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Research Article

Renewable energy in EU-China relations: Policy interdependence and its geopolitical implications

Thomas Sattich^{a,*}, Duncan Freeman^b, Daniel Scholten^c, Shaohua Yan^d

^a University of Stavanger, Norway

^b College of Europe, Belgium

^c Delft University of Technology, Netherlands

^d Fudan University, China



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ABSTRACT

The geopolitical implications of renewable energy involve changes beyond the immediate impact on energy and commodity streams. Energy policies of individual countries affect each other via different economic and political channels. This paper studies the role of renewable energy in EU-China relations, two leading powers in the field of renewable energy. Both polities have recently increased their individual ambitions towards decarbonisation of their domestic energy systems, and renewables play an increasingly important role in shaping their bilateral dealings. We therefore ask what influence renewable energy has on the relationship between both sides. To capture the effect, we employ the concept of policy interdependence in four areas related to renewable energy namely climate, energy, industry, and trade and investment policy. While these are often seen as separate fields, they are all related to renewable energy. Findings indicate that renewable energy has the potential to be a determinant of bilateral relations. Renewable energy contributed to greater alignment between the EU and China in the past, while increasing recourse to policy choices based on national priorities today creates obstacles to further cooperation. However, the patterns of policy interdependence identified in this study also suggest potential for renewed cooperation in the field of energy policy, depending on the capability of policymakers to see beyond the current structure of the bilateral relationship.

1. Introduction

Scholars in the field of renewable energy (RE) largely agree that the transition to renewables is a source of international influence (Oberthür and Dupont, 2021, pp. 10–12) and capable of reconfiguring countries' external energy relations (Adelphi, 2020). Several expectations about the likely geopolitical implications of this transition have been raised (Scholten, 2018), and different future scenarios exist (Goldthau et al., 2019). By and large, the central focal points in these studies are changing trade flows and shifting dependencies as energy carriers replace energy sources and new materials are necessary in the production of energy generation and storage technologies. In addition, much emphasis goes to industrial competition on the one hand and the effects of stranded fossil assets on the other.

The geopolitical implications of renewable energy, however, also involve changes beyond the immediate impact on energy and commodity streams. Energy policies of individual countries affect each other via different economic and political channels as well. Renewable energy targets and climate commitments in one country may spur similar efforts in others (or a backlash) while they hardly share any physical energy or commodity trade. The more physical and/or territorial lens of the geopolitics of renewable energy literature hence only captures part of the issue.

In order to contribute to the discussion, this paper analyses the role of renewable energy in EU-China relations,¹ two front-runners in the race to a low-carbon energy transition² (Espa, 2018). Linked together in a complex trade relationship, a Comprehensive Strategic Partnership and many formal sector-specific agreements and dialogues, assertions of

* Corresponding author. Department of Media and Social Science, 4036 Stavanger, Postboks 8600 Forus, Norway.

E-mail address: thomas.sattich@uis.no (T. Sattich).

¹ In view of the significantly stronger role of EU energy policy as compared to the time before the Treaty of Lisbon, we focus on the EU as a bloc.

² In particular, this concerns the electricity sector where the EU and China already outpace other polities with regards to the deployment of RE capacity (EEA, 2018).

the prospects for peaceful political cooperation between the EU and China are commonplace (Christiansen et al., 2019). However, economic frictions and diverging perspectives on issues such as market access for trade and investment can also be observed, and the political relationship in the year 2021 is partly characterized by disagreement (Politico, 2021). In other words, the line that separates the Comprehensive Strategic Partnership between the EU and China (European Commission, 2003; Ministry of Foreign Affairs, 2003) from what has been termed competition and systemic rivalry (European Commission, 2019b), is relatively thin.

In this context, renewable energy represents an increasingly important factor. Both parties have developed ambitious policies such as the EU's 2030 package (European Commission, 2020a) or China's plans to achieve structural changes in their domestic energy systems (NDRG, 2016a; NDRG, 2016b; NDRG, 2016c). What is more, both sides have recently stepped up their ambitions in the field of sustainability, with close to full decarbonisation now being a goal for the EU (by 2050; (European Union, 2019a) as well as China (by 2060; Euractive, 2020). Accordingly, the relationship between the EU and China is increasingly marked by issues directly related to the renewable energy sector and both adverse and positive effects of renewables on the bilateral relations seem equally likely (Adelphi, 2020).

To understand the role of RE in the bilateral dealings between the EU and China, and thereby the geopolitical role of renewables per se, this paper utilizes the concept of policy interdependence. On this theoretical basis, we ask whether renewable energy brings the EU and China closer together or whether it has become a factor of dispute between the two sides. In order to provide answers to this question, we analyse policy interdependence in four distinct policy areas, as these are the potential areas of cooperation and counteraction: climate policy, energy policy, industrial policy, and international trade and investment policy.

In section 2 we introduce the literature on the geopolitics of renewables and highlight its neglect of policy interdependence as an important focal point. To guide the analysis towards capturing the effect of renewables on EU-China relations, section 3 delineates the concept of policy interdependence from various angles. Section 4 contains the materials and methods used in the study. Section 5 presents our findings. Section 6 discusses the results of our study and provides an outlook on the likely future impact of renewables on the trajectory of EU-China relations, while section 7 provides conclusions and policy recommendations.

