogen corridor is under development. H2Med will connect Portugal, Spain, France, and Germany. The network could transport up to 2 million tonnes of green hydrogen per year, amounting to 10% of forecasted European hydrogen demand by 2030

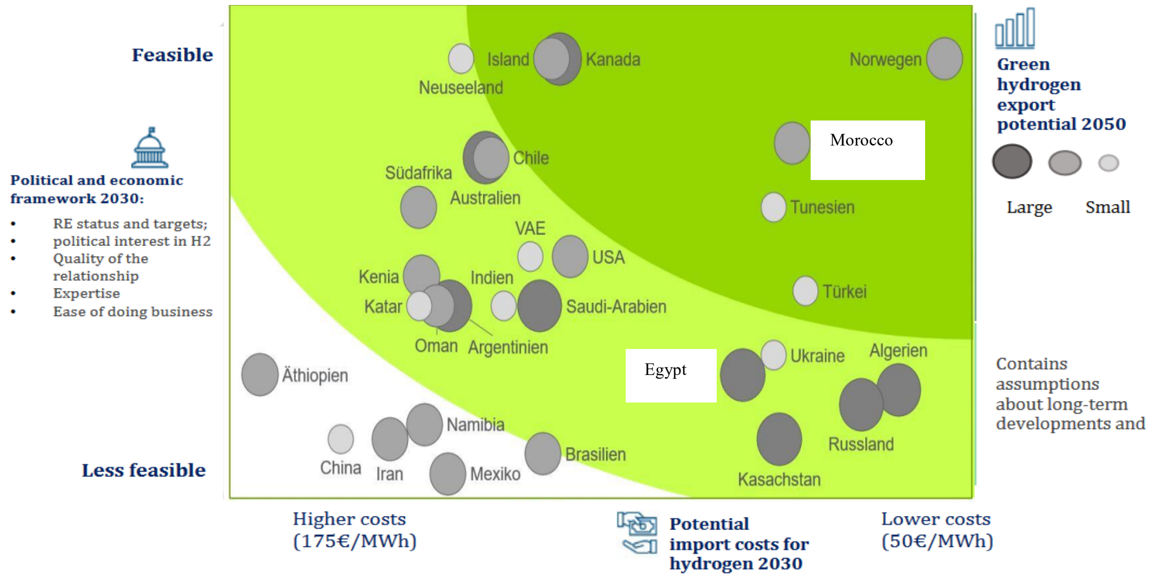
* In 2022 and 2023, Egypt signed two MoUs concerning the production of green fuel for marine bunkering in the SCZONE. The agreements involved Egyptian parties, the Danish shipping line Maersk, and the French Électricité de France (RVO, 2023). In August 2023, a Maersk container ship, the first powered by green methanol, a derivative of green hydrogen, docked in Port Said for its first green bunkering (Takouleu, 2023).	(Habibic 2023). * Morocco could ship liquified green hydrogen to its end markets in Europe and elsewhere. In 2020, the Port of Tangier Med and the Port of Hamburg signed a partnership agreement in anticipation of green hydrogen export to Germany (Ngounou, 2021).

* Source: Global Solar Power Tracker, 2023; ** Source: Global Wind Power Tracker, 2023.

Egypt and Morocco are attractive green hydrogen suppliers for Europe. Both countries possess a solid maritime infrastructure. Egypt is located along one of the world's busiest trade routes and controls the Suez Channel. Hence, Egypt has an excellent position as a producer and supplier of e-methanol, a green hydrogen derivative fuel for maritime bunkering. Morocco, in turn, is in a league of 40 countries hosting the best seaports that can handle international trade (Berahab and Zarkik, 2022).

A recent study comparing a series of green hydrogen exporters rates Egypt and Morocco as having high potential. The comparison is based on two parameters: (a) the import cost (potential production and transport cost) of green hydrogen into Germany by 2030 and (b) the favourability or feasibility of the political and economic framework by 2030 (Figure 1). The study places Morocco in the group of countries having the highest green hydrogen "fitness" by 2030, while it predicts that Egypt will be in the group of countries having the highest green hydrogen potential by 2050. Morocco is likely to have a "good" potential by 2050 (Jensterle et al., 2019).

Figure 1 Green hydrogen potential by 2030 and 2050 per country



Source: Jensterle et al., 2019; RVO, 2023.

Under what scenarios can Egypt and Morocco benefit from moving up the green hydrogen value chain?

The European Green Partnerships with Egypt and Morocco aim at win-win situations: supporting the domestic energy transition *and* securing sufficient green hydrogen supply to the EU. The extent to which this can be accomplished will likely be influenced by the unequal financial contributions of the main stakeholders.

The development of the green hydrogen value chain requires massive investments. According to Morocco's National Roadmap, developing a green hydrogen industry would require an investment of USD 75-100 billion (Bozier et al, 2022). In part, Morocco needs to borrow this capital from international finance institutions - in the case of the Noor Midelt 1 solar power plant, up to 80% - while the rest should come as foreign direct investment (FDI) from foreign companies. Egypt has been receiving funding from the ERDB and signed 25 MoUs in respect of green hydrogen projects with private parties (RVO, 2023). If all projects get a green light, the total investments would be over USD 80 billion (Parkes, 2023). Yet, almost all electrolysis projects in both countries are still in the pipeline awaiting final decisions.

Given the strong dependence on foreign financial flows, Egypt and Morocco face multiple influential foreign stakeholders in the implementation and further development of their hydrogen strategies. The question is how much agency the respective governments have to ensure that the emerging green hydrogen value chain indeed helps the countries decarbonize their industries and provide electricity security to their populations.

The key driver behind the EU green partnerships is the need to find suppliers of low-cost green hydrogen in support of the European energy transition. 'Team Europe' helps governments in Egypt and Morocco develop green hydrogen value chains that are largely foreign-financed, and many of them explicitly target export markets in Europe. To make this hydrogen cooperation truly a win-win, Team Europe should proactively support Morocco and Egypt to realize the benefits. There are a few priority issues in this respect.

Reduction of fossil-fuel imports

One anticipated benefit of the green hydrogen value chain is that it helps Morocco and Egypt replace fossil fuels. In 2021, Morocco spent about USD 9 billion on the import of oil and gas (OEC, 2023). The domestic generation of renewable energy and the production of green hydrogen could reduce imports to the benefit of the country's trade balance. Egypt is Africa's third largest natural gas exporter but imports petroleum. Natural gas is presently its central source of (grey) hydrogen, which is used to produce ammonia and nitrogen-based fertilizers. Egypt would benefit from renewable energy if it leads to a reduction in petroleum imports (RVO, 2023).

Realistic green hydrogen export opportunities
Exporting green hydrogen benefits the trade balance of the North African countries. However, as explained above, the options for transporting green hydrogen to Europe are problematic (Barnard, 2022). Transportation via pipelines is the best option, but these are not yet available. Marine transport of liquified hydrogen requires about two-thirds of the generated energy, while the only pilot with a specialized vessel did not end well. Moreover, closing long-term offtake deals is risky in view of the absence of a green hydrogen market (RVO, 2023). Technological development in hydrogen transportation is dynamic, and newer and better solutions may become available soon. European demand for green hydrogen may also turn into concrete demand by lead energy firms downstream of the value chain. Still, it remains unclear when and how the first green hydrogen from North Africa will land in Europe and who will be the buyer.

