Peter Hefele · Michael Palocz-Andresen
Maximilian Rech · Jan-Henrik Kohler
Editors

Climate and Energy Protection in the EU and China

5th Workshop on EU-Asia Relations in Global Politics

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Taking place in Hong Kong, an international financial centre that played an important role to promote relations between China and the outside world, the theme for the 2016 workshop was "EU-Asian Energy Politics in the Twenty-First Century". Some 70 participants from almost 20 countries presented their work in four thematic panels. This workshop and all the thought-provoking contributors inspired the realisation of this edited volume. The editors would also like to extend warm regards to the Academic Association for Contemporary European Studies (UACES) and the ESSCA EU*Asia Institute for their additional financing, most notably Emily Linnemann, Albrecht Sonntag and Thomas Hörber for their encouragement and continued support of this workshop series. The editors were very grateful for the warm welcome and very professional support of the Center for Economic Sustainability and Entrepreneurial Finance at the School of Accounting and Finance of Hong Kong Polytechnic University with Agnes Cheng and Louis Cheng and their wonderful team, most notably Connie LAU and Helen Chan.

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Executive Summary

Europe and China are today more intricately linked than ever before in history. The European Union (EU) on the western end and the People's Republic of China on the eastern end of the Eurasian landmass are exchanging more than a billion Euros worth of goods with each other every single day. Beyond trade in goods, the partners are reciprocally invested in each other. Next to annual EU-China Summits that discuss political dialogue, there are more than fifty forums for exchange and cooperation that bring the people and businesses of Europe and China closer together. In addition to that, many European Member States (MS) entertain bilateral cooperation formats with China.

The relationship is going from strength to strength, but challenges remain, and climate and energy protection in the EU and China is one of these challenges that the partners face today. Climate and energy protection, sustainable development, energy efficiency infrastructure and connectivity as well as urbanisation are important policy domains of cooperation between Europe and China. Closer coordination between the activities of the two sides promises win-win situations for companies in either market and may ultimately facilitate a more sustainable economic development in Eurasia.

This edited volume seeks to address the challenge of energy and climate protection by inviting ten authors from Europe and China to share their analyses and build a shared understanding on the priorities that need tackling. The authors of the various chapters have shared their analyses of policy domains that offer opportunities for such close cooperation and coordination. The chapters are clustered around three parts of particular importance. The volume starts out with the part 'Geopolitics of Energy in Europe and Asia' and then discussing 'Renewable Energy Solutions for Trade, Grid Resilience & Urbanisation', before closing with the part 'Innovation & Reciprocal Investment in EU-Asian Energy Sectors'.

This edited volume is the outcome of the 5th Workshop on EU-China Relations in Global Politics which took place in Hong Kong in March 2016. Entitled "EU-Asian Energy Politics in the twenty first Century", this workshop brought together more than 50 experts in the field of energy and environmental policy from partners in the European Union and China as well as beyond.

While the activities of the EU and China are already closely aligned in policy domains that are characterised by shared or overlapping interests, activities in other policy domains are still very different. The authors sought to shed further light on these policy domains and point to avenues of future cooperation. Beginning with the part 'Geopolitics of Energy in Europe and Asia', the Chap. 1 is entitled "Changing Patterns in Sino-Russian Energy Relations and their Implications for European Energy Security". In this chapter, *Saskia Jürgens* of Sciences Po, Paris, and Fudan University, Shanghai, examines the impact of Sino-Russian energy relations on European energy security. The changing patterns in energy cooperation between China and Russia from 2000 to 2014 show that the closer the energy relation is between Russia and China, the stronger the position Russia adopts in negotiations with the EU and the more unstable the energy supply is from Russia to European countries. In addition to a series of supply disruptions in 2006, 2008 and 2009 and Russia's conflicts with Georgia and Ukraine, the unpredictable behaviour of Russia associated with Sino-Russian energy cooperation has raised the EU's concerns over energy security. In consequence, EU Member States started cooperating in order to decrease energy dependency on Russia. Jürgens' analysis finds that this fostered the "Europeanisation" of the European Union's energy policy and resulted in the formulation of an Energy Union.