2. The geopolitics of renewables literature, the notion of territory, and EU-China relations

Around the globe, numerous countries have adopted measures to exploit the potential of renewable energy. However, in the respective academic literature the implications of RE for international relations have only recently come into the focus of scholarly research (Scholten and Bosman, 2016). Since then, numerous studies have discussed the geopolitical implications of RE (Vakulchuk et al., 2020). However, globally, the deployment of RE is still relatively low (BP, 2018), which makes it difficult to clearly identify international or 'geopolitical' implications.³ Furthermore, according to our observation, large parts of the new geopolitics of renewables literature adhere to the logic of territoriality ((Bridge et al., 2018, pp. 109–112), that is the relationship between territory and energy (Ibd. p. 109), e.g. flows of energy (as well as other resources such as rare earths) and the geography of socio-technical

³ In addition to this gap, the neighbouring field of transition studies is characterized by what (Fuenfschilling and Binz 2018, p. 737) call 'implicit methodological nationalism' – the overemphasis of domestic versus systemic factors in explaining outcomes (Chaudoin et al., 2015, p. 275), or, in other words, the neglect of international politics as a factor that co-determines political processes (Simmons and Elkins, 2004, p. 171).

energy systems. In particular, numerous studies assess the effect of renewable energy on the integration of electricity grids at various levels, from bilateral (Escribano, 2019) to global (Brinkerink et al., 2019). In this type of literature, the geographical and technical characteristics of energy systems are expected to represent major factors in shaping the economic interdependencies underlying the political relations between two or more states in the context of a 'grid community' (Scholten and Bosman, 2016; Högselius, 2019). By having an impact on the grid infrastructure (more integration or less integration), renewables are expected to have a geopolitical effect. By and large, this logic is similar to the geopolitics of oil and gas.

A territorial lens is, however, not suited to understand the whole spectrum of the geopolitical implications of RE. The relationship between the EU and China is, first and foremost marked by the vast geographical distance between the two. Notwithstanding this absence of territory as a factor, the political relationship between the two powers is of an order-shaping importance (Chen, 2016), and hence of geopolitical importance. Furthermore, renewable energy has become a major issue in EU-China relations (Sattich and Freeman, 2018). However, given the focus of the literature on territory and grid-bound energy systems, this geographical background poses a challenge for the analysis of the role of RE in international relations.

Direct interlinkages between energy systems are, however, not the only way renewables can determine the character of bilateral relations between states. Fossil fuel exporters, for example, are exposed to decreasing demand and the reality of stranded assets, which in turn might affect diplomatic relations (Bradshaw et al., 2019). Other countries may be exposed to the growing influence of certain actors (Janardhanan, 2017), for example in the context of the International Solar Alliance (Shidore and Busby, 2019).

In EU-China relations, direct exchange of energy does not play a major role. However, through world markets for manufactured products and services a certain level of interdependence exists. Where no such trade exists, domestic EU and Chinese policies on energy generation technologies may be affected by their activities in third countries. Hence, energy is an important subject in research on the relationship between China and other powers (Guedry and Liang, 2016). After the withdrawal of the United States from the Paris Agreement, literature on EU-China relations reports a certain optimism regarding the potential for cooperation between the two polities (Bocse, 2018). Despite generally different starting points, Chinese and EU perspectives on energy policy have also become more aligned over the past ten years according to some authors (Gippner and Torney, 2017). Renewables were identified as a driving force behind this alignment (Ibd.).

However, there are also more pessimistic accounts regarding the relations between the two sides in the area of RE. Divergent dynamics in policy fields related to renewables have been reported (García-Herrero et al., 2017). Moreover, economic, political as well as diplomatic difficulties have been pointed to as affecting the sector (Bocse, 2018). With regard to renewable energy, there is, hence, no reason to limit the analysis of EU-China relations to geographic modes of thinking (Beck et al., 2006). However, what is missing is a theoretical and empirical approach that captures the role of renewable energy beyond their influence on the grid and flows of raw materials. In the following section, policy interdependence is introduced to fill this gap.

3. Policy interdependence and its geopolitical importance

In a globalised world, domestic climate and energy policy is likely to have effects across individual polities (Adelphi, 2020).⁴ In the case of the

⁴ Following this notion, it can be said that the attempts by individual governments to formulate suitable renewable energy policies are limited not by domestic circumstances alone, but also the systemic (international) environment (Fuenfschilling and Binz, 2018).

EU and China, the political relations co-evolve with one of the most important economic relationships in the world (Jiang et al., 2019). Both the EU and China recognize the importance of this relationship in their official policy documents (European Commission, 2006; 2016a; Ministry of Foreign Affairs, 2003; Ministry of Foreign Affairs, 2014). For example, in 2016, the European Commission argued regarding their economic relationship that, “China needs the EU as much as the EU needs China” (European Commission, 2016a). It follows that characterising the economic interdependence between the EU and China (in the field of renewable energy) and its trajectory (i.e. its overall development) provides a first indicator regarding the role of RE in the relations between the two polities.

Beyond the economics of this relationship (Meckling and Hughes, 2018), the concept of interdependence aims at analysing the political relationship between two or more units at the international level (Keohane and Nye, 2012, p. 3). In that regard, a perennial tension has been observed between interdependent relationships that are mutually beneficial and those that are a source of political costs, and thus tensions of interests (Wilson, 2018, p. 6).