The national grid must have the capacity to integrate renewables
Egypt has a large hydrogen industry, but it is produced from natural gas. Since grey hydrogen accounts for 6% of Egypt's total carbon emissions (Habib and Ouki, 2021), switching from grey to green hydrogen seems an obvious priority in decarbonizing the Egyptian industry. However, transmitting the new, renewable energy to the electrolyzers is challenging. Unless the existing hydrogen facilities build their own solar or wind power facilities, they must be connected to the grid. Local industry experts doubt whether the national electricity grid has the capacity or flexibility to transmit the vast quantities of renewable energy that energy-intensive hydrogen production plants require (Fouad, 2022).

Backward linkages: domestic R&D, skills development, and SME involvement
An essential potential benefit of building up a green hydrogen value chain in North African countries is the development of domestic R&D and practical technical skills and the involvement of local Small and medium-sized companies as suppliers. FDI has been associated with knowledge spillovers, where knowledge and technology unintentionally transfer from foreign to domestic firms (Almeida and Kogut, 1997). For such a process to occur, sufficient absorptive capacity must exist among local firms and research centers. Initiatives in this direction in Morocco look promising. The country is building a domestic Green H2 Cluster, a knowledge infrastructure that should help the country become a central hub for renewable energy production. The main actors in the cluster are the Research Institute for Solar and New Energies (IRESEN) and the Mohammed VI Polytechnic University (UM6P). In Egypt, such initiatives have yet to be taken. Egypt used to be the "educational powerhouse" of the Arab world but faces challenges in R&D development. Research efforts have historically depended on state initiatives rather than the private sector, while R&D spending remains behind those of other nations (Dargin, 2023).
At the more practical level, both countries anticipate the creation of practical jobs along the value chain. The Office for Vocational Training and Labour Promotion, the Green H2 Cluster,

and IRESEN agreed to develop specialized vocational training programs in the green hydrogen value chain (Ntungwabona, 2023). In Egypt, the Egyptian German Technical Academy specifically addresses the discrepancy between the skills and competencies needed by the industry and the qualifications of the labor force. The Academy is a facility for vocational and technical training that started in 2019 as a public-private partnership involving industry partners, such as Siemens Energy. One of the Academy's main training areas is on renewable energy technology, where it offers certified training for wind farm professionals (Amin, 2022).

Employing green hydrogen for the national energy transition
Should the cost-effective transportation of green hydrogen become available, the question arises of how much of the green hydrogen generated in Morocco and Egypt can be employed for the greening of the domestic industry. This is not only relevant in the context of the Climate Change agreement obligations of both countries but also in relation to the EU Carbon Border Adjustment Mechanism (CBAM), adopted in August 2023. This import regulation addresses carbon leakage that occurs when EU products are replaced by imported products that are more carbon-intensive. Such replacement would undermine EU climate action efforts. The CBAM puts an emissions tariff on imported goods that have a high risk of carbon leakage because they are produced in countries that are not members of the EU Emissions Trading System (ETS) (European Commission, 2023b).
Egypt and Morocco are not members of the ETS, and their exports to the EU of products manufactured in energy-intensive industries, such as fertilizer and cement, may be at risk. According to an Egyptian expert, the CBAM could lead to a situation where Egypt is helping the EU greening its economy, while the EU raises a barrier to Egypt's exports of grey hydrogen-based products to the EU (Fouad, 2022).
The better option would be to first decarbonize the Egyptian and Moroccan industries via green electricity or green hydrogen. The EU is the biggest trading partner for both countries. Over 55% of Moroccan exports and almost 22% of Egyptian exports went to the EU in 2022 (European Commission, 2023a). Using renewable energy will improve the competitiveness of those industry sectors that focus on European markets (Bozier et al., 2022, EU 2023). For example, the EU relies on agricultural imports from both Morocco and Egypt. If the countries replace their fossil-based fertilizers with locally produced, green ammonia, it could create, in the words of an energy expert, "an excellent win-win opportunity for both exporters and the EU" (Barnard, 2022). Yet, even in this scenario, sufficient renewable energy and funding should remain available to decarbonize all grey-hydrogen plants that produce for non-European or domestic markets. Otherwise, Europe would benefit from green versions of a product, whereas in North African export countries, grey hydrogen industries would continue to release an immense volume of carbon emissions.

Conclusion

The green hydrogen economy is yet to begin. The extent to which Egypt and Morocco can benefit from the EU's intensive search for green hydrogen is therefore shrouded in uncertainty. The potential gains will differ for Egypt and Morocco because of, among other things, their different geographic locations, the level of advancement of green hydrogen strategies, domestic support for these strategies, the business climate, and the political relations they maintain with the EU and the superpowers of the present world. However, Egypt and Morocco share a position among the EU's top candidates for green hydrogen supply. If the EU is committed to turning the green partnerships with both countries into a truly win-win opportunity, it must consider under what conditions they can win. The

European quest for green hydrogen is linked to the wider geopolitical and geoeconomic goal of the EU, namely regaining influence on the African continent. The EU could accomplish its diverse goals by ensuring that the emerging green hydrogen industry indeed supports the green industrialization of Egypt and Morocco. This implies that the European funding and investments help both countries reduce fossil fuel imports, enable the national electricity grid to manage renewable energy, open up opportunities for domestic SMEs and workforce to join the new industry, and promote the greening of those industries that target European markets.

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12- Transitioning to Carbon Neutrality in China's Energy Sector: A Review of Law and Policy Evolution

Authors:
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Transitioning to Carbon Neutrality in China's Energy Sector: A Review of Law and Policy Evolution

Abstract

Amid a global shift in the energy landscape influenced by the pandemic and geopolitical factors, China, currently navigating the initial stage of energy transition, has pledged to peak its carbon emissions by 2030 and achieve carbon neutrality by 2060, introducing a blend of opportunities and challenges. This paper analyzes China's energy transition from two perspectives: policy and legislation. It explores the government's strategies to promote low-carbon energy sources through national and local policies, while acknowledging the challenges in regulatory frameworks and the complexities inherent to such a large-scale energy transition. It also evaluates China's existing energy legal framework, emphasizing the need for a foundational Energy Law, and reviews the efficacy of existing regulations, such as the Renewable Energy Law. The paper culminates in offering recommendations for the enhancement of China's legal and policy frameworks for its energy transition. It underlines the need to expedite a comprehensive Energy Law, refine fossil energy regulations, and strengthen renewable energy legislation.

Keywords

Carbon Neutrality; China; Energy Legislation; Energy Policy; Energy Transition; Fossil Energy; Renewable Energy Law

Chapter I. Energy Transition

The concept of energy transition takes center stage in the global quest for sustainable development. This chapter will provide an understanding of energy revolution, energy decarbonization, and energy transition, showing how they intertwine in the current discourse of sustainability. It will then explore the international laws of energy transition that provide a baseline for countries to shape their domestic legal and policy frameworks. In the final part of this chapter, it presents a snapshot of the current energy situation in China, providing a background against which the country's energy transition can be understood.

1.1 Conceptual Clarification: Energy Revolution, Energy Decarbonization, Energy Transition

Energy revolution, energy decarbonization, and energy transition are three key terms of energy in light of climate change context, each term is pivotal to comprehend both global and national energy landscapes.