Chapter 2 discusses "The EU and China: Energy Policy Interdependence: Interactions Between Internal Energy Policies of the EU and China". In their chapter, *Thomas Sattich* of the University of Oslo, Norway, and *Duncan Freeman* of the EU-China Research Centre at College of Europe highlight commonalities and differences between the domestic energy markets of China and the European Union. In their work, the authors suggest a framework for a systematic analysis of these interactions while taking into account the domestic factors such as renewable energy provision and the resilience of the electric power grid. While the external environment is characterised by interdependency, domestic energy policy goals, instruments and outcomes can be understood to coexist in parallel. Due to the interdependent character of energy policy globally, domestic policy initiatives may have global repercussions, however. This is particularly true for instances when Europe and China find themselves in competition while pursuing diversification of supply or when seeking to integrate the electricity grid beyond national boundaries. The examination of the domestic energy markets leads Sattich and Freeman to the conclusion that both China and Europe are dependent on each other as well as other global energy actors for the formulation of their respective energy policies.

The volume continues with a Chap. 3 from India entitled "The One Belt, One Road Project as a Response to Eurasia's Energy Crisis: An Exploratory Study". In this chapter, *Preksha Shree Chhetri* of Jawaharlal Nehru University discusses the energy challenges facing Europe and Asia and argues that the China-led Belt and Road Initiative has a positive impact on Eurasian energy security. The modern Silk Road plan enables Europe to access new sources of energy in Asia and to expand its energy trade network across Eurasia, which reduces its dependence on Russian energy resources in the long run. If Belt and Road projects integrate Europe and Asia into one regional energy market, Central Asia can utilise its rich fossil energy reserves on a much larger scale. This gives the countries in the region room to develop alternative energy sources. Chhetri argues that investments would significantly improve infrastructure in energy generation and transportation in South and Southeast Asia to meet high energy demands associated with rapid urbanisation and economic growth.

Part I closes with the Chap. 4, "Securing Energy Insecurity? China and the EU's Quest for Energy in the Caspian Sea Region". *Stratos Pourzitakis* of Hong Kong Baptist University analyses the energy policies of China and the European Union in the Caspian Sea region. To enhance energy security, both actors attempt to get access to oil and natural gas resources in the sea via developing strategic energy partnerships with countries bordering the region. Over the past decade, with increasing energy demand, China has signed a series of agreements with Russia, Kazakhstan and Turkmenistan on the construction of several oil and gas pipelines. Similarly, to reduce dependency on Russian energy supply, the EU has cooperated mainly with Azerbaijan and Turkmenistan via implementing pipeline projects such as "the Southern Gas Corridor". However, Pourzitakis posits that Chinese and EU involvement in the Caspian Sea's energy market has been constantly challenged by issues of reliability of their suppliers, the pipelines' high economic costs, limited capability and underperformance.

Part I of this edited volume highlights the importance of internal dimensions of energy security, but also emphasises the role of external stakeholders such as Russia and other states in Eurasia.

Part II discusses 'Renewable Energy Solutions for Trade, Grid Resilience & Urbanisation' pointing to some original solutions that can facilitate EU-China cooperation in this important domain. Founded on legal analysis of the regulatory environment, the next Chap. 5 is titled "The Rise of Trade Remedies in the Renewable Energy Sector and the Need for Bilateral Agreement between the EU and China". *Fang Meng* of the Faculty of Law at the Chinese University of Hong Kong discusses the need for a bilateral treaty between the EU and China, concerning the rise of trade remedies in the renewable energy sector. She focuses on the issue of renewable energy trade remedies and proposes solutions that can reduce or even eliminate the need for remedial measures. Furthermore, Fang discusses renewable energy industrial policies and delineates relevant WTO rules. She puts forward the idea of reaching a bilateral agreement between the EU and China that explicitly deals with the use of trade remedies targeting renewable energy goods. Overall, Fang critically examines the use of trade remedies in the renewable energy sector as tools of protectionism, which is detrimental to accelerated deployment of renewable energies, the mitigation of climate change and not least the overall trade relations between Europe and China.

The subsequent chapter of the co-authors, *Prudence Dato* of IREGE at the University of Savoie; *Tunç Durmaz* of School of Energy and Environment (SEE) at City University (CityU) Hong Kong and the Department of Economics at Yildiz Technical University; and *Aude Pommeret* of School of Energy and Environment (SEE) at City University (CityU) Hong Kong and IREGE at University of Savoie, discusses energy investment and grid resilience. Chapter 6 is entitled "Renewables, Energy Storage and Smart Grids". The authors conduct an economic analysis of the energy transition, studying the optimal investment decision on renewable energy, storage devices and central grid electricity provision at the household level. The statistical models demonstrate that for households with a smart meter, it will be most desirable to store energy by purchasing electricity from the central grid when the tariff is sufficiently low. In this case, there will be no investments in solar energy. Besides, when comparing purchases from the central grid with and without smart meters, it is found that a larger amount of electricity from the central grid is purchased with the use of smart meters. Also, the installation of smart meters seems to be beneficial to households only when the expected electricity price is sufficiently low.

