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The Great Significance and Broad Prospects of China-CEEC Renewable Energy Cooperation

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Abstract

Since the adoption of the Paris Climate Agreement in 2015, China and the EU have undertaken progressive collaboration on energy transition and environmental protection, with commitments to become carbon neutral by 2060 and 2050, respectively. However, due to the sudden outbreak of the pandemic, the ongoing military conflict between Russia and Ukraine, and the intensifying US-China strategic competition, China and the EU, particularly Central and Eastern European countries, face enormous challenges in making the energy transition and achieving their set climate goals. How China and CEE countries achieve their energy transition and climate goals in the midst of an economic downturn and an energy security crisis will put their national governance capabilities, as well as the resilience and flexibility of policy formulation and implementation, to the ultimate test.

For governments in CEE nations, curbing inflation, restoring the economy, and ensuring energy security are currently pressing matters. Therefore, energy cooperation, particularly renewable energy cooperation, should be prioritized in the China-CEEC cooperation framework in the short and medium term. Against this backdrop, this paper aims to identify the current state and challenges of energy transition in China and the EU, as well as to investigate how China and CEE countries can leverage the China-EU Energy Cooperation Platform and the energy and climate policies of China and the EU to expand and deepen their renewable energy cooperation under the 16+1 cooperation framework.

Key Words: *China-CEEC, Renewable Energy Cooperation, Great Significance, Broad Prospects, Energy and Climate Policies.*

Introduction

Climate cooperation has been instrumental in the development of China-EU relations and the strengthening of Europe's leadership in global climate governance. Climate change cooperation between China and the European Union (EU) dates back to 2005, when the two parties issued the "Joint Declaration on Climate Change", formally establishing a climate change partnership focused on the development and deployment of clean energy technology (European Commission, 2005). The establishment of a ministerial dialogue mechanism in 2010 has further deepened the China-EU climate change partnership. China and the EU issued the “China-EU Joint Statement on Climate Change” and the “China-EU Leaders' Statement on Climate Change and Clean Energy” in 2015 and 2018, respectively, which has effectively promoted the institutionalization of global climate governance (European Commission, 2015; European Commission 2018). Following the United States' withdrawal from the Paris Agreement, China and the EU have made concrete commitments to jointly implement the agreement, and expanded cooperation in areas such as greenhouse gas emissions, carbon emissions trading, clean energy, low-carbon cities, and climate change technology.

To demonstrate their firm resolve and stand on climate change, China and the EU have undertaken progressive collaboration on energy transition and environmental protection, with commitments to become carbon neutral by 2060 and 2050, respectively. The EU and its member states have committed to achieving a binding target of at least a 55% reduction in domestic greenhouse gas emissions by 2030 from 1990 levels (European Commission, 2020). In December 2019, the European Green Deal was introduced, to transform the EU into a modern, resource-efficient, and competitive economy, as well as achieving climate neutrality and net zero greenhouse gas emissions by 2050 (European Commission, 2019). In response to the global energy market disruption, the European Commission unveiled the REPowerEU Plan, intending to transform Europe's energy system by ending the EU's reliance on Russian fossil fuels and addressing the climate crisis (European Commission, 2022).

As for China, since the start of the 12th Five-Year Plan period (2011-2015), carbon intensity reduction has been included as a binding target in China's plans for national economic and social development, with identified key tasks, priority areas, and major

projects (The State Council Information Office of the People's Republic of China, 2021). On September 22, 2020, Chinese President Xi Jinping stated in a video address to the 75th session of the United Nations General Assembly that China aims to peak its carbon dioxide emissions by 2030 and become carbon neutral by 2060 (Xia, 2022). The "14th Five-Year Plan for National Economic and Social Development in China Through the Year 2035" established a legally binding goal of reducing carbon intensity by 18% between 2020 and 2025 (The State Council Information Office of the People's Republic of China, 2021). In September 2021, President Xi announced that China would increase assistance to other developing nations in the development of clean, low-carbon energy and would not construct any new coal-fired power projects abroad (The State Council Information Office of the People's Republic of China, 2021).