Energy revolution, as defined by Smil,[171] refers to radical technological shifts that drastically alter the energy landscape. Such revolutions include the shift from wood to coal during the Industrial Revolution and the present shift towards renewable energy.[172] It's pertinent to note that the pace and scale of these revolutions vary across different countries and regions.[173]

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[171] See Vaclav Smil, *Energy Transitions*: *History*, *Requirements*, *Prospects* (Praeger, 2010).

[172] Ibid.

[173] See Benjamin K. Sovacool and Michael H. Dworkin, *Global Energy Justice* (Cambridge University Press, 2014).

Energy decarbonization, on the other hand, is a strategic approach to decrease the carbon intensity of the energy sector. Decarbonization involves reducing CO_2 emissions per unit of energy or economic output.[174] This strategy has gained traction globally due to the need to mitigate climate change, with many countries adopting decarbonization targets.[175]

Lastly, the term energy transition denotes a broader, structural shift from an energy system dominated by fossil fuels to one centered on renewable energy and enhanced energy efficiency.[176] This shift is influenced by a variety of factors including technological advances, policy changes, and environmental considerations.[177]

While each of these concepts addresses changes in the energy landscape, they differ in scope and emphasis. The energy revolution focuses on technological shifts, energy decarbonization emphasizes carbon reduction, and energy transition encapsulates broader structural changes encompassing not only technology and carbon emissions but also policy and socio-economic aspects. Here provides a summary comparison of these definitions (Table 1). In addition, energy transition acts as an umbrella term that embraces the technological advancements highlighted in energy revolution and the strategic carbon reduction goals of energy decarbonization, it presents a holistic view of the ongoing shifts within global and national energy landscapes, underlining its pivotal role in guiding a sustainable future.[178]

Table 1. Comparison of Definitions

Concept	Emphasis	Scope
Energy Revolution	Technological changes	Varies across countries and regions
Energy Decarbonization	Carbon reduction	Global
Energy Transition	Structural changes (technological, policy, and socio-economic)	Global

1.2 Historical Progress and Influential Factors of Energy Transition

Reviewing the history of energy development, we find that human society has completed two energy transitions.[179] The first, from the late 18th to the mid-19th century, saw a productivity revolution, symbolized by the steam engine, triggering the first industrial revolution,[180] this transition moved us from the era of firewood to the era of coal.[181] The second, from the late 19th to the mid-20th century, came with the invention and proliferation of internal combustion

[174] See Arnulf Grübler and Nebojša Nakićenović, "Decarbonizing the global energy system," 53, 1, *Technological Forecasting and Social Change* (1996), pp. 97-110.
[175] Ibid.
[176] See Arnulf Grübler, *The Rise and Fall of Infrastructures*: *Dynamics of Evolution and Technological Change in Transport* (*Physica-Verlag*, 1990).
[177] See Frank W. Geels, "Technological Transitions as Evolutionary Reconfiguration Processes: A Multi-Level Perspective and A Case-Study," 31, *Research Policy* (2002), pp. 1257-1274.
[178] See Dolf Gielen et al., "World Energy Transitions Outlook: 1.5°C Pathway," International Renewable Energy Agency, 2021.
[179] See Vaclav Smil, *Energy Transitions*: *Global and National Perspectives* (2nd ed.) (Praeger, 2017).
[180] See Kenneth Pomeranz, *The Great Divergence*: *China*, *Europe*, *and the Making of the Modern World Economy* (Princeton University Press, 2000).
[181] See Paul Warde, "Energy Consumption in England and Wales, 1560–2004," 2007.

engines, which gradually positioned oil and gas as the globally dominant resources,[182] marking our shift from the coal era to the oil and gas era.[183] Currently, human society is in the process of moving towards the third energy transition.[184] Many experts and scholars believe that this transition is from fossil fuels to renewable energy,[185] with the aim of promoting the development of renewable energy and increasing its proportion in primary energy[186] and electricity, ultimately achieving a transition from the current fossil fuel system to a green, sustainable renewable energy system.[187] It's worth noting that the previous two energy transitions coincided with industrial revolutions and were spontaneous reforms driven by productivity progress, while the third energy transition stems from concerns about the sustainability of economic growth under energy and environmental constraints.[188] The fundamental driving force for this transition is not only productivity progress but also the resolution of contradictions between economic growth and the increasingly deteriorating environment, climate, and safety issues.[189]

Driven primarily by climate change concerns and the need for energy security,[190] the ongoing third energy transition globally strives for long-term goals encompassing the shift from fossil energy sources to non-fossil ones such as hydropower, wind power, solar energy, and nuclear energy, along with an increase in societal electrification to replace direct coal and oil use.[191] Currently, we are in the early stage of this pivotal transition. In examining the global process, major energy consumers such as the European Union and China are actively exploring their transition pathways. Nevertheless, these pathways exhibit variation, influenced not only by each country's resource endowments[192] but also significantly shaped by their distinct policy landscapes, and legal frameworks.

Distinct from earlier transitions, the present energy shift is primarily steered not by technological advances but strategic decisions towards sustainable development, marking policy, rather than innovation, as its key initiator.[193] An example is the European Union's endeavor to establish an 'Energy Union', which involves harmonizing energy policies and legal

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[182] See Daniel Yergin, *The Prize*: *The Epic Quest for Oil*, *Money* & *Power* (Simon and Schuster, 2011).

[183] See Ying Fan and Bowen Yi, "Evolution, Driving Mechanism, and Pathway of China's Energy Transition," 8, *Management World* (2021), p. 95. [in Chinese]

[184] Ibid.

[185] See Fan and Yi, *supra* note 13, pp. 95-105; Jacobson, Mark Z., and Delucchi, Mark A, "Providing All Global Energy with Wind, Water, and Solar Power," *Energy Policy* (2011).

[186] Primary energy is typically classified into four main categories based on their carbon content, with non-fossil energy leading the list, followed by natural gas, oil, and coal in descending order. See Fan and Yi, *supra* note 13, p. 96.

[187] Qingfan Zhou, "Four Basic Rules for the Energy Transition,", 4, *Energy Outlook* (2018), pp. 35-36. [in Chinese]

[188] See Fan and Yi, *supra* note 13, p. 95.

[189] Ibid.

[190] Angela Wilkinson et al., *World Energy Issue Monitor 2021: Humanising Energy*, World Energy Council, 2021.

[191] Junfeng Li and Qimin Chai, "On the Key Issues and Policy Recommendations for China's Energy Transition," 9, *Environmental Protection* (2016), pp. 16-21. [in Chinese]

[192] See Fan and Yi, *supra* note 13, p. 97. For instance, the author pointed out that European Union countries, exemplified by Germany, are highly conscious of climate change and have limited hydrocarbon resources. This scarcity propels them to expedite the shift away from coal and, to a certain extent, oil, with natural gas acting as a transitional energy source, constrained to a certain extent by resource availability.