The final Chap. 7 for the part discusses "Green Urban Housing". A computer simulation conducted by *Ali Cheshmehzangi* and *Ayotunde Dawodu* of the University of Nottingham Ningbo and *Chris Butters* of the University of Warwick highlights the potential of greening residential buildings for energy-use reduction and improved living comfort. Residential buildings play an important role in contributing to greenhouse gas reduction—especially in China, which is the world's greatest emitter of CO_2 and bears a huge potential for energy savings due to its large population. This study assesses the potential of lowering the temperature in buildings by planting trees in their immediate proximity. Three building types commonly found in Chinese cities—from 2-storey private buildings to 30-storey residential blocks—and three types typical for European cities are compared regarding efficiency of space use, indoor temperature and the impact of tree planting. Although the results of the simulation are only indicative and cannot be generalised for every concrete case, they show a significant correlation between the indoor temperature and the density of trees in the building's surroundings. High-rise buildings which are very common in Chinese cities benefit less from this cooling effect, because trees do not reach their higher levels. For the best results, trees should be clustered with gaps allowing sufficient air flow. Based on these results, the authors derive concrete recommendations, including greening unused space, opening this space for residents' social activities, greening facades and balconies and reducing the density of streets in residential areas. Besides a higher living comfort, there are financial incentives in the form of lower energy expenses.

Part II of this edited volume has thus provided solutions focusing on macro-level cooperation in the form of cooperation between Europe and China, but also offered analyses on micro-level with household investment in state-of-the-art equipment and urban planning for increased energy efficiency and heightened living quality.

The book closes with a highly relevant and fascinating part on 'Innovation & Reciprocal Investment in EU-Asian Energy Sectors' reviewing investments, regulatory frameworks and innovative energy sources in Europe and Asia. The section starts out with a comprehensive overview of Chap. 8, "Chinese Investment in the European Union's Energy Sector". The author, *Kin Pong Leung* of Hong Kong Baptist University, analyses the rapid growth of Chinese investment in the EU, and in particular in the EU's energy sector. In 2014 alone, Chinese companies invested US$ 18 billion, of which nearly one-third went into the generation and distribution of electric energy. However, no study has so far dealt with China's energy investment in Europe. Leung's chapter addresses this knowledge deficit by looking at the causes and characteristics of the 37 investment projects between 2005 and 2015. In the beginning, Chinese investment primarily focused on fossil-based electricity generation. The investors, however, soon diversified their portfolio. Since 2010, there is significant investment in the energy grid and renewable energies. The latest trend in 2015 shows the investor's increasing interest in nuclear energy production.

The study finds several reasons for this development. On the one hand, China announced its "Go Global" policy in 1999, promoting international economic cooperation. On the other hand, with ongoing privatisation of European companies, there had been plenty of opportunities for investors and Chinese companies are increasingly striving for access to foreign markets. Furthermore, the transfer of technology and gaining know-how of energy system management as well as investment in renewables are the main driver, which are not the least pushed by the agenda of sustainable cooperation between both regions.

A comprehensive and evolutionary overview of the climate policy of China as the world's largest greenhouse gas emitter is analysed by *Jian Guan* of Sun Yat-sen University in Guangzhou in her Chap. 9 "Climate Change Policies in China". Guan argues that as a rising regional power, China takes both the engagement in international climate diplomacy and national climate strategies very serious. Chinese climate policy evolved in three steps, from mere environmental protection in the 1970s to a responsible leading role in the global community and the integration of social issues into the national climate strategy. The study identifies four main drivers of this transition: (1) international pressure on China during the COP process and in bilateral relations; (2) the country's aspiration to strengthen its reputation as an evolving great power; (3) scientific evidence promoted by epistemic communities; and (4) the need for transformation to achieve a modern economy and sustainable development. However, climate protection is not yet fully seen in line with rapid economic growth which remains a main source of legitimisation for the Chinese Communist Party. Only if further economic development is no longer associated with constantly high gross domestic product (GDP) growth rates, Guan argues, can comprehensive climate policy be effectively implemented in China.