The sudden pandemic outbreak, the ongoing military conflict between Russia and Ukraine, and the escalating strategic rivalry between the US and China present China and the EU, especially the CEE countries, with enormous challenges in implementing the energy transition and meeting their stated climate goals. Their national governance capacities, as well as the resilience and flexibility of policy formulation and implementation, have been put to the ultimate test by how China and CEE countries would accomplish their energy transition and climate goals amid an economic downturn and an energy security crisis. Against this backdrop, this paper aims to identify the current state and challenges of renewable energy transition in China and the EU, CEECs in particular, and investigate how to leverage the China-EU Energy Cooperation Platform and China's and EU's energy and climate policies to expand and deepen renewable energy cooperation between China and CEE countries under the 16+1 cooperation.

Current State and Challenges of Energy Transition in China and the EU

In response to the accelerating pace of global climate change, the disruption of the current energy market, and the shifting geopolitical landscape, China and the EU, which share similar energy consumption patterns, have been actively speeding up the energy revolution and transformation. China and the EU's climate change and energy transition policies have been continuously strengthened and improved, with significant progress made

in adjusting the energy structure and lowering carbon emissions. China and the EU aim to increase the share of renewable energy in total energy consumption to 25% and 45%, respectively, by 2030. Meanwhile, both China and the EU face common energy transition challenges, such as the relative scarcity of fossil fuels and the necessity to import energy from politically unstable countries and regions, particularly natural gas, which plays a crucial role in the energy transition.

Only by reducing reliance on fossil fuels and accelerating the development of renewable energy can energy independence and decarbonization be achieved. Yet, the drastic change in the energy sector causes a shortage of energy supply with rising energy and electricity prices, which, when combined with the conflict between Russia and Ukraine, places a significant burden on people's lives and business operations. Hence, how to develop renewable energy to ensure energy stability and meet carbon reduction targets without jeopardizing energy security or economic growth has become an insurmountable challenge for both.

Major Challenges of Energy Transition in China

In 2021, China's installed renewable energy capacity has exceeded 1.1 billion kW, with hydropower, wind power, solar power, and biomass power installed capacity ranking first in the world. However, China and India have contributed to more than 70% of the increase in coal demand in 2021, with China's energy consumption increasing 7.1 percent year on year, accounting for 26.5 percent of global energy consumption (BP Statistical Review of World Energy, 2022). Despite accounting for 40% of China's GDP, industry consumes 73% of the country's total energy usage. Accordingly, for China's energy transition to succeed, multiple challenges such as energy structure and security, energy efficiency and technology, carbon reduction, and economic growth must be identified and addressed.

Energy Structure and Security

Based on the resource endowment of rich coal and insufficient oil and gas, China still relies heavily on coal for its energy supply, which accounts for 56.8% of total energy consumption in 2020, followed by oil (18.9%), non-fossil fuels (15.9%), and natural gas (8.4%) (Wu, 2022). Coal-fired power generation accounts for the vast majority of China's

electricity generation, with solar and wind accounting for less than 10% of the total. The fall of 2021 saw the worst power outages in a long time, which highlighted the necessity of ensuring a stable energy supply and elevated energy security to a top priority for 2022 (Huld, 2022). According to the China Commerce Industry Research Institute database (2022), China's crude oil imports in 2021 totaled $257,331.2 million, up 44.2% year on year. China's high reliance on crude oil and gas imports makes the country's energy supply more vulnerable to geopolitical conflicts. For instance, trade relations between China and Australia have deteriorated in recent years, with Chinese trade sanctions against Australia exacerbating a shortage of coal in China. Subsequently, China has turned to Indonesia for coal supplies, making the country China's largest coal importer. Nevertheless, early in the year, Indonesia banned coal exports from January 2022 because of concerns about domestic electricity shortages (Christina, 2022). In addition, the Russia-Ukraine conflict led some nations to burn more coal and buy non-Russian gas, which disrupted the energy supply, drove up energy prices, and contributed to global inflation, all of which posed serious threats to China's security of supply energy.

In terms of renewable energy, due to the uneven distribution of renewable resources in China, there are significant differences in the consumption of renewable energy in Eastern, Western, Northern, and Southern provinces and regions. According to the National Energy Administration's evaluation report, renewables accounted for approximately 80% of the mix of electricity consumed in three western inland provinces as of 2021, compared to less than 20% in most east-coastal provinces (Yin &Yep, 2022). The reliability and security of cross-provincial and cross-regional power trading and distribution networks for renewable energy have been hampered by the imbalance of supply and demand between regions, the unstable nature of wind power and photovoltaic power generation, and provincial protectionism. Incorporating increasing percentages of renewable energy sources into the power grid, as well as balancing real-time discrepancies between electricity demand and supply to ensure grid stability, also entails a significant challenge (Xie, 2022).