[193] See Jianlei Mo et al., "China's Energy and Climate Policy Goals in the Context of the Paris Agreement: An Integrated Assessment and Policy Options," 9, *Economic Research Journal* (2018), pp. 168-181. [in Chinese]

frameworks among member states to promote a competitive, integrated energy market, thereby serving as a testament to the role of policy and legal constructs in fostering energy transition.[194] Despite this, innovation continues to be a vital part of this narrative,[195] particularly in reducing the costs associated with solar PV and wind power technologies.[196] Further, a robust, adaptable market mechanism is key to integrating these innovative technologies and business models, underlining the importance of a well-designed electricity market.[197] Alongside, the transition involves shifts in demand-side energy use behaviors[198], necessitating broad acceptance among consumers towards climate change mitigation and environmental protection, facilitated by innovative policies and business models. In conclusion, the energy transition involves an intricate interplay of policy decisions, legal frameworks, innovation, market mechanisms, and consumer behavior changes, each serving as an integral component driving the path towards a more sustainable future.

Chapter II. Policies Directing China's Energy Transition

2.1 China's Energy and Climate Policies: Carbon Neutrality Goals and Current Policies

As a key player in global climate change response, China, among 52 other nations and the European Union, has set forth significant carbon neutrality goals.[199] Emphasizing the importance of the energy transition and climate change, the Chinese government continues to promote the energy transition process through double-control binding targets of energy intensity and carbon intensity (Table 2). China's President Xi Jinping made a commitment at the United Nations General Assembly in September 2020 to have CO_2 emissions peak before 2030 and achieve carbon neutrality by 2060, signifying a critical transformation in China's environmental and economic policies.[200]

Table 2. Timeline of Key Strategic Objectives in China's Nationwide Energy Transition and

[194] The European Union's robust legal and policy framework supporting energy transition, manifested in its long-term commitment to achieving climate neutrality by 2050. This commitment is anchored in a series of climate and energy strategies, such as the “2020 Climate and Energy Package” (2007), the “2030 Climate & Energy Policy Framework” (2014), the “European Green Deal” (2019), and the “European Climate Law” (2020).

[195] International Renewable Energy Agency (IRENA), “Innovation Priorities to Transform the Energy System,” 2018.

[196] See IRENA, “Future of Solar Photovoltaic: Development, Investment, Technology, Grid Integration and Socio-economic Aspects,” 2019; IRENA, “Future of Wind: Development, Investment, Technology, Grid Integration and Socio-economic Aspects,” 2019.

[197] See Fan and Yi, *supra* note 13; Jochen Markard, “The Next Phrase of the Energy Transition and its Implications for Research and Policy,” 3(8), *Nature Energy* (2018), pp. 628-633.

[198] See Fan and Yi, *supra* note 13; Nadejda Komendantova, “Transferring Awareness into Action: A Meta-analysis of the Behavioral Drivers of Energy Transitions in Germany, Austria, Finland, Morocco, Jordan and Iran,” 71, *Energy Research* & *Social Science* (2021), p.101826.

[199] Organisation for Economic Co-operation and Development (OECD), “Understanding Countries’ Net-Zero Emissions Targets,” COM/ENV/EPOC/IEA/SLT(2021)3, 2021.

[200] See International Energy Agency (IEA), “An Energy Sector Roadmap to Carbon Neutrality in China,” 2022, p. 34. Furthering this commitment, China has outlined enhancements to its Nationally Determined Contributions (NDC) targets for 2030. These enhancements include reducing its CO_2 emissions per unit of GDP by over 65% from the 2005 level, elevating the share of non-fossil fuels in primary energy consumption to about 25%, and increasing the total installed capacity of wind and solar power to over 1200 GW. China is also set on strictly controlling coal-fired power generation projects and capping the increase in coal consumption during the 14th Five-Year Plan (FYP) period (2021-2025), with plans to decrease it in the 15th Five-Year Plan period (2026-2030).

Climate Policies[201]

Date	Policy	Strategic Objectives
Nov 2000	Outline of China's Ecological Environmental Protection	Propose corresponding measures for environmental protection, development of renewable energy
Mar 2006	11th FYP (2006-2010)	Introduce a target to reduce energy intensity - 20% over the period of the plan
Jun 2007	Work Plan on energy conservation and pollutant emissions reductions	Release first national programme on climate change, set out targets and supporting measures for 2010
Dec 2009	UN Climate Conference in Copenhagen	40%-45% reduction in CO2 emissions per unit of GDP by 2020 compared to 2005
Mar 2011	12th FYP (2011-2015)	Set cap on total energy consumption, as well as targets to reduce energy intensity by 16% and carbon intensity by 17%
Jun 2014	Strategic Action Plan for Energy Development (2014-2020)	Total primary energy consumption controlled at 4.8 billion tonnes of standard coal in 2020, with the share of non-fossil energy reaching 15%
Nov 2014	China-US Joint Statement on Climate Change	CO2 emissions to peak by 2030, non-fossil energy to reach 20% of primary energy consumption
Jun 2015	China's National Autonomous Contribution	CO2 emissions per unit of GDP to fall by 60-65% by 2030 compared to 2005
Mar 2016	13th FYP (2016-2020)	Established a new cap on coal consumption, set energy intensity target at 15% and carbon intensity target at 18%
Apr 2017	Energy Supply and Consumption Revolution Strategy (2016-2030)	Total primary energy consumption controlled at 6 billion tonnes of standard coal in 2030 and the share of natural gas in primary energy to reach 15%
Sep 2020	75th Session of the UN General Assembly	Pledge to increase national contribution, adopt stronger policies, strive to peak CO2 emissions by 2030 and work towards carbon neutrality by 2060
Dec 2020	Climate Ambition Summit	By 2030, carbon emissions per unit of GDP will be 65% lower than in 2005, non-fossil energy will account for 25% of primary energy consumption, and the total installed capacity of wind and solar power will exceed 1.2 billion kilowatts
Jun 2021	14th FYP (2021-2025)	Stated a binding target to reduce energy intensity by 13.5%, and a target for reducing carbon intensity by 18%.

This commitment forms an integral part of China's broader development strategy, seen as a catalyst for a transition towards more sustainable, high-quality economic growth that prioritizes environmental protection and enhances public health.[202] The government has thus initiated a "1+N" policy framework to effectively coordinate and execute these carbon neutrality goals, focusing on transformation and innovation in ten strategic areas.[203]

[201] While this table outlines key nationwide policies, it is important to note that China's energy transition and climate response also involve numerous initiatives at regional and sector-specific levels. Several provinces and cities in China have their own local climate plans and targets, and specific initiatives are focused on individual sectors like transportation, manufacturing, and construction. These localized and sector-specific policies, while not explicitly listed here, play a significant role in China's overall strategy to combat climate change and transition towards a sustainable energy future.

[202] See IEA (2022), *supra* note 30, p. 36.

[203] See National Center for Climate Change Strategy and International Cooperation (NCSC), "Xie Zhenhua explained the formulation of a 1+N policy system as a timetable and roadmap for achieving the carbon peak and carbon neutrality goals," 2021, http://www.ncsc.org.cn/xwdt/gnxw/202107/t20210727_851433.shtml (accessed 1 May 2023). [in Chinese]. The "1+N" policy framework focuses on strategic changes in the energy mix, industry

The policy-making process for achieving these goals is implemented at both the national and subnational levels. The National Energy Commission and the Leadership Group on Climate Change, Energy Conservation and Emission Reduction, chaired by the premier, are crucial in coordinating these efforts. They synergize with the National Development and Reform Commission (NDRC), the National Energy Administration, and the Ministry of Ecology and Environment (MEE) to advance these initiatives.[204] Additionally, provincial governments play a key role, tailoring and implementing national policies while also creating initiatives at a provincial level. For instance, certain provinces and cities such as Shanghai, Hainan, Jiangsu, Guangdong, and Beijing have declared their ambitions to achieve peak emissions before the national goal.[205]

The Five-Year Plans guide China's socio-economic development, supplemented by sector-specific and technological plans.[206] They contain detailed targets, action strategies, and some provincial level objectives.[207] Provincial FYPs, crafted within a couple of years following the national FYP release, implement national goals, adapting them to local contexts. Additionally, laws and strategic action plans[208] for specific sectors or themes are developed alongside FYPs, influencing their future iterations.