To analyse the role of RE in the political relationship between the EU and China, we draw on the concept of *policy interdependence*. This framework refers to (the need for) reformulating domestic policy frameworks in response to policy choices of another external actor (Chaudoin et al., 2015, p. 303), such as economic strategies regarding renewable energy (Meckling and Hughes, 2018). Analysing the *structure* (i.e. strong/weak) of policy interdependence in the area of renewable energy allows to ascertain the overall political relations between the two sides. Beyond, it has been argued by (Chaudoin et al. 2015, p. 276) that the generally heightened interdependence among states produces increasing *convergence* of domestic sets of norms, rules and institutions in the field of renewables. Building on this idea, we expect that the *direction* of policy diffusion between the EU and China (i.e. symmetric/asymmetric) helps determining the character of their overall relationship.

Together, analysing the different dimensions of policy interdependence between the EU and China in the field of renewable energy allows inferring insights in the overall geopolitical implications (Franzese and Hays, 2008, p; 771).

4. Measuring policy interdependence between the EU and China

Phenomena of interest in international relations are often outcomes resulting from complex interactions between domestic and systemic factors (Chaudoin et al., 2015, p. 275). Therefore, to analyse the role of renewables in EU-China relations, we follow Maull (2017) who distinguishes between two separate dimensions: i) the horizontal relations between China and the EU, and ii) the vertical aggregation of collective interests and formulation of policies. Both dimensions need to be considered if the role of renewable energy in EU-China relations is to be understood.⁵ While recognising the importance of the vertical dimension, for the sake of simplicity in this paper we focus on the horizontal relationship between the EU and China:

⁵ The vertical dimension is, however, complicated by the different nature of the two blocs. While China can be described as a unitary actor in the international environment, the EU represents a unique regional polity with a significant degree of actorness in international affairs – but not a state (Christiansen et al., 2019, p. 2). Where political processes occur on a direct bilateral, state-to-state (EU Member - China) basis, the asymmetries in diplomatic capabilities and power are growing (to China’s favour). According to one European study, many EU member states are therefore increasingly faced with the reality that, by themselves, they are insignificant players in China’s eyes (Huotari et al., 2015, p. 9). The potential for lack of coherence in the EU in its relationship with China is recognised by the EU itself (Commission, 2016, 2019b).

- On the horizontal dimension, we include the economic interdependence between the EU and China in the area of renewable energy. By taking economic indicators such as trade volumes into account, we capture the strength, the dynamics and the character of the economic interdependence that underlies the political relationship between the EU and China. Furthermore, we include policy interdependence.
- On the vertical dimension, we assess the evolution of domestic policies. Here, we focus on the degree one unit is influenced by policy changes of the other side.

To determine strength and structure of policy interdependence between the EU and China, we employ ‘process theory’ (Geels, 2011, pp. 34–35). We trace unfolding processes and events in four different policy areas related to renewable energy: climate, energy, industry, trade and investment. The focus is on timing and conjunctures as well as policy initiatives and counter-moves (Geels, 2011, p. 34). In the four areas, we document how both sides respond to external developments and to what the other actor does. The empirical data includes documents on institutionalized dialogue, and non-institutionalized policy interaction.

On this basis, we discuss the overall role of renewable energy in the relations between the EU and China. Further, we discuss the trajectory of renewables in EU-China relations, and thus the question whether renewables represent a factor that brings the two sides closer together and makes their relationship more harmonious, or whether the opposite is the case (see section 6). To draw this kind of inference about the geopolitical consequences stemming from the relationship between the EU-China in the field of renewables, we rely on the understanding of interdependence as conceived by Keohane and Nye (2012). On that basis, we expect that policy response to the structure of interdependence between the EU and China is characterized by two distinct sets of political logic. One is a competitive geopolitical approach with the end of asserting national control over energy sectors, energy trade and investment. The other is a cooperative global energy governance approach in which states seek to augment the operation of international markets through negotiated policy coordination (Wilson, 2018; see Table 1). Where the interdependence is symmetrical, the interest in cooperation is mutual, with common institutions being likely to be the outcome of political dialogue. Where, on the other hand, the interdependencies on the horizontal dimension are found to be strong and asymmetrically structured, we expect that the political costs involved with an interdependent relationship may result in one side wanting to change or to leave the relationship, while the other side wanting to defend the status quo. In these cases, frictions in the political relationship are expected.

5. Renewable energy in EU–China relations

Table 1
Interdependence and political interaction.

	Asymmetric	Symmetric
Strong interdependence	Political approach: Competitive geopolitics, conflict over trade and investment Outcome: Power struggles	Political approach: Cooperative global governance Outcome: World market, institution building
Weak interdependence	Political approach: Competitive geopolitics, conflict over trade and investment Outcome: Sporadic disruptions	Political approach: Cooperative global governance Outcome: Unrelated and uneventful coexistence

The EU and China are engaged in a dynamic and long-standing

dialogue across many policy areas including energy in different fora at various levels: political, sectoral, academic, people-to-people etc.⁶ Renewable energy is an important subject area in this context and Chinese and EU perspectives in this field have become more aligned over the past ten years (Gippner and Torney, 2017) as a result of the perception of common challenges and goals related to climate change, the environment and energy. However, this did not lead to a complete convergence in policy goals or outcomes. Domestic economic, industry and technology policy involves competitive political approaches to RE, frequently as a result of linkages through trade and investment. Finally, the policy interdependence is dynamic, without, as yet, any clear or stable hierarchy of priorities, and in some cases changes in policy priorities within relatively short periods of time.