Energy Efficiency and Technology

Although China is the world's largest producer and exporter of solar panels, wind turbines, batteries, and electric vehicles, and holds nearly a third of the world's renewable

energy patents, China still has relatively low energy efficiency and conservation when compared to developed countries. The intensity of energy efficiency is 1.5 times higher than the global average and 2.3 times higher than that of developed countries. In terms of industrial structure and energy consumption, the secondary industry consumes a significant amount of energy, particularly several high-energy-consuming industries such as manufacturing, construction, transportation, and other sectors. As a major energy consumer and carbon emitter, the improvement of energy efficiency will play an important role in achieving China's "dual carbon" goal. Therefore, the “14th Five-Year Plan” outline calls for a "more rational allocation of energy resources and a substantial increase in utilization efficiency" (The State Council Information Office of the People’s Republic of China, 2020). Given China's abundance of coal-based energy resources, utilizing coal efficiently while also saving coal and replacing coal in an orderly fashion are all necessary steps toward achieving carbon neutrality.

Achieving carbon neutrality also requires breakthroughs in low-carbon innovation, energy storage, methane reduction, carbon capture and storage (CCS), and carbon capture, utilization, and storage (CCUS) technologies. Despite China's leadership in some green energy technologies, real-time supply and demand balance, as well as safe and stable operation, remain technical challenges for wind and photovoltaic power system planning, design, and operation. Energy storage will be critical to China's green transition, which will require a cutting-edge energy-storage system and hydrogen fuel cell technology to address the challenge of volatile renewable power generation and to support the growth of the domestic and overseas EV markets. Moreover, as renewable power generation, energy storage, hydrogen energy, electric vehicles, and other technologies develop and expand, the operation of energy systems will become even more complex and challenging, necessitating energy system transformation and upgrading.

Carbon Reduction and Economic Growth

Based on established ecological goals and strategic energy security considerations, China needs to increase the share of renewable energy in its electricity consumption to reduce its reliance on energy imports from unstable regions and ease geopolitical tensions (Chiu, 2022). Yet, the ongoing Covid-19 pandemic, the 2021 power shortage event, the current

global energy crisis, and the increasingly complex geopolitical environment have forced China to avoid taking a drastic transition to renewable energy. Given China's recent significant slowdown in economic growth, which has resulted in lower fiscal revenue and higher fiscal expenditure, maintaining economic stability and ensuring domestic energy security have thus become top priorities in the short term. The most pressing issue for China at the moment has become how to efficiently execute the domestic-international dual circulation strategy while maintaining economic and financial stability in the midst of geopolitical upheaval and a Sino-US trade and technology war.

China's economic growth has been accompanied by rising energy demand, making it difficult for the country to strike a balance between economic stability and energy transition under the “dual carbon” target. Despite the pandemic slowing China's economic growth from 6% in 2019 to 2.3% in 2020, China's overall energy consumption increased by 2.2% in 2020 compared to 2019 (National Bureau of Statistics, 2021). In addition, the low-carbon transition also requires significant financial and human capital investment from both the public and private sectors. With the strengthening of carbon reduction laws and regulations, many emitters in high-carbon industries may face closure and increased operating costs, increasing financial pressure and financial risks for enterprises. When regulations mandated the removal of coal and the reduction of carbon emissions, as well as the closure of some coal-burning power plants and boilers, high energy-consuming enterprises had to either undertake costly coal conversion or simply shut down their operations. Therefore, while pursuing carbon reduction targets, aggressive energy policies and actions should be avoided to ensure economic and social stability during the energy transition.

Major Challenges of Energy Transition in the EU

The EU's policies on climate change and energy transition have effectively adjusted the EU's energy structure and made remarkable achievements in carbon emission reduction. Nonetheless, the radical energy transition has also led to a shortage of energy supply, coupled with an economic downturn and the conflict between Russia and Ukraine, which has resulted in soaring electricity prices and severe inflation, posing a greater challenge to the EU's long-term energy transition. More importantly, without addressing energy security, improving

energy efficiency, and increasing investment in low-carbon technologies, together with reducing the energy policy gap between the EU and its member states, meeting climate targets and achieving a sustainable energy transition would be hard to accomplish.