Part III closes with the Chap. 10, "Unconventional Sources of Fossil Fuel in the European Union and China: Perspectives on Trade, Climate Change and Energy Security". Following the US "shale gas revolution", China and the EU have discovered large reservoirs on their respective territories and are examining the possibility of fracking. *Rafael Leal-Arcas* of Queen Mary University of London analyses the current political discussion and trends of using unconventional sources of fossil fuels in light of climate policy and energy security in Europe and China. He argues that even if the EU does not intend to use fracking, its energy policy will be massively influenced by shale gas in the global market. Technically, the EU has the potential to extract shale gas, but there is strong opposition in governments and public opinion alike. While burning of gas produces fewer greenhouse gases and air pollutants than coal, fracking has severe impacts on the (local) environment. The long-term risks and impacts are not yet fully assessed, and scientists disagree in whether the net balance of extracting and burning shale gas is positive or negative for the environment. Geopolitically speaking, however, the EU seeks to reduce its external energy dependence. Shale gas could be a huge step towards this goal. China, with its growing energy demand and its ongoing investments in United States (US) fracking, is another potential employer of this technology. Indeed, China's own resources are limited, and with its increasing engagement in the Middle East, it has access to much cheaper conventional gas. Leal-Arcas concludes that the EU can significantly support decarbonisation of energy markets by developing a sustainable framework for international energy trade. This approach would offer alternatives to the increase in environmentally harmful fracking activities in other regions.

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Abbreviations

ACER	Agency for the Cooperation of Energy Regulators
AD	Aggregate demand
ADB	Asian Development Bank
AMI	Amity-enmity index
AS	Aggregate supply
Bbl	Barrels of oil
Bcm	Billion cubic meters
BRICs	Brazil, Russia, India and China
btu	British thermal unit
CAC	Central Asia–China
CBDR	Common but differentiated responsibilities
CCP	Chinese Communist Party
CDM	Clean development mechanism
CDU	Christian Democratic Union
CEO	Chief executive officer
CESEF	Center for Economic Sustainability and Entrepreneurial Finance
CGN	China General Nuclear Power Corporation
CIF	Cost, insurance and freight
CIS	Commonwealth of Independent States
CityU	City University
CNOOC	China National Offshore Oil Corporation
CNPC	China National Petroleum Corporation
CO_2	Carbon dioxide
COP	Conference of the Parties
CPD	Cassa Depositi e Prestiti Spa
CPEC	China–Pakistan Economic Corridor
CRN	Collaborative Research Network
CVD	Countervailing duty
DECC	Department for Energy and Climate Change

DFID	Department for International Development
DG RELEX	Directorate General External Relations
e.g.	For example
EAEU	Eurasian Economic Union
ECT	Energy Charter Treaty
EDP	Energias de Portugal
EESS	European Energy Security Strategy
ENP	European Neighbourhood Policy
EPSRC	Engineering and Physical Science Research Council
ESPO	Eastern Siberia–Pacific Ocean
ESS	European Security Strategy
ESSCA	École des Sciences Supérieurs Commerciales d'Angers
EU	European Union
FAR	Floor area ratio
GDP	Gross domestic product
GI	Green infrastructure
GSGP	Graduate School of Global Politics
HH	Household
Hong Kong PolyU	Hong Kong Polytechnic University
HV	High voltage
ibid	In the same source
IEA	International Energy Agency
IREGE	Institut de Recherche en Gestion et en Economie
ITGI	Interconnector Turkey–Greece–Italy
JRC	Joint Research Centre of the European Commission
KAS	Konrad-Adenauer-Stiftung
km	Kilometre
kWh	Kilowatt hour
LNG	Liquefied natural gas
MOFCOM	Ministry of Commerce of People's Republic of China
MoU	Memorandum of understanding
MS	Member States
MSR	Maritime Silk Road
MW	Megawatt
N/A	Not applicable
NATO	North Atlantic Treaty Organisation
NBP	National Balancing Point
NDC	Nationally determined contribution
NDRC	National Development and Reform Commission
OBOR	One Belt, One Road
OECD	Organisation of Economic Cooperation and Development
PEEREA	Protocol on Energy Efficiency and Related Environmental Aspects
PRC	People's Republic of China
PV	Photovoltaic

R&D	Research and development
RECAP	Regional Project "Energy Security and Climate Change Asia-Pacific"
REES	Risky External Energy Supply
REN	Redes Energéticas Nacionais
RESC	Regional Energy Security Complex
RMB	Renminbi
SAFE	State Administration of Foreign Exchange
SAR	Special Administrative Region
SC	Surface Coverage
SEE	School of Energy and Environment
SER	Strategic Energy Review
SOEs	State-owned enterprises
SREB	Silk Road Economic Belt
TAP	Trans Adriatic Pipeline
Tcf	Trillion cubic feet
TCP	Trans-Caspian Pipeline
TRACECA	Transport Corridor Europe-Caucasus-Asia
UACES	University Association for Contemporary European Studies
UHIE	Urban Heat Island Effect
UHV	Ultra-high voltage
UK	United Kingdom
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
US	United States of America
USD	United States Dollars
USSR	Union of Soviet Socialist Republics
WTO	World Trade Organization