Economically, EU-China relations in the field of renewables are complex because they extend well-beyond the influence of renewables on energy systems. Exchanged in world markets via trade and investment, different product groups such as solar panels, wind turbines, components, raw materials, technology and manufacturing equipment are involved. In other words, RE in EU-China relations is not limited to the exchange of one specific kind of energy or technology but is expressed through multiple economic channels related to a variety of policy areas. The four policy areas discussed here are climate policy, energy policy, industrial policy, and trade and investment policy. While these are often seen as separate policy fields, they all have an important overlap with RE policy.

In none of the four policy areas hard geopolitical struggles between the EU and China can be expected, yet given that with both polities have implemented apparently convergent strategies of energy transformation, green-growth and sustainability and also competitive economic policies, the interdependence between the two blocs involves significant political sensitivities and vulnerabilities – and hence the basis for measure and counter-measure.

5.1. Climate policy interdependence

The EU and China are key actors in global policy on climate change, engaging in bilateral and multilateral cooperation, although this has not always been the case. The EU was a global leader on tackling climate change for many years (Rayner and Jordan, 2013; Skovgaard, 2014), while climate change was not a policy priority in China until its first government White Paper on climate change was published in 2008. At the Copenhagen Climate Change Conference in 2009 the EU and China, while sharing the same overall goal of emissions reduction, had differing priorities, especially their view of the distribution of responsibility for mitigation and its impact on development, which contributed to failure to reach an agreement. Nevertheless, the commitment of the EU and China to bilateral cooperation in this area is not new (European Commission, 2005), and is implemented not just through domestic policy, but also through cooperation in energy and more broadly in other areas related to climate under agreements such as the EU-China 2020 Strategic Agenda for Cooperation and the EU-China Roadmap on Energy Cooperation (European Commission, 2013, 2016b). There has, for instance, been close cooperation between the two sides in the development of carbon trading policy in China (European Commission, 2018a). The commitment to bilateral cooperation was reiterated following the Trump administration announcement that the US would withdraw from the Paris Agreement (European Commission, 2018b), and the EU and China sectoral dialogues in environmental policy and climate policy were upgraded to a High-Level Environment and Climate Dialogue after the 2020 EU-China Summit to pursue joint commitments in these areas.

The success in negotiating and signing the Paris Climate Agreement in 2015 has been attributed to a significant degree to the roles of the EU

and China, and signifies a high level of policy alignment. The goals of the Paris Agreement will be achieved through Nationally Determined Contributions (NDCs) in areas such as renewable energy and the agreement constitutes an overarching regime within which the EU and China interact at a global level under United Nations auspices. The Paris Agreement has, however, also been called a weak legal regime, in that it has abandoned the legally binding targets of the Kyoto Regime for voluntary national policy commitments (Doelle, 2015; Bodansky, 2016; Falkner, 2016; Rajamani, 2016). China, nevertheless, restated its commitment to the Paris Agreement following the announcement of US withdrawal and the Chinese government also continues to implement its domestic policy on energy, climate and the environment (Xi, 2017). The EU likewise committed itself to the Paris Agreement and continues to pursue climate policies at the EU and also member state level (Council of the EU, 2017a; Council of the EU, 2017b).

Although this has not always been the case, today, the climate policy linkage between the EU and China has become cooperative in itself, and reinforces linkages in other areas, such as energy policy in the RE sector. Interdependence between the EU and China can be seen in areas such as scientific research on climate-related subjects including energy. In this regard, the Co-Funding Mechanism (CFM) under Horizon 2020, or the JPI Urban Europe programme can be highlighted. These and earlier types of research collaboration such as the EU's FP6 and FP7 programmes finance research in thematic areas such as climate monitoring, adaptation, mitigation strategies, or sustainable urbanisation (European Commission, 2008). These activities involve universities, research institutes and companies, and hence interdependence, particularly in light of scientific cooperation that has a history of more than 20 years (Wang et al., 2017, pp. 766–767). However, the actual figures of financial support are relatively low. Between 2018 and 2020, the CFM has mobilised circa 100 million Euros from the EU, and 200 million RMB from China (European Commission, 2019c).

The Paris Agreement has created a convergent path to a cooperative regime on climate change, although not one that necessarily leads to full convergence. There remain differences, and at their Leaders' Meeting in September 2020 the EU was critical of China's climate policy (European Commission, 2020b). The approaches in the EU and China to climate policy have been different in important aspects that create potential for divergence: although the EU has adopted emissions targets and regulatory approaches, it has generally sought to rely on market mechanisms such as carbon trading while China has emphasised state-centred administrative means such as targeting through planning and interventionist industrial policy to achieve goals on climate (Goron and Freeman, 2017). These two different approaches exist in other policy areas related to RE, and, while there may be a sign of alignment on the overall goals of climate change policy, this may be less so in other areas where they result in outcomes that have potential to generate conflict. What is more, even in an existential crisis of climate change, it is far from evident that there is now a policy hierarchy with climate mitigation at the top in either the EU or China. Hence, what has come to be the relatively strong and symmetric policy interdependence between the EU and China in the area of climate change may not always extend to every aspect of all policy areas that impact RE (Table 2).

5.2. Energy policy interdependence

Energy policy, including that for RE, has been to a considerable extent determined within the domestic context and priorities in the EU and China. Energy policy in the EU and China has had multiple policy

Table 2
Policy interdependence in climate.