Energy Security

Europe currently faces two major energy challenges: energy insecurity and climate change (Noffsinger et al., 2022). Europe's energy supply is heavily reliant on imported fuels, particularly gas from Russia, Norway, Qatar, and North African countries, with annual energy import costs amounting to two percent of global GDP (Hafner & Raimondi, 2020). Oil and gas account for the majority of the energy consumed in the EU, and as of 2022, the Ukraine crisis has exacerbated surging oil and gas prices, further threatening supply security and driving inflation to record levels (Enerdata, 2022). This risk is even more worrying for some Member States if the energy supply is disrupted due to a lack of strategic infrastructure, particularly in Central and Eastern Europe (Sartor et al., 2014). Following Russia's military attack on Ukraine, in addition to importing more than 90% of its gas, the EU received more than two-fifths of it from Russia, the European Commission further revealed in March that Russia supplied 46% of the EU's coal imports and 27% of its oil imports (Krecke, 2022). Like China, the EU countries' energy security risks stem primarily from their reliance on imported fossil fuels, the rising cost of which is caused by the deterioration of geopolitics in energy exporting countries, exacerbating their energy vulnerability and energy transition.

Despite efforts to diversify their energy supply to reduce their reliance on Russian energy, EU countries continue to rely heavily on fossil fuels, of which natural gas will become a part of their energy mix and play an important role in the energy transition. The EU has been in contact with "relevant" partners, most recently Azerbaijan, as well as other potential third parties including Qatar, Algeria, Egypt, Korea, Japan, Nigeria, Israel, Turkey, Norway, and the United States (Krecke, 2022). Meanwhile, EU member states have been exploring for alternate energy sources throughout the world to replenish their strategic energy reserves and secure their energy supply. Some EU nations have partnered with African producers of fossil fuels, even though these collaborations may result in new issues with pollution, exploitation, and political unrest in the partner nations (Krecke, 2022). On the other hand, exploring new sources of natural gas imports inevitably also involves high natural gas

transport and infrastructure costs, and the risk associated with volatility in natural gas prices.

Energy Finance and Technology

According to the McKinsey & Company report (2021), Europe would need to spend approximately 28 trillion euros over the next 30 years to achieve climate neutrality by 2050. Between 2021 and 2050, Europe will need to invest $3.8 trillion in new power generation projects, primarily wind and solar, and an additional $1.5 trillion in green hydrogen advancement (Masterson, 2022). The EU has identified three pillars—renewable energy sources, energy efficiency, and greenhouse gas (GHG) reduction—to help the EU reach carbon neutrality (Hafner & Raimondi, 2020). The European Commission also suggested raising the energy efficiency target from 9% to 13% and reducing EU gas consumption by 30% by 2030, with energy efficiency accounting for one-third of the savings (Balkan Green Energy News, 2022). Nuclear energy, a stable and dependable source of clean, low-carbon energy, is crucial to the energy transition because it not only increases the efficiency and security of the transition's costs but also tracks and manages the systematic costs associated with intermittent renewable energy production. Yet, even though EU countries intend to replace declining coal power generation with increased gas and nuclear power, the European Investment Bank's revised lending policy excludes funding for new nuclear infrastructure (Amon, Popp & Heilmann, 2020).

The REPowerEU Plan calls for an additional 210 billion euros in investments to scale and accelerate the development of renewable energy, with 113 billion for renewables and hydrogen infrastructure, 56 billion for energy efficiency and heat pumps, and 37 billion to increase biomethane production (European Commission, 2022). Nevertheless, because of the energy crisis, high inflation, and the European Central Bank's aggressive interest rates, European countries face an economic slowdown and the risk of recession. When it comes to public investment in energy-related technologies, the majority of funds have gone to integrated flexible energy systems and renewable fuels, with almost no EU R&I investment in CCS technologies, decarbonizing industrial processes, or improving energy efficiency in buildings (Zachmann et al., 2019). The EU has thus lagged behind other major players in the global energy industry in terms of investments in energy storage, low-carbon technologies, and decarbonization.

The Energy Policy Gap between the EU and the Member States

The European Commission has stepped up its efforts to ramp up the green energy transition, intending to increase the share of renewables from 40% to 45% by 2030. However, because of the EU's diverse socioeconomic environments, each member state prioritizes the fight against climate change differently, making agreements on the policies to be implemented difficult (Institut Montaigne, 2021). Each EU member state plays a critical role in achieving the EU's energy transition, which necessitates the political commitment and will of member states; and yet, differences between member states (North and South, West and East) due to multiple and competing interests may impede the realization of Europe's energy transition (Hafner & Raimondi, 2020). Some EU countries are markedly divided on stringent energy policies and measures to cut carbon emissions and impose carbon tariffs due to the different energy compositions and renewable energy potential of member states. The differing attitudes of EU member states to the pace of decarbonization could also stymie Europe's efforts to tackle carbon emissions while also jeopardizing its energy security (Morningstar et al., 2020).