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Part I
The Geopolitics of Energy in Europe and Asia

Chapter 1
Changing Patterns in Sino-Russian Energy Relations and Their Implications for European Energy Security

Saskia Jürgens

1.1 Introduction

The year 2014 was an eventful one for the European Union (EU) and its energy security. Shaken by the Ukraine crisis, the annexation of Crimea and the 'Power of Siberia' gas deal between China and Russia, the EU considered the possible consequences of these events on its security of energy supply in the European Energy Security Strategy and the European Commission's proposal for an energy union. Throughout the evolution of European energy policy, a trend of gradual Europeanisation is evident. Thereby, certain recurring issues on a supranational and Member State level, such as competing national interests, multi-level governance deficiencies, energy dependency have influenced its development. Simultaneously, strong reactions to Russia's behaviour, as the EU's single largest energy supplier, are noticeable. As China is Russia's alternative, or additional, buyer of large amounts of resources, it is debatable if this Sino-Russian relationship has an influence on the Europeanisation trend in energy policy. This chapter investigates if Sino-Russian energy relations impact European energy security and how, why and to what extent the recent developments in Sino-Russian energy relations have impacted the EU's energy security. In view of Buzan and Wæver's regional security complex theory, with energy security as an additional dimension, the EU is theorised as a developing regional energy security complex which is penetrated by the changing patterns in Sino-Russian energy relations. Thereby, the internally induced factors of European energy security (five at the Union level) and externally induced factors (the two Sino-Russian energy relational patterns) are considered. The patterns in Sino-Russian energy relations do impact

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the EU and its energy security. In fact, they have, to a certain extent, accelerated the Europeanisation of energy policy for the benefit of collective security.

1.2 European Security and the Energy Factor

The timing of the 'Friendship Treaty' agreed between China and Russia during the Ukraine crisis, the simultaneous signing of a $400 billion USD gas deal, and Russia's intention to double bilateral trade with China by 2020, is noteworthy (Barkin and Rinke 2014). This development is interesting for the European Union's (EU) energy security, when we take into account the Ukraine crisis, the consequent sanctions and the potential competition for Russian resources with China (Stang 2014). The 2014 European Energy Security Strategy (EESS) highlights energy security as significant for its security and prosperity, and identifies Russia and the EU's dependency on Russian energy supplies as key challenges. As the EU increased its energy security, it started a trend of Europeanisation, however, it remains vulnerable to external shocks. Although Russia has historically been the 'challenger' in energy security, China's role in this respect is gaining in importance. Thus, the bilateral patterns in the Sino-Russian energy relationship and their implications for European energy security are investigated: Do Sino-Russian energy relations impact European energy security? How, why and to what extent do the recent developments in Sino-Russian energy relations affect the EU's energy security?

To provide answers to these questions, an analytical framework based on the regional security complex theory of Buzan and Wæver is used. A Regional Security Community (RSC) is 'a set of units whose major processes of securitisation, de-securitisation, or both are so interlinked that their security problems cannot reasonably be analysed or resolved [individually]' Buzan and Wæver (2003). They are designed by fears and aspirations, thereby patterns of amity and enmity shape them based on *roles* (enemy, rival, friend), which are expressed in geographically coherent patterns of security interdependence, affected by historical relations or civilisational areas. Thereby *penetration* is the connection between global powers and the RSC (Buzan and Wæver 2003, pp. 45–48). The EU stands out as a *centred region integrated by institutions*, through the development of a security community, de-securitisation occurs and units behave as friends, therein problems are solved as 'normal political, economic, environmental, and societal problems—not as matters of security' (Buzan and Wæver 2003, p. 55). The end of the Cold War brought ten new security challenges to Europe, but Buzan and Wæver excluded energy security in their listing of these security challenges (Buzan and Wæver 2003, pp. 356–361). Despite the analytical strength of their framework, this chapter argues that energy security cannot be neglected today. Traditionally, energy security is defined as the 'availability of energy at all times, in various forms, in sufficient quantities and at reasonable prices' (Meidan 2008, p. 34). The RSC theory is conducive for assessing the case of European energy security because it allows us to look at the EU as a (developing) Regional Energy Security Complex (RESC); its external *penetration* concept allows us to locate the changing patterns in Sino-Russian energy relations within the EU's RESC; and it connects regional (EU level) with unit level (Member State level) analysis. Thereby, the internally induced factors of European Energy Security (five on the EU level)[1] and the externally induced factors (the two Sino-Russian energy relation patterns) are taken into account. It is argued that the existing trend of the Europeanisation of energy policies is amplified by Sino-Russian energy relations.