	Asymmetric	Symmetric
Strong		X
Weak		

⁶ Some of these fora are well-established, for example the sectoral energy dialogue which has been started in 1994.

goals – security of supply, economic efficiency and cost – but there has been convergence around goals that emphasise transformation of energy systems. Both the EU and China have adopted energy policies that target reduction of emissions, energy efficiency and transition, focusing on a shift from fossil fuels to RE. In their separate ways, these energy policies have brought results. The EU is outpacing other regions in transforming its energy sector. With RE accounting for 85 per cent of newly installed electricity capacity renewable (EEA, 2018), RE capacity in the EU has more than doubled over the last decade and RE electricity capacity per capita has increased significantly (EEA, 2018). At the same time, China is the single largest investor in the RE sector (Buckley and Nicholas, 2017). As a result, the country has multiplied the share of RE in the electricity sector by a factor of more than five over the period 2005–2017 and is now home of 30 per cent of the world’s renewable power capacity (EEA, 2018). In 2020 China accounted for 56% of global additions for new wind power capacity (Global Wind Energy Council, 2021) and for 26% of solar PV installations in 2019 (SolarPower Europe, 2020).

The links between the two polities have strengthened over recent years with regards to energy policy, much of which has focused on RE. Since 1994, the EU and China have been engaged in an energy dialogue which covers the areas of renewable energy, energy efficiency, energy infrastructure, access to each other’s markets and reciprocal investment opportunities, and security of supply. Some of these dialogues have taken place as part of the EU-China Summits, showing that energy policy cooperation has become one of the pillars of the EU-China relationship, and which has been reiterated in several joint statements (European Commission, 2018b, 2019e). As noted above, energy has been a key feature of the EU-China 2020 Strategic Agenda for Cooperation since 2013 and there has been extensive cooperation in scientific research and policy development in the energy sector (European Commission, 2013, 2016a). In 2016 the EU and China signed an energy cooperation roadmap for the period up until 2020 which noted that “Both China and the EU are highly dependent on imports of fossil energy sources and together represent approximately a third of total global consumption. This creates common interests in the pursuit of energy security, cleaner technologies and renewable energy sources” (European Commission, 2016b). The roadmap covered issues of both supply and consumption in areas such as renewable energy sources, power grids, fossil fuels and nuclear safety and energy efficiency. Prior to the signing of the roadmap, a concept note written by European and Chinese scholars had argued for cooperation in the energy sector (Liu et al., 2015), and policy goals have been frequently cooperative, with increasing entanglement, driven as they are by common overarching concerns, especially in the area of climate change. In this sense they are non-geopolitical in nature. In 2019 the EU and China established an EU-China Energy Cooperation Platform following a Joint Statement issued at the 8th EU-China Energy Dialogue intended to enhance cooperation and “help increase mutual trust and understanding between EU and China and contribute to a global transition towards clean energy on the basis of a common vision of a sustainable, reliable and secure energy system” (European Commission, 2019e).

However, while policy interdependence in the field of energy has been cooperative, it remains relatively weak as a result of the lack of any strong international regime, and the fact that the primary policy focus and activity in the RE sector remains domestic. Furthermore, while the broad policy goals of the EU and China in this sector may be aligned, the domestic approaches and the tools adopted have not been parallel. In the EU, there has been a preference for regulatory and market-based solutions whereas in China state intervention and administrative driven targets remain central feature of the energy policy system (Goron and Freeman, 2017). This is related to the broader question of policy and economic models adopted in the EU and China and their external impacts through trade and investment. Cooperation on RE has been seen as a key element in the effort to achieve climate and related energy policy goals, but the sector, and others related to it, are also increasingly seen in

terms of their potential for competition. As the EU Joint Research Centre noted, from the EU perspective China represents a competitive industrial challenge across a range of manufacturing sectors important to future economic development, including RE (JRC, 2019b). Furthermore, there exists the possibility of greater geopolitical or strategic politico-military influence in RE policymaking, and hence competition. (Scholten, 2018; IRENA, 2019). Thus, while in this area policy interdependence has in the past been relatively weak, but symmetric and cooperative, it has the potential to become increasingly asymmetric and focus on competitive policy goals as RE and related sectors are perceived in terms of key economic and technological interests (Table 3).

5.3. Industrial policy interdependence

As already noted, there are differences in policy approaches to development of RE in the EU and China which are rooted in their different economic policy frameworks and development paths. Although in the EU state support and incentives have not been absent and the role of industrial policy is growing, it has generally relied on market-based approaches, while in China state intervention through industrial policy has been central to RE development over several decades. The policies adopted in the RE sector reflect different economic systems. The EU models itself on market capitalism, and in the decades following the founding of the EEC sought increasing liberalisation through the single market. In China since the reform of the Soviet style planned economic model, the economic system has undergone a transition in which markets have been increasingly important (Brandt and Rawski, 2008; Naughton, 2018). But expectations that this transformation would lead to adoption by China of an economic model based on those of the West have been disappointed. While China defines itself as a socialist market economy and the exact nature of the Chinese economic system is debated and has been variously described as a developmental state, state capitalism, Sino-capitalism and other terms, there is agreement that interventionist role of state remains significant (Breslin, 1996; Brandt and Rawski, 2008; McNally, 2012; Heilmann and Melton, 2013; Naughton, 2018). In this context, convergence of policies toward cooperation is constrained by structural economic differences. Rather, industrial policy involves an increasingly competitive approach in both polities.