While the proportion of Russian gas in EU gas demand has decreased from 40% in 2021 to 9% in 2022, gas continues to play a significant role in the industry, power generation, and space heating in CEE countries (Beyer & Molnar, 2022). As the conflict between Russia and Ukraine intensifies, Central and Eastern Europe experience substantial macroeconomic shocks, including negative growth and higher inflation rates. In contrast to Slovakia, Hungary, and the Czech Republic, which are heavily reliant on Russian gas and lack alternative energy sources, Baltic states such as Poland and Lithuania can obtain alternative fossil fuels through pipelines or liquefied natural gas from the Middle East, the United States, and Norway. Consequently, other landlocked EU countries, aside from Austria, such as the Czech Republic, Hungary, Slovakia, and Romania, have not disclosed any plans or deadlines for transitioning away from Russian gas (Beyer & Molnar, 2022). Additionally, finance for renewable energy projects and green technology remains inadequate in CEE nations. When it comes to renewable energy, despite having enormous potential, countries in Central and Eastern Europe lack funding sources and projects for the production of hydrogen with low emissions or biomethane (Beyer & Molnar, 2022).

Renewable Energy Cooperation between China and CEE Countries

Because of their reliance on imported fossil fuels, China and Europe, CEE countries, in particular, are more susceptible to global energy market volatility and energy security risks resulting from geopolitical tensions and conflicts. Given the ongoing threat of conflict on their eastern borders, rising inflation, and energy and refugee crises, CEE countries face enormous challenges in emerging from economic recession, achieving energy transformation, and meeting climate targets. The energy crisis caused by the conflict between Russia and Ukraine has severely impeded China and Europe's efforts to transition to green energy, forcing them to temporarily revert to a higher reliance on coal. Accelerating renewable energy development and striving to achieve relative energy independence while ensuring short-term energy security and long-term emission reductions have become shared interests and goals for China and CEE countries.

The EU has long been committed to making clean energy a core industry with an aim to accelerate the energy transformation and economic recovery in European countries. Despite the EU's strong support for member countries' transition to green energy, implementing common energy policies among CEE countries proves challenging due to their substantial differences in natural resource endowment, economic development, and energy consumption mix. For this reason, the 16+1 cooperation framework for renewable energy cooperation between China and CEECs should not only adhere to member states' national energy strategies and EU energy laws and regulations, but should also take into account their national conditions and carry out targeted renewable energy projects among CEE countries.

Based on the challenges that China and CEE countries face, three areas for cooperation under the 16+1 framework are proposed to address energy security, economic stagflation, and low-carbon transition: renewable energy, green finance, and talent and technology exchanges.

Renewable Energy

China and the EU, which share similar energy consumption patterns, have long sought to achieve energy transition and decarbonization by reducing their reliance on fossil fuels, promoting renewable energy and widespread electrification, increasing their energy efficiency, and utilizing carbon removal technologies. Since 1994, China and the EU have held an

annual energy dialogue at the ministerial level to advance the transition to clean energy, focusing on four main areas: energy efficiency, renewable energy, design and transformation of energy systems and global energy markets, and the role of innovative energy actors (European Commission, 2022). The focus of the exchange at the 2022 Energy Dialogue was on policies and practices to speed up the green energy transition, among other issues of common concern, including energy security, the transition to renewable energy, and power market reform (European Commission, 2022). Despite recent setbacks in China-EU relations, both sides have maintained energy cooperation and dialogue, as well as significant investments in renewable energy. According to the International Energy Agency's World Energy Investment Report (2022, p. 12), China invested the most in clean energy in 2021, with USD 380 billion, followed by the European Union and the United States, with USD 260 billion and USD 215 billion, respectively. While China's FDI in Europe (EU-27 and the UK) has continued its multi-year decline, falling from 47.4 billion euros in 2016 to 10.6 billion euros in 2021, Chinese greenfield investment in EV batteries in Europe has reached 3.3 billion euros in 2021, accounting for nearly a third of all Chinese FDI (the Rhodium Group and MERICS 2022).