1.3 Phase 1: Russia's Advantage (2000–2008)

China and Russia appear to be ideal partners; besides the geographic proximity of the countries, their supply and demand structures are complementary. Nevertheless, significant bilateral cooperation between the two developed slowly, with Russia initially approaching China about a cross-border oil pipeline cooperation in 1994 (Yu 2003). Due to China's domestic circumstances, this option only became feasible after the Asian financial crisis (1997–1998) when the country became a net oil importer, based on a combination of increased demand and very limited domestic resources, as China owns only 1% of gas and 2% of the world's oil reserves. China's 'Going Out Policy' (走出去战略) highlights the importance of energy security (Shi 2008, pp. 137–143) and its 'Twenty-first Century Oil Strategy' aims at diversifying suppliers, decreasing foreign oil imports, establishing national reserves, more efficient consumption and cleaner energy sources (People's Daily 2002).

Russia had an advantageous negotiating position on energy, due to the rising price of oil from 2000 onwards and China's growing demand and increasing preference for overland supply. Furthermore, Russia's bargaining power was enhanced by a combination of factors including the Russian rouble's devaluation (Wilson 2004, p. 84), the power projection policy through energy supply earnings, the diversification of buyers for political leverage, flexibility and profits, and the steady increase in oil production since the early 2000s (Downs 2010, pp. 150–151). While China's energy market was restructuring towards cleaner technologies, such as the consumption of natural gas and oil, imports were still necessary (Downs 2010, p. 148) and domestic oil production was insufficient. Furthermore, domestic oil prices, once pegged to international prices, increased and demand for imports rose (Zha 2006, p. 180). Geopolitically, energy market latecomer China faces challenges in its search for a secure supply as available resources are often located in unstable or conflict-prone regions, and any resources shipped have to pass through the increasingly unpredictable South China Sea (Amineh and Guang 2012, pp. 27–28). This results in its state-owned enterprises (SOEs) aggressively pursuing resources abroad, searching for maximised long-term supply through control (Blank 2005, p. 102) and partnering with other energy-producing/consuming countries (Shi 2008, pp. 142–143). Thus,

[1]The initial paper included a second Member State level of analysis on the pattern's impact on Germany, but no direct impact on Germany was found, explainable through the strong reliance of Germany on Russia through direct pipelines.

overland suppliers like Russia and Central Asia, who possess 37% of global gas reserves, are prioritised, moving up from their position as 'strategic backup' (Ziegler 2006; Downs 2010). This prioritisation is very much in line with Russia's focus on diversification of buyers, as outlined in Russia's 'Energy Strategy up to 2020' that was published in 2000 (Wilson 2004, p. 85). Vladimir Putin, then Prime Minister, declared construction of an oil pipeline with China a priority in 2000 (Wilson 2004, p. 69) and Russia played the 'China card'[2] in price negotiations with Europe (Lo 2008, pp. 138–141). However, Russia's goal of exerting autarchic control and price manipulation to remain a monopolistic producer, contradicted China's shared equity strategy.

Despite the incentives for cooperation, the countries' track record demonstrates the challenging nature of this relationship. First, the realisation of the Angarsk—Daqing pipeline, was prevented by Russian reservations in 2002 about a single customer pipeline, the consequent dependency on China and the involvement of the private oil company Yukos. Despite eventual deals between Yukos and China National Petroleum Corporation (CNPC) in 2003, succeeding developments troubled the Chinese; Yukos' CEO was arrested, the company was dismantled and the pipeline modified to include a leg to Japan. The latter allayed Russian concerns, as it would involve selling oil via a pipeline to two new customers and involved the less developed Russian Far East (Downs 2010, pp. 152–157). Moscow's manoeuvring typifies the 'depth of bilateral mistrust' (Itoh 2011, p. 157). A second proposal for Russia to export to China and South Korea failed due to China's disinterest (high costs and Gazprom's pipeline monopoly) and geopolitical games with the EU in simultaneous negotiations, which Russia put down to financial disagreements (Downs 2010, pp. 152–153; Wilson 2004, p. 84). Thus, for Russia this pipeline project 'testifies to its geopolitical manoeuvre concerning energy' (Itoh 2011, p. 33).