In the EU, significant differences between individual EU member states exist (Maull, 2017). However, EU energy policy has sought to support the development of RE through frameworks for subsidies at the national level as well as successive energy packages to build a single common market for energy. While the initial energy packages, the first of which came into effect in 1996, focused on market liberalisation, they have increasingly sought to promote sustainability and renewable energy as in the Fourth Energy Package of 2019. The economic costs of promoting RE are no longer generally considered a barrier to industrial development, but as a promising investment in future industries. Where the EU has adopted targets for the adoption of RE, it has – until recently – not sought to achieve them through strong industrial policy. More recently, however, the element of industrial policy has increased, as considerations of economic competition, especially with China, have come to the fore, as for instance the EU has initiated a battery alliance in order to create industry capacity in this sector (European Commission, 2019d). As the EU clearly asserts, this reflects not merely concern about energy and climate policy, but also global industrial competition, especially with China.

In China, development of the RE sector has been supported by the

Table 3
Policy interdependence in energy.

	Asymmetric	Symmetric
Strong		
Weak		X

state since the 1980s, first in R&D and later increasingly in industrial production and deployment in the energy system (Zhang et al., 2017). Rather than an economic cost, RE has long been seen as a strategic opportunity not just for transformation of the energy system or economic growth in one sector but for wider structural change in the Chinese economy (NDRC, 2007). RE and other related sectors have thus received strong government support. In 2005, China adopted a Renewable Energy Law, which creates a policy environment for the development of clean energy industry. President Xi Jinping and the Chinese government have called for an energy revolution that will transform China's reliance on fossil fuels (NDRC, 2016a). In the 12th Five Year Plan, which ran from 2011 to 2015, and its successor the transformation of China's energy system has been deeply integrated into industrial policy, and sectors such as wind and solar power have received considerable government support (NEA, 2016a; NEA, 2016b; NDRC, 2016a; NDRC, 2016b; NDRC, 2016c). Under these plans, support has been provided to R&D and market deployment of RE, but also to producers such as solar module and wind turbine manufacturers.

The consequences of these policies are not just domestic in their direct impact on RE development. For instance, overcapacity in the solar PV industry in China was at one point severe as a result of mismatched domestic supply and demand, and in particular has had external consequences through export of surplus products at a time when European governments were providing significant support for solar installation, leading to trade defence measures in the EU in 2013 that led to import restrictions (Pasimeni, 2017). China's domestic industry, driven by industrial policy and benefiting from significant economies of scale as well as technological advances, has been a major contributor to the falling costs of RE, especially in solar PV but also in wind power (IRENA, 2020). This has global benefits in the cost of deployment, but the trade and investment consequences in the sector and the underlying economic model is increasingly perceived as a threat rather than a benefit by foreign governments, including in the EU and its member states. China's efforts to develop RE have created the possibility for its companies to overtake European companies (IRENA, 2019). In the wind segment, there are now seven Chinese companies in the top 15 global wind turbine manufacturers, while the former European champions are at risk of losing much of their market share (Euractive, 2019) and China also has the world's largest wind turbine manufacturer (Chiu, 2017). Similarly, as of early 2017, five of the world's six largest solar-module manufacturing companies were Chinese (Chiu, 2017) with major markets being in the EU, with deliveries to the Netherlands, Spain, Hungary, Germany, and Belgium (Reuters, 2019). These overseas markets rank amongst the main driving forces behind the maintenance of growth in China's solar manufacturing (Ibid.). On the other hand, the vulnerability of the European economies, particularly German industry, is well documented (DW, 2012). In this area, the interdependence has been described as strong and asymmetric, with China being in a favourable position (Chen, 2015).

These developments in the renewable energy sector accentuate the increasing predominance of China's manufacturing industry (JRC, 2019a), to the detriment of the European industry. With the European industry losing ground, the interdependence in the industrial sector may become more asymmetrical. Industrial policy and the role of the state in the economic competition is increasingly an area of contestation in the EU-China relationship, including in RE (JRC, 2019b). China's policy on the role of the state remains consistent and largely unchanged and the EU has adopted measures in areas such as investment screening, subsidies and in public procurement that are intended to challenge the role of the state, especially state-owned enterprises, in the Chinese economy, especially their external impacts in the EU (European Parliament and Council, 2019; European Commission, 2020c). The EU in alliance with the US and Japan has also sought to use the WTO to limit the role of state intervention and the role of state-owned enterprises. While the EU adopts measures to challenge the role of the Chinese state, it has also moved to increase the role of industrial policy in the EU economy, as

already noted in the important case of batteries (European Commission, 2018c; Bundesministerium Für Wirtschaft Und Energie, Ministère de l'Économie et des Finances, 2019). As a result, despite their important economic relationship, policy interdependence in this area has been weak, as China has generally resisted EU efforts to fundamentally influence its economic model. This has been matched by an increasing view of the EU in particular of an asymmetric interdependence in which competition has come to dominate (European Commission, 2019b) (Table 4).

5.4. Trade and investment policy interdependence

Due to the effects of geography (Zha, 2015) and the fact that they are two of the world's main energy importers from other regions (Espa, 2018), the degree of interdependence that is realised through trade in energy commodities between China and the EU is either very small in scale (e.g. oil) or inexistent (e.g. electricity). Rather than through trade in energy itself, interdependence in the RE sector is mainly manifested through trade and investment in the means to produce energy, especially the extensive trade in solar PV panels. Furthermore, production technologies in the RE sector are transferred internationally, often as intellectual property, for instance through licencing, as well as in their tangible form of manufacturing equipment. Raw materials used in the RE sector such as rare earths and silicon are also traded. Services such as design and engineering consulting or project management are also provided across borders.