In terms of cooperation between China and CEE countries, energy dialogue and cooperation is an important component of the 16+1 cooperation framework. During the Suzhou Summit in 2015, leaders of China and CEE Countries issued the Suzhou Outline for Cooperation between China and CEE Countries, which proposed the establishment of the Center for Dialogue and Cooperation on Energy Projects between China and CEE Countries, namely, “16+1” Energy Center (Belt and Road Energy Cooperation, 2019). In 2017, the “16+1” Energy Center hosted the China-CEEC Energy Expo and Forum, which resulted in the adoption of the Ministerial Statement on China-CEEC Joint Research on Energy Cooperation and the White Paper on China-CEEC Energy Cooperation (Belt and Road Energy Cooperation, 2019). A number of energy cooperation projects have been implemented by China and CEE countries, with wind and solar power being two examples of low-carbon energy that will play a significant role in the expansion of China-CEEC energy cooperation. Until 2021, 15 projects worth more than 2.9 billion euros have been completed successfully in the CEE region, and some recently proposed projects appear to have great potential (Zakić

& Šekarić, 2021, p. 22). Based on the findings of Zakic and Šekaric's analysis report (2021, p.24), China has shown an increasing interest in green energy in CEE countries and has so far achieved the greatest success for the investments made, which is also largely consistent with European energy policies.

Under the Fit for 55 packages, the European Commission suggests raising the overall 2030 renewable energy target from 40% to 45%, which includes doubling solar photovoltaic capacity by 2025 and ramping up the installation of 600GW by 2030 (European Commission, 2022). China currently accounts for 50% of the world's manufacturing capacity for wind turbines, 66% of that for solar modules, and 88% of that for battery storage, according to data from Wood Mackenzie (Evans, 2022). As two major producers and consumers of wind and photovoltaic energy, electric vehicles and batteries, Chinese and European companies can cooperate in renewable energy investment in CEE countries. Through bilateral cooperation on renewable energy, CEE countries can not only create new jobs, train renewable energy technical personnel, and contribute to economic recovery and transformation, but also achieve energy transition and carbon reduction targets at national and EU levels. For instance, Amperex Technology Co., Limited (CATL), a lithium-ion battery development and manufacturing leader, has revealed plans to invest 7.34 billion euros in the construction of a 100 GWh battery plant in Debrecen, Hungary. This investment will not only create over 9,000 new jobs, but will also help CATL better serve European customers like Mercedes-Benz and BMW, as well as advance the growth of electric vehicles in Europe and the energy transformation of the European nations. Hence, in conjunction with the China-EU energy cooperation platform, renewable energy could play an essential role in future cooperation between China and CEE countries for both to achieve carbon neutrality and recover from pandemic and global energy crises.

Green Finance

To compare and harmonize terminology usage in the field of green finance and develop a common green finance system, the European Investment Bank (EIB) and China Society for Finance and Banking (GFC) published a white paper on green finance in 2017 (Von Rottenburg, 2021). In 2021, the International Platform on Sustainable Finance (IPSF)

unveiled the "EU-China Common Ground Taxonomy - Climate Change Mitigation (CGT)", which represents a watershed moment in global collaboration on sustainable finance and will be critical for harmonizing and standardizing taxonomies around the world (Gong & Merle, 2021). This year, the Bank of China Frankfurt Branch issued US $500 million of green bonds based on the Common Ground Taxonomy to raise funds for green projects in China, Germany, the Netherlands, and other countries (Crédit Agricole CIB, 2022). Bank of China's Hungarian branch recently completed the international issuance of a US $300 million, two-year green bond, the first green bond issued by a Chinese-funded financial institution in Central and Eastern Europe, for sustainable projects such as photovoltaic power generation and sewage treatment (National Development and Reform Commission, 2022).

Many CEE countries prioritize green economy development and promote energy structure transformation, such as Hungary's National Energy Strategy 2030, Poland's Energy Policy until 2040, the Czech Republic's Industry 4.0, and Croatia's National Development Strategy 2030. Nonetheless, there is a growing gap between Europe's stated climate targets and actual climate investment. According to the most recent impact assessment from the European Commission, annual investments in the EU energy system would need to increase from an average of 1.3% of GDP over the previous ten years to 3.7% of GDP annually for European funding for climate change mitigation (EIB, 2021, p.1). Although the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD) have made green loans to CEE countries, these loans have primarily gone to a few countries, including Poland, the Czech Republic, and Hungary, because their green finance policies are more developed than those of other CEE countries. Provided that some CEE countries' share of consumption of renewable energy is still significantly below the EU's 2030 target, accelerating the energy transition will require significant investments in renewable energy. To this end, having Chinese financial institutions and investment funds that can provide alternative green financing for renewable energy projects in the CEE region would be not only beneficial but also essential.