The current 14th Five-Year Plan period (2021-2025) is crucial in realizing these carbon neutrality ambitions. It presents comprehensive targets to decrease energy intensity by 13.5% and carbon intensity by 18%.[209] This period emphasizes the need for energy market reforms, increased investment in low-carbon energy, and fortified energy security.[210] It also identifies emerging strategic industries such as new energy sources and vehicle technologies and underlines the significant role of energy infrastructure development.[211]

The initiatives underline China's broader vision for sustainable and high-quality economic growth. The coordination and implementation of the carbon neutrality goals are integrated into various strategic areas, from alterations in the energy mix and industrial modernization to low-carbon transport and clean energy technology, demonstrating China's commitment to its ambitious energy and climate goals.

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modernization, resource use efficiency, energy efficiency, low-carbon transport, clean energy technology, green finance, supportive economic policies, carbon pricing mechanisms, and nature-based solutions.

[204] See IEA (2022), *supra* note 30, pp. 43-44.

[205] Ibid. For example, Shanghai and Hainan aim for peak emissions by 2025, Hainan also targets carbon neutrality by 2050. Provinces like Jiangsu and Guangdong have plans to reach peak emissions before the national timeline. Notably, Beijing has already achieved peak emissions due to various regional measures.

[206] See IEA (2022), *supra* note 30, p. 44. The Five-Year Plan is augmented with an extensive array of specific sectoral and technological blueprints, such as the Energy Development Five-Year Plan, the Power Development Five-Year Plan, and the Environmental Protection Five-Year Plan.

[207] Ibid.

[208] Simultaneously with the FYP process, distinct national strategies and action plans are crafted for specific sectors or overarching themes, providing a flexible timeline for implementation. For example, in Table 1, Strategic Action Plan for Energy Development (2014-2020) was a significant long-term strategy that guided China's energy sector in the past, while the current Energy Supply and Consumption Revolution Strategy (2016-2030) is now steering China's energy sector toward sustainable transformation.

[209] State Council, "14th Five-Year Plan (2021-2025) for National Economic and Social Development and the Long-Range Objectives," 2021.

[210] Ibid.

[211] Ibid.

2.2 Current Status of Energy in China and its Challenges

As of 2023, China stands as the world's largest energy consumer and emitter of greenhouse gases.[212] Predominantly, coal continues to be a substantial part of its energy mix, despite the ongoing effort to increase the share of renewables.[213] This ambition is reflected in the robust targets set in China's recent Five-Year Plans, indicating a strategic push towards renewable energy resources.[214] This has been evidenced by substantial investments in diverse renewable energy sources, such as solar, wind, and hydropower.

China's commitment to the green energy transition is not merely in policy but also in practice. While the dominance of coal persists in China's energy mix, there has been significant progress in renewable energy development. In particular, China has emerged as a global powerhouse in renewable energy, boasting the world's highest installed capacities of wind power, solar photovoltaics (PV), and hydropower.[215] Moreover, key regions like the Yangtze River Economic Belt, the Guangdong-Hong Kong-Macao Greater Bay Area, the Yangtze River Delta, and the Yellow River Basin have become the front-runners in promoting green and low-carbon development.[216] These regions, by leveraging their unique local realities, are shaping a new regional landscape for energy transition in China.

Despite these impressive strides, there exist noteworthy challenges that must be navigated in the pursuit of a green energy future. Grid integration remains a technical obstacle, as the national grid must be adapted to handle increasingly diverse energy sources.[217] Similarly, energy storage, a crucial element for the reliable supply of renewable energy, requires further advancement.[218] Coordination across different policy domains is needed to ensure synergistic efforts towards achieving China's ambitious renewable energy targets.

In 2021 and 2022, China experienced a number of severe energy shortages,[219] since then, maintaining national energy security has become a priority and China has temporarily had to reverse its established policy of severely limiting coal consumption in order to address blackouts, resulting in an increase in both coal production and consumption in China.[220] Such short-term energy security measures are not conducive to China's climate action and energy transition goals, but China remains committed and reaffirmed its commitment to carbon

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[212] Xavier Chen et al., “Decoding China's Energy Transition,” *Peking University's Institute of Energy*, 2023.

[213] Ibid.

[214] The 14th Five-Year plan, covering the years 2021 to 2025, was officially endorsed by the National People’s Congress (NPC) on 11 March 2021, it sets a goal for 50 percent of China’s incremental energy consumption to come from renewables.

[215] See Xavier Chen et al., *supra* note 42.

[216] See Zhongying Wang et al., "China Energy Transformation Outlook 2023: Special Report for COP27,” Energy Research Institute of China Academy of Macroeconomic Research, 2022.

[217] Ibid.

[218] Ibid.

[219] The factors contributing to the shortages were multiple, including reduced operating incentives for coal-fired power plants due to restrictions on generation hours and low electricity prices, coal shortages, limited hydroelectric power generation due to extreme drought, and specific policies. See Xinhua, “China to control, phase down coal consumption in next decade: Xi,” 22 April 2021, at www.xinhuanet.com/english/2021-04/22/c_139899306.htm (accessed 8 May 2023).

[220] Corina Bolintineanu et al., “Energy Transition in China and Germany,” German Energy Agency (DENA), 2022, pp. 18-19.

reduction targets at the 20th National People's Congress of the Communist Party of China and at the UN Climate Change Conference (COP27). In order to move away from fossil fuels as soon as possible, China needs to advance its energy transition and do its utmost to remove all obstacles to the further expansion and integration of renewable energy.[221]

2.3 New Opportunities and Challenges for China's Legal System for New Energy Use in the Context of the Belt and Road Initiative

The Belt and Road Initiative (BRI)[222] is a significant component of China's global energy strategy. Among its wide array of objectives, the BRI notably includes fostering high-quality energy development and strengthening international energy cooperation.[223]

By facilitating cross-border cooperation and large-scale infrastructure projects, the BRI has enriched China's energy diplomacy and fostered cooperative relations with an increasing number of countries and regions.[224] One of the significant achievements under the BRI is the establishment of the Belt and Road Energy Partnership, which currently encompasses 33 member countries and serves as an international platform for promoting energy cooperation.[225] Successful projects such as the Kalot Hydropower Plant in the China-Pakistan Economic Corridor exemplify the BRI's potential. This project, as the first large-scale hydropower initiative constructed by China along the BRI, supplies 3.2 billion kWh of clean energy annually to Pakistan, effectively addressing local electricity issues.[226]

The BRI presents substantial opportunities for energy trade through the interconnection of electric power grids and can promote the development of efficient low-carbon energy technologies necessary for decarbonizing economies and combating climate change.[227] However, it also introduces significant challenges to China's legal system for new energy use. Harmonizing standards for building cross-border transport connections, such as railways, is a considerable challenge.[228] The development of institutions that improve cross-regional coordination and address gaps in areas like cooperative planning and implementation processes is another significant hurdle.[229] Addressing these discrepancies calls for substantial diplomatic effort and international coordination. The geopolitical challenges related to local interests and potential conflicts also present notable risks.