China has emerged as a major EU partner in low carbon energy technology (LCET) (Pasimeni, 2017). While in 2000 the US ranked as the number one partner for both EU imports and exports, and China fifth for both, in 2015 China ranked first for EU imports and fourth for exports (Pasimeni, 2017). In this period China became a dominant supplier in sectors such as energy storage, solar PV, solar thermal and wind power. Although China became an important market in sectors such as clean coal and gas, energy storage and nuclear, it remained relatively small compared to imports. The overall balance in LCET trade has been dominated by trade in the solar PV sector, and in 2012 solar PV imports from China accounted for 72% of total EU imports in the sector (Pasimeni, 2017).

In addition to trade, companies invest internationally in R&D and production in the RE sector, including for both solar PV and wind turbines. They also increasingly invest transnationally in RE generation and distribution, usually in the form of solar and wind farms. While trade was the main means by which the RE sector was globalised, FDI has become more important as power generation in solar and wind has grown. Chinese investors have been active in the sector globally (Buckley and Nicholas, 2017), including in the US and the EU.

In contrast to energy policy, trade and investment policies are placed in the context of the existing global, regional and bilateral regimes of which the WTO has been the apogee. International trade policy may be considered a prime example of cooperative regimes created as a result of high levels of interdependence between states and resulting in multi-lateral, plurilateral and bilateral agreements. It has been implicitly assumed that trade and investment in the RE sector takes place in a globalised economy under a liberal order. The EU in particular has been a strong promoter of the global trade regime, for instance through the creation of the WTO in which China has also become a participant. China on the other hand, has supported globalisation based on reduction of trade and investment barriers, while retaining a central role of the state in the economy.

Table 4
Policy interdependence in industry.

	Asymmetric	Symmetric
Strong		
Weak	x	

While no regime similar to the WTO exists for investment, over many decades there has been a general trend to greater liberalisation under bilateral or regional agreements. In the case of the EU and China the former has adopted an open investment environment both in its internal single market and also externally, while the latter has moved from one that was closed in the 1970s to one that has become relatively open. These have permitted increased interdependence between the EU and China through vastly increased trade and investment, including in the RE sector. While this has been the case, there have been well-known frictions between the two, notably as a result of what are perceived on the EU side to be imbalances in the relationship, often expressed from the European perspective in terms of a lack of reciprocity or a level playing field (European Commission, 2016a). The integration of the two economies in trade and investment has not necessarily led to integration of the domestic and external policy regimes.

Today, the direction of policy integration globally has changed, and if anything has been reversed. This is demonstrated in the RE sector in solar PV. Trade has been central to the development of solar PV in the EU and China and the relationship between them. This became the subject of one of the most important trade disputes between the EU and China over solar panels which resulted in the EU and China adopting a price agreement and anti-dumping duties on imports from China in 2013 (European Commission, 2013). However, despite the settlement, EU imports from China had already fallen to a fraction of the peak level in 2012, as the result of falling demand in the EU as governments withdrew financial incentives for installation in the wake of the economic crisis which hit the EU after 2008 and also rapidly growing demand in China as the government significantly increased incentives for installation (Pasimeni, 2017).

The dispute demonstrates the external impact of domestic policy manifested as the unsustainable incentivization of both production in China and demand in the EU. The import duties on solar panels have been terminated, but from an EU perspective this history demonstrates not just the disruptive effects of unaligned domestic policy incentives in the EU and China for RE, but also the impact of prioritisation of trade defence over other climate and energy policy priorities such as the deployment of RE at the lowest possible cost, where such tariffs potentially have a negative impact on the cost of renewables in the EU.

Aside from trade, the focus of friction has shifted to investment from China which is frequently the subject of security review, particularly in the US, and which in the past has included projects related to renewable energy. The European Commission's regulation on the screening of FDI which came into effect in 2020, although officially non-discriminatory, is directed at China and seeks to restrict investment in "critical" infrastructure, technology and inputs including in the energy sector, where Chinese investors have been active (European Parliament, 2018; European Parliament and Council, 2019). This applies particularly to state-owned enterprises, which dominate electricity distribution in China.

The defensive economic priorities with regard to China were made clear in the document on China issued by the European Commission in June 2016, which places a priority on reciprocity and market access (European Commission, 2016a). The failure of the EU-China Summit in 2016 to issue a joint communiqué, partly as a result of differences over economic issues such as steel, demonstrated the impact of economic differences on the political relationship. More specifically, the 2017 EU-China summit failed to produce a widely expected statement on climate change, again in part because of differences on economic issues. It was only at their bilateral summit in 2018 that the EU and China finally issued a joint statement on climate change reaffirming their commitment to the Paris Agreement (European Commission, 2018b).

This does not indicate a breakdown in the bilateral relationship concerning energy and RE, but it suggests that it is susceptible to the pressures of economic priorities and disputes as the EU has given precedence to bilateral economic interests. While both the EU and China are members of the WTO and thus part of a strong policy regime, this has not

resulted in a high degree of convergence or integration in this area, including its impact on RE. For instance, the attempt under UN auspices to negotiate an agreement on trade in environmental goods failed. Policy interdependence remains weak despite participation in common multilateral regimes, and, at least on the EU side, is increasingly seen as asymmetric. As a result, the domestic and external economic priorities in the EU and China do not necessarily lead to increasing cooperation in trade and investment in general, including in the RE sector, but rather to competition. The high levels of actual interdependence in trade and investment and even the potential that they could increase has not led to higher levels of policy cooperation in trade and investment in general or in the RE sector. On the contrary, if any there has in recent years been a trend toward increased competition and focus on national interest in both trade and investment in this sector (Table 5).