Cooperation between China and CEE countries in energy conservation, emission reduction, clean energy, and ecological protection has yielded fruitful results over the last five years, which has not only facilitated the energy transformation of CEE countries but also

enabled China and CEE countries to achieve more sustainable economic development and reach carbon reduction goals. Based on the green energy projects in which Chinese firms have invested, nine of the 14 green projects have been completed successfully (Zakić & Šekarić, 2021, p. 18). Investment and acquisition of photovoltaic power stations and wind farms by the China-CEE Investment Cooperation Fund, construction of the Ulog hydropower plant in Bosnia and Herzegovina, investment in a lithium battery production base in Hungary, and import and export of electric buses and new energy electric vehicles, among other energy projects, have showed the vast opportunities and broad prospects for renewable energy between China and CEE countries.

Given the enormous potential of renewable resources in CEE countries, such as onshore and offshore wind power in Poland, hydropower in Romania, and solar energy in Hungary and the Balkans, China and EU countries should strengthen their green finance cooperation to channel private capital flows toward greener and more sustainable energy projects. China and CEE countries should not only leverage the green funds, bonds, and loans under China-EU energy cooperation, but also the China-CEE Fund, China-Europe Belt and Road Industrial Fund, Silk Road Fund, and Asian Infrastructure Investment Bank, as well as EU funds such as the Just Transition Fund and the EU Modernization Fund, to finance projects on energy transmission infrastructure, renewable energy projects, grid connectivity, energy storage, and efficiency. The EU, CEE countries, and China should also work together to incentivize private investment in renewable energy projects and technologies for carbon reduction and capture, hydrogen, water treatment, and e-waste management by utilizing public funds and speeding up approval processes.

Talent and Technology Exchange

China has conducted extensive exchanges and cooperation with European countries in the fields of energy security, energy infrastructure construction, and energy technology innovation. In a joint statement issued in Beijing in 2018, the leaders of China and the EU emphasized the importance of continuing their yearly energy dialogue to advance energy cooperation and the transition to clean energy. The EU-China Energy Cooperation Platform was established at the 8th China-EU Energy Dialogue in Brussels in 2019 to facilitate the

implementation of activities outlined in the “Joint Statement on the Implementation of EU-China Energy Cooperation” (EU-China Energy Cooperation Platform, 2019). China and CEE countries can leverage the China-EU Energy Cooperation Platform and the China-CEE Energy Cooperation Forum to identify priority areas for energy cooperation under the 16+1 framework through talent and technology exchanges, sub-national energy cooperation, and best practices sharing in the energy transition. Through these platforms, forums, and exchanges, EU regions can learn from their Chinese counterparts about how to turn innovative ideas into market opportunities, while China should learn from its European partners about how to engage stakeholders, particularly businesses, in the innovative process rather than relying on national ministries of science, technology, and innovation (Hassink et al., 2020, p. 89).

European companies have developed substantial experience in advanced technologies in renewable energy, energy storage, and smart energy, whereas China has comparative advantages in industrial manufacturing, ultra-high voltage transmission, and smart grid technologies. Considering their respective advantages, Chinese and European energy institutions and businesses should strengthen personnel exchanges and collaborate more on technological innovation and incubation, as well as renewables technology transfer. At the first China-CEEC Innovation Cooperation Conference held in Nanjing in November 2016, the Nanjing Declaration on China-CEEC Innovation Cooperation was issued and the China-CEEC (Virtual) Technology Transfer Center was inaugurated (China-CEEC Technology Transfer Center, 2022). According to Han, Jiang, and Hong's (2022, p.111) dynamics factor analysis that aims to assess the potential of scientific and technological talents exchange between China and CEECs and its dynamic trends from 2010 to 2019, Greece, Hungary, Slovenia, Serbia, and Poland perform relatively well, mainly attributed to their economic and trade exchanges, particularly the increasingly close trade in services, and the growing popularity of educational interaction. Thus, China and CEECs should expand bilateral trade in services, particularly in renewable energy, and deepen their educational cooperation, both of which would better facilitate the exchange of talents and technologies between China and CEE countries.