Increasingly frustrated by Russia's tactics, China strongly diversified its energy suppliers from Central Asian countries (Herberg 2009, p. 292). They provide the same geopolitical advantages but are less concerned about Chinese influence on domestic policies (Downs 2010, p. 157), prices and turning into 'China's source for raw materials' rather than an equal partner, furthermore these suppliers allay China's concerns regarding a strong energy dependency on 'unreliable' Russia. For Russia, the Chinese competition in its 'sphere of influence' is bothersome, as its 'Energy Strategy up to 2020' (2000/2003) strongly highlights state control and the use of energy as a political tool, which can be used with members of the Commonwealth of Independent States (CIS) where the neo-imperialistic interpretation of strategy emphasises leverage and power over these states (Blank 2005, pp. 102–107; Wilson 2004, pp. 85–106). This is further fanned by the need to sustain economic growth and freedom of manoeuvre. Thus, as China diversifies suppliers in Central Asia, intensified by the 2006 Ukraine crisis and memories of the Sino-Soviet conflict in the 1960s (Itoh 2011, p. 41), it also 'increased its bargaining power *vis-à-vis* Russia'

[2]Playing the 'China card' refers to a negotiation tactic employed by the Russian negotiators to emphasise China's interest to buy Russian resources, mostly in negotiations with European countries.

(Itoh 2011, p. 35; Eder 2014, p. 56) by undercutting the latter's influence in the region.

To summarise, the energy relationship between China and Russia is a 'protracted and uncertain courtship' (Downs 2010, p. 146). Both are interested in achieving deals, but since China realised that negotiations with Russia are difficult and their outcome unpredictable, it has diversified its efforts. Russia's mistrust and its pricing 'games' with Europe and China weakened its position, especially towards the end of this phase.

1.4 Phase 2: Growing Chinese Advantage (2008–2014)

Russia suffered grievously as a result of the 2008 global financial and economic crisis, as the country's energy-export-led economy caused it major financial problems. Indeed, the crisis was a 'turning point' (Yang 2010 in Eder 2014, p. 52) in Sino-Russian energy relations, as investment shortages stimulated greater cooperation between the two countries (Itoh 2011, p. 32). China's superior financial situation caused the balance of power to shift; in 2009 it provided Russia with a series of long-term development loans for infrastructure projects in return for long-term supply contracts (Pradeep 2009, p. 268). The crisis resulted in the increased dependency of Russia on China and joint investments and greater cooperation between Central Asia and China (Eder 2014, pp. 53–56; Itoh 2011, p. 33).

In 2014, China faced a foreign policy dilemma concerning Ukraine, but due to potential energy contracts with Russia and the importance of bilateral relations, Putin's behaviour was tolerated by China (Godehardt et al. 2014, pp. 1–4). Putin's visit to China focused on upgrading bilateral relations and finalising the 'Power of Siberia' pipeline deal after 20 years of negotiations (Yu 2014a, p. 131), paving the way for a Friendship Treaty. Retrospectively, the 'Ukraine factor … added urgency to the goal of closer coordination' (ibid.). Indeed, with Russia facing European and American sanctions, the focus of the trip was clearly economic, highlighting the dynamics of *realpolitik* in the Sino-Russian relationship (Freire and Mendes 2009). Despite observers' scepticism due to price issues, the pipeline deal was reached as a result of Russia's need to mitigate the crisis (Yu 2014a, p. 134). Construction of the pipeline was launched quickly (Yu 2014b, p. 125), and the pipeline may send China the equivalent of Russia's current supplies to Europe within ten years (Yu 2014a, p. 133). To further illustrate Russian eagerness, a second deal capable of doubling the gas supplied, the 'Altai/Power of Siberia 2' pipeline, was negotiated, which would allow Russia to become a true 'swing supplier between Europe and Asia' (Feng 2014). A framework agreement was signed in 2014 but because of China's economic slowdown, it was delayed indefinitely. Needless to say, Russian eagerness provides China with great leverage (Shek et al. 2014).

In summary, this phase is characterised by Chinese irritation, the search for alternative suppliers and the repercussions of the crisis. Consequent to the dispute with the EU and USA, Russia found in China a good option for fulfilling its customer diversification (Verlin and Inozemtsev 2011). Simultaneously, this need also created an increasingly asymmetric relationship (Klein 2014). Awkwardly for Russia, this happened while China was successfully diversifying its own suppliers (Rudolf 2014; Wishnick 2010), thereby reducing Russia to a 'junior partner' (Klein 2014, p. 6).