6. Summary and discussion

Broadly speaking, energy policies in China and the EU have the same goals. In 2020, China has stated its ambition to reach carbon neutrality by 2060, while the EU's European Green Deal calls for increased ambitions regarding decarbonisation and reaching net zero emissions of greenhouse gases in 2050. In both polities, RE deployment is deemed a key element for reaching their goals. Although the domestic policy frameworks may be seen as existing largely in parallel, there is interdependence between them. Changes in the domestic renewable energy policy framework of one side (the EU or China) involve the need for potentially costly adjustments in the policy framework of the other. Analysing the structure of these interdependencies allows to make determinations about the significance of RE policies for the wider political relationship between the two sides.

According to our findings, policy interdependence in the field of RE appear to increasingly determine the character of the bilateral political relations. Yet findings also suggest that the implications vary across those policy areas related to RE - climate, energy, industry, trade and investment - depending on the character of the interdependence. Moreover, it seems that in the case of renewables, policy interdependence between the EU and China does not necessarily entail policy convergence in every field - in fact the opposite may be true.

In the context of international climate policy, cooperation appears to have become stable and supportive of RE deployment thanks to the strong and largely symmetrical nature of the policy interdependence. Cooperation appears to densify, with common research projects perhaps representing the core of a more aligned approach to the domestic policy approaches. To a lesser degree, this is also true for the wider field of energy policy. Similar to climate, common goals exist, and policy interdependence has become stronger. This is expressed via different fora for dialogue and cooperation, and generally an increasing entanglement of the policy frameworks of both sides. However, differences in policy solutions and broader questions regarding economic models limit further alignment. Furthermore, the interdependence is becoming more asymmetric and competition is an increasingly important factor.

In the neighbouring fields of industry as well as trade and investment policy, the picture is different. While still relatively weak, the interdependence is seemingly getting stronger. Yet, compared to climate and energy, the structure of the policy interdependence is asymmetrical. Accordingly, it could be observed that domestic industrial measures are being followed by defensive counter-moves, which in turn indicates (increasing) competition and rivalry. The same is true with regard to the increasing importance of industrial policy in the EU, and China's refusal

Table 5
Policy interdependence in trade and investment.

	Asymmetric	Symmetric
Strong		
Weak	x	

to adopt economic models in closer alignment with the EU's. Both sides follow largely different approaches, and little convergence between policy frameworks is observable. On the contrary, both with regard to industrial as well as trade and investment policy, frictions between the policy regimes in place could be observed.

The identified policy interdependencies in industry and trade/investment are still relatively weak, but since there is no hierarchy between the policy areas covered by this analysis, the implications of these variations need to be considered carefully. Economic and climate priorities may be aligned through industrial policy, and it may be the key driver of global cost reductions in sectors such as renewables, but the results are often considered potential threats in the wider context of trade and investment. Trade policy therefore may override climate and energy policy, resulting in frictions and disputes. In order to make it clearer whether renewables bring the EU and China closer together or further apart in international relations, future research should therefore include a structured analysis of the dynamics between the EU's and China's policies in the mentioned areas. It may, for example, become clearer that in a given policy area one side of the bilateral relationship is driving policy change, while in another policy area it is the other side. Hence, to understand the dynamics of the relationship, future analysis should also include the interdependence between the four related policy areas on the domestic level.

7. Conclusion and policy implications

The case of renewable energy in EU-China relations suggests that renewables are an increasingly important and strong determinant of the character of bilateral relations. In the geopolitics of RE, many traditional geopolitical considerations may not apply due to the different technological characteristics of renewables compared to fossil fuel. However, beyond the immediate energy and material flows between individual countries, policy interdependence between the EU and China via different channels in the field of RE indicates that renewables co-determine bilateral relations. As the case of EU and China shows, RE policies affect each other, leading to both more alignment and proximity on the one hand, and increased competition and frictions on the other. The development of RE thus enjoys the potential of 'de-geopoliticalizing' international relations and allows states to transcend the 'zero-sum' thinking in their pursuit of energy security. However, RE is not free from international competition, which is increasingly manifested in the rivalry over the setting of industrial standards in RE and trade and investment.

Thus, our results in the areas of climate, energy, industrial, and trade and investment policy suggest that a cooperative governance approach to RE may apply in some areas, while a competitive approach may apply in others. Moreover, the current patterns do not appear to be stable and may change over time. In EU-China relations, the past impressions of renewables leading to more alignment and cooperation have to be amended with the risk that RE will involve a trend to more competition. However, it should also be noted that the policies adopted by the EU and China are the result of economic realities as well as the individual perceptions by policymakers of existing interdependencies. This includes their structures and implications for the relationship between the two sides. In other words, the EU and China act on the basis of their perceived interests and defend their individual preferences, but they are also capable of cooperation where voluntary cooperation appears more fruitful than geopolitical struggles.

One area that is suited to strengthen the element of cooperation in EU-China relations, is energy policy. In view of the structure of the found policy interdependence, and the fact that there is no formal policy regime in place, it appears possible that the EU and China can strengthen their cooperation in the field of energy policy - despite occasional disruption in neighbouring policy areas and a trend towards a more asymmetrical relationship.

CRedit authorship contribution statement

Thomas Sattich: Conceptualization, Writing – original draft, Writing – review & editing, Methodology, Term. **Duncan Freeman:** Investigation, Resources, Writing – original draft, Writing – review & editing. **Daniel Scholten:** Term, Writing – original draft, Writing – review & editing. **Shaohua Yan:** Writing – original draft, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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