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221 Ibid.

222 In 2013, China's President Xi Jinping announced the inception of the Belt and Road Initiative (BRI) during a speech at Nazarbayev University in Astana, Kazakhstan. This initiative proposed the creation of an 'economic belt' following the path of the historic Silk Road, it intended to foster economic and infrastructure connectivity throughout Asia and beyond, marked a significant shift in China's international policy.

223 See Shao-zhou Qi et al., "Energy Intensity Convergence in Belt and Road Initiative (BRI) Countries: What Role does China-BRI Trade Play?," 239, *Journal of Cleaner Production* (2019), p. 118022.

224 China Energy News, Officials from the National Energy Administration talk about the cooperation results of the BRI Initiative, 4 July 2023, at https://obor.nea.gov.cn/detail2/19394.html (accessed 4 July 2023), [in Chinese].

225 Ibid.

226 Ibid.

227 See Peter Wolff, "China's 'Belt and Road' Initiative – Challenges and Opportunities," German Development Institute, 2016.

228 Ibid.

229 Ibid. Case in point is the Hambantota Port in Sri Lanka, developed with Chinese investment. Despite its intended role as a hub for oil tankers, the port has encountered financial difficulties and has been leased toa Chinese company for 99 years, raising concerns about China's strategic interests in the region.

In conclusion, the Belt and Road Initiative has significantly influenced China's energy transition by providing new opportunities while also posing considerable challenges. To effectively exploit these opportunities and navigate the challenges, China needs to enhance its legal and regulatory frameworks, cultivate international cooperation, and proactively address financial and geopolitical challenges. The interplay between the BRI and China's domestic energy and legal landscapes will undeniably play a crucial role in China's ongoing pursuit of energy transition.

Chapter III. Legal Framework for Energy Transition in China

3.1 Overview of China's Energy Legal Framework

Integral to China's broader climate legislation system, the energy legal framework sustains the development and refinement of legal and regulatory measures to address climate change and achieve carbon peaking and carbon neutrality.

The energy legislation framework is characterized by its dual vertical and horizontal structure. In the vertical dimension, it expands from laws promulgated by the National People's Congress to the administrative regulations, departmental and local rules, along with normative documents from various entities. Each layer addresses a unique aspect of energy regulation, weaving them together into a unified regulatory environment. In the horizontal dimension, the existing energy law system in China is still awaiting a comprehensive Energy Law that could serve as a foundational document.[230] The current energy law system comprises discrete laws, mainly in two areas: energy conservation and emission reduction, exemplified by the Energy Conservation Law and the Cleaner Production Promotion Law, and renewable energy, represented by the Renewable Energy Law and the Coal Law. Notably, the energy legislation linked with China's goals of peak carbon emissions and carbon neutrality encompasses the Energy Law (Draft for Public Comments), the Coal Law, the Electricity Law, the Renewable Energy Law, relevant ancillary regulations and rules, along with local regulations.

In the fossil fuels field, there exist specific laws for traditional energy sources, including the Coal Law and the proposed Oil and Natural Gas Law. These laws fundamentally aim for “decarbonization,” “carbon constraints,” and “decarbonization,” with “clean substitution” posited as the fundamental strategy for reducing carbon and emissions in traditional fossil fuel production. The Coal Law endeavors to exploit and conserve coal resources judiciously, to regulate coal production and commercial activities, and to foster and safeguard the coal industry's growth. Since the 1980s, legislative work on the Oil and Natural Gas Law has been underway, but it has not yet been enacted. Current legislation pertaining to oil and gas primarily consists of the Oil and Natural Gas Pipeline Protection Law[231] and a series of lower-tier rules and regulations[232].[233]

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[230] In April 2020, the National Energy Administration (NEA) initiated discussions on the Energy Law (Draft for Public Comments), with the final legislation expected to be adopted and promulgated soon.

[231] The primary objective of the Oil and Natural Gas Pipeline Protection Law is the preservation of oil and natural gas pipelines, ensuring the secure transmission of oil and gas while safeguarding national energy security and public safety.

[232] For example, Regulations for the Supervision of Fair Access to Oil and Gas Pipeline Facilities, with the aim to encourage the secure and stable supply of oil and gas, protecting the rights of oil and gas pipeline facility operators and users.

[233] See Chuntao Yang, “Research on the Innovation of Low Carbon Energy Legal System in China under the Dual-Carbon Goal,” 2, *Social Sciences in Guangxi* (2023), p.22. [in Chinese]

In the renewable energy sector, as per the Renewable Energy Law established in 2005, renewable energy in China predominantly encompasses wind, hydro, geothermal, solar, and biomass energy, excluding direct-burn energy sources like straw and livestock manure. Centered on the Renewable Energy Law and supplemented by central and local policy documents, China's renewable energy legal framework provides a legal foundation for the development, utilization, and supervision of renewable energy. At the central level, new energy policies are jointly issued by multiple departments, predominantly by the National Development and Reform Commission and the NEA, which primarily draw on the Renewable Energy Law.[234] These regulations have not yet formed a comprehensive legal system promoting new energy utilization. At the local level, regulations specific to each administrative region have been formulated to implement central provisions, including two main types: one that interprets central policy documents and puts forth specific implementation plans, and another that introduces administrative rules based on the regional context.[235]

3.2 Issues and Obstacles

From the review of the energy law system above, it is evident that there is a gap between the current energy law system in China and the requirements needed to achieve the carbon peaking and carbon neutrality goals. The energy legislation and corresponding legal systems are still imperfect, facing issues like incomplete laws and regulations, and internal inconsistencies.

Firstly, from a structural design perspective, the basic energy law lacks comprehensive planning. the Energy Law, has been under development since 1981 but is yet to be enacted.[236] As the foundational and comprehensive law in the energy field, the Energy Law should address overarching issues in energy management and holistic issues not suitable for regulation by individual energy laws. However, this draft Energy Law does not specify institutional designs linked to the realization of dual carbon goals.[237]

Secondly, within the fossil energy sector, although the Coal Law pays attention to environmental protection,[238] there are no explicit institutional provisions on “decarbonization,”

[234] If other sectors are involved, the corresponding departments will jointly formulate them. For example, the “Offshore Wind Power Development and Construction Management Measures” were jointly created by the National Energy Administration and the State Oceanic Administration.

[235] See Wenge Zeng and Tingyu Ren, “On the Legal System Guarantee of Promoting China’s New Energy Utilization under the Dual-Carbon Goal,” 5, *Yuejiang Academic Journal* (2022), pp. 43-44. [in Chines]

[236] China began drafting its basic energy law in 1981. Despite nearly four decades of effort, and the National Energy Administration issuing the Energy Law (Draft for Public Comments) in April 2020, the Energy Law has yet to be enacted.