Furthermore, university collaboration in renewable energy should be highlighted in

energy cooperation between China and CEE countries, particularly in the fields of energy efficiency, low-carbon transportation, energy storage, hydrogen energy, e-waste management, re-electrification, and digitalization. As shown by the EU-China Regional Innovation Joint Study, successful collaboration between the EU and China has frequently taken place when university representatives are involved (Hassink et al., 2020, p. 90). Ningbo, China's first demonstration zone for economic and trade cooperation between China and CEECs, serves as an example by promoting economic and trade cooperation through educational exchanges. Ningbo has established cooperative partnerships with nearly 90 universities across CEE region, making positive contributions to the bilateral economic and trade exchanges and people-to-people exchanges between China and CEE countries. Likewise, more Chinese provinces and cities should be encouraged to engage in personnel and technology exchanges with CEE counterparts through trade in services and educational collaboration, capitalizing on their respective advantages in renewable energy, such as scientific research capability, industrial manufacturing capacity, logistics and supply chain, human and financial capital, geographical location, and consumer market, among others.

Conclusion

As global climate partners and practitioners, China and the EU have maintained close cooperation on climate change and energy transition since the signing of the Paris Agreement. However, the economic slowdown caused by the Covid-19 outbreak, as well as the global energy crisis and high inflation as a result of the Russia-Ukraine conflict, shifting geopolitics, and intense power competition, have all hampered their economic and trade cooperation and energy transformation. In the energy transition, China and the EU, especially the CEE countries, share similar energy consumption structures and rely heavily on foreign fossil energy imports; as a result, both parties are easily exposed to energy security risks due to external energy market fluctuations and internal energy transitions. In addition, China confronts difficulties in energy efficiency and balancing carbon reduction targets with economic stability, whilst the EU faces challenges in green energy financing and green technology advancements, as well as coordinating energy policies between the EU and member states.

In view of the aforementioned challenges faced by China and European nations, three areas of energy collaboration under the 16+1 China-CEEC cooperation framework are proposed: renewable energy cooperation, green financing, and talent and technology exchanges. Compared with cooperation in other fields, renewable energy cooperation between China and CEE countries has been generally welcomed and supported by the EU and its member states, which can not only help EU member states achieve economic and energy transformation but also strengthen the international discourse of the EU in global governance. The energy sector under 16+1 benefits from Chinese investment, with green energy development having the greatest potential, and it is in line with China and the EU's energy policies, as well as CEE countries' internal strategic positioning for green development (Zakić & Šekarić, 2021, p. 24). Given the substantial investment required for renewable energy infrastructure, green financing and public-private partnerships from Chinese financial institutions and businesses under the China-EU Energy Cooperation Platform and the 16+1 China-CEEC Energy Center are crucially important for CEECs to successfully phase out coal and fossil fuel-based energy consumption. Furthermore, China and CEE countries should expand trade in services and promote personnel and technology exchanges. Through talent and technology exchanges, both sides can better collaborate and coordinate policies on climate change and energy transition, share best practices, and achieve breakthroughs in carbon reduction, carbon capture, and other alternative fuel technologies.

To further improve energy cooperation between China and CEECs, CEE governments should better coordinate their energy transition policies with the EU and remove licensing and permission barriers to accelerate investment and construction of renewable energy projects. China should make targeted investments in renewable energy in CEE countries, taking into account their specific political, economic, cultural, and ethnic characteristics, as well as their green energy resource endowments. Meanwhile, to alleviate concerns that the EU may become overly reliant on China in the energy transition, Chinese and European investors and businesses should be encouraged to collaborate and invest jointly in renewable energy projects in CEE region, such as electric buses and vehicles, renewable-related technologies, and energy infrastructure and power grids. Since transportation is one of the primary sources of emissions in the EU, effective transportation solutions are critical to

meeting carbon reduction targets, and both parties can collaborate more closely on hydrogen storage systems, smart charging, and railway electrification. Lastly, given Africa's untapped renewable energy potential, China and Europe can collaborate in renewable energy projects in Africa, including joint investment, construction, technology transfer, and capacity building, among others, to empower African countries in their energy transition while opening up more green energy routes to diversify energy imports and strengthen Europe's energy security.

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