[237] See Chuntao Yang, *supra* note 63, pp. 21-22. It lacks provisions for mechanisms crucial to realizing the dual carbon goals, such as “renewable energy power quota system,” “green power certificates,” “thermal power phase-out mechanism,” and “green finance”.

[238] For example, Art. 11 principally stipulates that coal resource development and utilization should comply with relevant environmental protection laws and regulations to protect the ecological environment; Art. 19 stipulates that coal mine construction projects' environmental protection facilities must comply with the “three simultaneous” system; Art. 15 stipulates that the entities responsible for formulating and implementing national and regional coal production development planning are the State Council's coal management department and the provincial (autonomous regions, municipalities) people's government coal management department. Art. 29 (1) stipulates the content of state development and promotion of clean coal technology; Art. 43 (1) stipulates that the coal quality supplied to users by coal mine enterprises and coal business enterprises should meet national or industry standards.

"clean substitution," "carbon emission tax," and "exit mechanisms for coal production and operation entities."[239]

Thirdly, regarding renewable energy, despite a large number of laws and norms promoting the development of new energy industries, the legislative framework remains fragmented with weak enforceability, lacking focus on the unique technological attributes of different types of renewable energy.[240] There is a dearth of local legislation addressing the uneven geographical distribution of renewable energy resources, impeding the creation of local regulations tailored to specific regional conditions.[241] In addition, the Renewable Energy Law is rather generalized and principle-oriented, lacking the operative strength necessary for effective implementation.[242] Despite an array of supporting policies, the system lacks robustness as critical regulatory standards are yet to be established.[243] Furthermore, there is low coordination between the Renewable Energy Law and other legal regulations, signifying a need for harmonization to ensure sustainable development.[244]

Chapter IV. Conclusion

From the policy perspective, this paper delves into China's ambitious energy transition goals and how they are integrated within the broader development strategy. It analyzes China's energy and climate policies, including the considerable challenges the nation faces as it transitions toward renewable energy resources. Simultaneously, the potential of the Belt and Road Initiative to influence China's energy landscape is considered, with both its opportunities and significant challenges considered. This initiative is seen as a key component that may shape the pace and nature of China's energy transition.

From the legal framework lens, this paper provides a broad understanding of China's energy legislation, which primarily focuses on two domains: energy conservation and emission reduction, and renewable energy. It is evident, however, that certain areas require further attention and development, including the need for a comprehensive Energy Law, regulatory

[239] See Chuntao Yang, *supra* note 63, p. 22.

[240] See Xuejun Tang and Xiaoxia Chen, "A Study on the Law and Policy of Renewable Energy in China," 19, 5, *Journal of Southwest Petroleum University* (*Social Sciences Edition*) (2017), pp. 13-14. [in Chinese]. A key omission in China's Renewable Energy Law is the lack of differentiation between technologies used in solar versus wind energy. The effectiveness of departmental regulations for renewable energy development, such as those for wind, biomass, geothermal, and solar energy, is limited.

[241] In China, resource disparities across regions, such as the abundance of hydro resources in the southwest and solar resources in the Qinghai-Tibet Plateau, underscore the necessity for region-specific renewable energy legislation. In addition, despite some provinces having implemented specific regulations for renewable energy development, the overall renewable energy legislation in China remains underdeveloped.

[242] The Renewable Energy Law, although flexible, provides significant discretionary space for enforcement bodies, making it heavily reliant on associated administrative regulations and rules. For example, it wasn't until the National Development and Reform Commission issued the Regulations on Renewable Energy Power Generation Management in 2006 that detailed provisions on grid-connected renewable energy generation were established.

[243] Although there are over 20 policy standards and implementation rules related to the Renewable Energy Law, certain key policy standards, such as regulations for hydroelectric systems, are still absent.

[244] See Tang and Chen, *supra* note 70, pp. 14-15. There are discrepancies between the Renewable Energy Law and other legal regulations, such as the Electricity Law. For instance, while the latter stipulates that only entities with legal personality can apply for grid-connected power generation, the Renewable Energy Law does not impose such a requirement. Also, The Renewable Energy Law does not adequately address environmental issues associated with the utilization of renewable energy sources, such as biomass energy. For instance, while the Solid Waste Environmental Pollution Prevention Law and its subsidiary regulations have detailed provisions for waste recycling, the Renewable Energy Law does not cover pollution issues caused by solid waste during renewable energy utilization.

shortcomings around fossil energy sources, and a fragmented and somewhat weak legislative framework for renewable energy. China's energy law system still has shortcomings. It is hoped that these can be improved soon, providing legal assurance for increasing energy supply, regulating the energy market, optimizing the energy structure, and safeguarding energy security.

Based on these findings, I propose a series of recommendations. First, China should prioritize the enhancement of its legal and regulatory frameworks for the energy transition, potentially drawing lessons from the experiences of other regions such as the EU, which is a pioneer of climate and energy policy and legislation. The drafting and enactment of a comprehensive Energy Law should be expedited, providing a structured and well-planned guide for the transition. This foundational document should prominently incorporate the dual carbon goals. Regarding fossil energy sources, it is suggested that existing legislation, like the Coal Law, should be revised to include explicit institutional provisions on “decarbonization,” “clean substitution,” “carbon emission tax,” and “exit mechanisms for coal production and operation entities.” Further, the proposed Oil and Natural Gas Law should be enacted with priority. In the context of renewable energy, it is vital to establish more comprehensive laws and norms to boost the development of new energy industries. This includes enforcing laws that cater to the unique technological attributes of different types of renewable energy and introducing solid regulatory standards. Efforts to enhance local legislation, addressing the uneven geographical distribution of renewable energy resources, should be considered. A better harmonization between the Renewable Energy Law and other legal regulations is crucial for sustainable development. Lastly, China should proactively address the potential challenges and opportunities presented by the Belt and Road Initiative. Strengthening international cooperation and strategically managing financial and geopolitical challenges could play a vital role in this process.

While China's commitment to carbon neutrality is impressive, and its shift towards renewable energy sources has shown significant progress, extensive legal and policy efforts are still required to realize these ambitious goals. By refining its legal framework continually, China can facilitate an effective energy transition that meets its national objectives and contributes to global efforts to mitigate climate change.

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16- China-led BRI investment in the Green Energy in Brazil and its geopolitical and geo-economic challenges

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Project title	China-led BRI investment in the Green Energy in Brazil and its geopolitical and geo-economic challenges **Keywords** 1. Energy transition, 2. Green industry, 3. Geopolitical economy, 4. China, 5. Brazil
Research question and subquestions	**Main research question** In how far does China's investments in the renewable energy sectors in Brazil, and biofuels in particular, contribute to Brazil's energy transition? **Subquestions** 1. What are China's overall policy ttrategy towards Brazil? 2. What are the opportunities and challenges of China's BRI economic activities in the Brazilian energy sector in general and biofuels in particular? 3. What are the domestic and geopolitical economic challenges of China's involvement in Brazil?
Abstract and context	Brazil is a global leader of renewable energy,particularly on biofuel sector. In the last decade, Brazil has become the world's largest recipient of Chinese energy investments. The country can attract even more investment with the launching of the International Green Development Coalition of the Belt and Route Initiative (BRI), which aims to deepen China's international cooperation on issues related to sustainable development. The usage of ethanol in Brazil has a long history, beginning in the middle of the 1970s with the Proálcool program, a set of state policies to turn ethanol and biodiesel into viable energy sources. Then, the production of flex cars—vehicles that can run on both gasoline and ethanol—was actively promoted. Unlike other countries, including China, where automotive manufacturers engage in the development of new electric models to decarbonize the fleet, the fuel used in the fleet of light vehicles in Brazil is already heavily renewable. Biofuels account for 40% of the energy used in the transportation sector. The key question of the this proposed research paper are twofolds: 1. is in how far China's trade investments and finance in Brazil's renewable energy sectors contribute to the energy transition?, and 2. what are the domestic and geopolitical economic challenges of China's involvement in Brazil? **Reseach methodology** **The following issues need to emphesize) involved Chinese corporation in rniewable energy sectors, Biofule secor (trade-investment-finance), politics behind China's involvement in Brzil (diplomacy with focus on 2000-up to now). The role of Brazil in China's global strategy (transnationalization of Chinese economy/BRI and the role of Brazil)** …

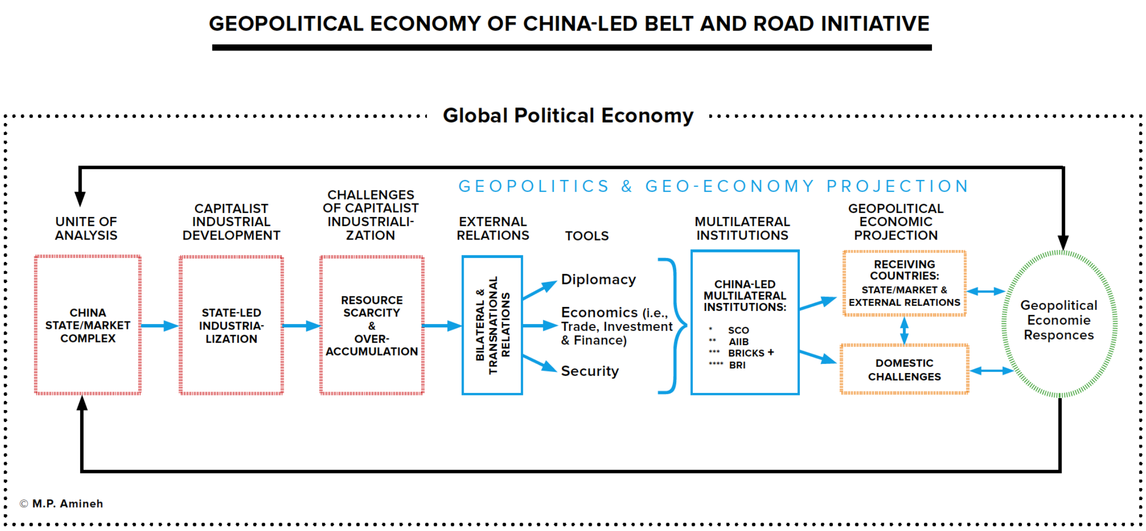
Participants	**Mehdi Amineh** *Theoretical and conceptual framework of China's activities in South America's Green Energy Sectors* **Anna** *China's foreign relations towards Brazil* **Williams…** *China's trade, investment and investments finance in Brazil's Energy Sectors in general and the biofuel industry -* *Domestic impacts and responses* **Rafael Abrão, Anna and Mehdi Amineh** *Geopolitical and geoeconomic impacts of China's acctivities in Brazil's energy sectors* **Mehdi** *Trend*
Set-up and Methodology	The methodology used in this research is based on mixed methods (i.e., qualitative and quantitative) and semi-structural interviews. The interviews tap into time-bound and partly personal points of view. These data will be compared against the ongoing data trends noted above. Qualitative data is gathered from primary and secondary sources in the selected case countries. Economic data has been gathered from the following institutes for trade, investment, and finance: *Trade* data from UNComtrade and IMFdata provide import/export data desegregated by countries of origin/destination. This data serves to (1) analyse the evolution of China's trade with the observed regional (i.e., Central and Eastern Europe) and national actors (e.g., Poland and Hungary), and (2) identify China's place in their trade relations in comparison to other major trade partners. Data from UNComtrade and Atlas of Economic Complexity provide import/export data desegregated per commodity types. This data serves to determine the nature of trade interdependencies of the observed actors with China. *Investment* data is gathered from the following databases that complement each other to complete the investment analysis: - The "China Global Investment Tracker" from the American Enterprise institute (AEI) gathers China's overseas investment and construction combined since 2005. - The "Global Power Database" from Boston University tracks global power plants outside of China financed by Chinese foreign direct investment (FDI) and/or China's policy banks. - The "China Overseas Finance Inventory Database" from the World Resource Institute which consolidates nine different source databases to include the transaction details of 584 investments in 509 power plants. The database is a collaboration between the Boston University Global Development Policy Center, the Inter-American Dialogue, the China-Africa Research Initiative at Johns Hopkins University and World Resources Institute.

- The “Reconnecting Asia Project Database” from the Center for Strategic and International Studies tracks seven types of infrastructure projects – power plants, roads, rails, ports, intermodal, transmission, and pipelines – active across Eurasia since 2006.
- The website of the Ministry of Commerce of the People's Republic of China (MOFCOM) provides further details about specific projects. While all investments will be included in the analysis, a special attention will be given to the energy and infrastructure sectors.

These datasets will serve to (1) show the evolution of Chinese investments in the region and each country, (2) determine the share of Chinese investments in comparison to other major investor countries, (3) find in which sectors of which countries Chinese companies invest most, and (4) determine which Chinese companies invest in which countries and sectors, and how they are related to one another.

Finance data is gathered using two sources. The first source is Aiddata “Chinese development finance dataset” and will serve two purposes. First, to understand which countries, sectors, and projects China decides to provide finance. Second, to highlight the connectivity between Chinese financial institutions, host countries, and sectors. The second source is the World Bank “International Debt Statistics” dataset and will serve to analyse each country’s debt level to China.

Theoretical Framework



NOTES
* **SCO:** SHANGHAI COOPERATION ORGANIZATION: The full members are China, India, Iran, Kazakhstan, Pakistan, Russia, Tajikistan and Uzbekistan
** **AIIB:** ASIAN INFRASTRUTURE INVESTMENT BANK
*** **BRICS +**: BRICS - BRAZIL, RUSSIA, INDIA, CHINA, SOUTH-AFRICA + FROM 2024 EGYPT, ETHEOPIA, IRAN, SAUDI-ARABIA AND UNITED ARAB EMIRATIS
**** **BRI:** BELT & ROAD INITIATIVE

17- Understanding the Localization of External Climate Change Governance Norms in China

Author:

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Understanding the Localization of External Climate Change Governance Norms in China

It is widely agreed that the rise in climate action in China has strongly been influenced by developments at the international level. However, it is also hard to conclude that China has fully adopted those external climate governance norms. Rather than the clear-cut dichotomous resistance or adoption that most of the existing norm diffusion literature predicted, China reinterpreted and adapted most of these norms and localized them. However, existing literature on China's localization of those norms remains inconclusive. We still know very little about how Western ideas on climate change governance contest with the domestic norms of China and how China as a norm-taker seeks to solve the contestation and build the congruence between existing domestic norms and external norms. Based on the norm localization and norm contestation literature, this research project aims to provide a better understanding of the localization process of external climate change norms within the Chinese context.