1.4.1 Factors in European Energy Security

1.4.1.1 Import Dependency

The EU faces an energy import security challenge due to insufficient domestic resources, high consumption and insufficient energy production. Together, the Member States possess about 0.6% of the world's oil, 2% of gas and 7.3% of coal reserves (Umbach 2008, p. 13). Since 1995, the EU's import dependency on all fuel types has increased, due to the EU's domestic decline in production and growth in imports, thereby Russia is by far the largest exporter of gas, crude oil and liquefied natural gas (LNG) to the EU. In fact, the volume of Russian exports to the EU increased more than 4.5 times (1990–2012), to the point where by 2012, Russia provided 34% of crude oil, 32% of gas and 26% of solid fuels imports of the EU's total imports of these resources. This resulted in an import dependency of 53.4% for all fuels in 2012 (European Commission 2014b, pp. 24–66). Thus, Europe increased its energy *in*security in this period. Further exacerbating the asymmetrical relationship is the fact that many other energy suppliers to the EU are either unstable states, or are located in unstable regions. Disturbances, such as the Arab Spring and the Ukraine crisis, the obstruction of production, blockage of transit networks and important choke points and the consequent sharp price increase, are a constant fear for the EU (Amineh and Guang 2012, 4; Commission of the European Communities 2007).

1.4.1.2 Incoherent Liberalisation Policies

The EU's incoherent liberalisation policies are strongly connected to its set-up. 'Energy' is a shared competence as outlined in the Lisbon Treaty (European Union 2012, Art. 4), still competences are mostly limited to infrastructure, environmental and internal-market-related issues. Pre-Lisbon the EU could *de jure* not act on energy policy, although the importance of energy for the stability and prosperity of the EU was de facto recognised in connection with climate change and internal market policy (European Commission 2000). Consequently, even post-Lisbon the EU's competences are limited, until an energy union is established or rights are transferred to the EU. However, the EU's sole responsibility for the energy infrastructure and the functioning of the internal market creates a scope of action for energy security, such as completing important infrastructure projects.

1.4.1.3 Competing National Interests

In the EU, energy supply structures partially explain diverging national opinions and strategies. Baumann and Simmerl (2011) identify four geographic fossil fuel supply energy regions: Northern/Central Europe, Adriatic/South Eastern Europe, Central/Eastern Europe and Western Europe. Although Member States from Northern/Central Europe, Adriatic/South Eastern Europe and Central/Eastern Europe are highly dependent on imports from the former Union of Soviet Socialist Republics (USSR), the non-ex-Soviet states have since diversified their suppliers. Countries from the Adriatic/South Eastern Europe receive additional supplies from Africa and the Middle East, while Central/Eastern European Member States lack an alternative supplier and are extremely dependent on Russia. As Western European countries, with the exception of Germany, do not enjoy strong energy ties with Russia, they rely on intra-European suppliers and imports from Africa, the Middle East and Latin America (Baumann Simmerl 2011, pp. 14–15).

These 'energy regions' have a decisive effect on national interests and expectations regarding policies, e.g. the Central/Eastern Member States worry about Russian dependency, thus favour a common policy for collective security. In addition, a state's relationship with Russia, both in the light of it being the single largest energy provider and the historical context of the two countries, influences national preferences. Generally, the 'old' Member States are more accommodating and tolerant of Russian behaviour than the 'new' ones, which are suspicious of Russia and deeply disdain the use of energy as a weapon (Walker 2007). Additionally, national strategies and decisions on the energy mix, especially nuclear energy, highlight diverging opinions (Amineh and Guang 2012, p. 21). Whereas the United Kingdom (UK) favours a strong market-based policy, Germany is sceptical of the market, advocating steering. This was illustrated in July 2007 during a European Parliament debate on unbundling. Germany, France and several new members argued against the Commission's proposal of further liberalisation, which was supported by the UK, the Netherlands and the Scandinavian countries (Eikeland 2011, pp. 31–32).

1.4.1.4 Inability to Create a Common Foreign Energy Approach

Although the Commission and some Member States tried to establish a common energy policy, the Commission (European Commission 2000) addressed the asymmetry between the EU's import vulnerability and its lack of tools to 'negotiate and exert pressure'. Since then, a process has been achieved through treaties, e.g. the Memorandum of Understanding on energy cooperation with Ukraine in 2005. However, the cutting-off of gas to Ukraine in 2006 drastically highlighted the EU's vulnerability and the need for a common external policy (Jegen 2014, p. 8). Suggestions like Poland's 'Energy NATO' and the 2006 Green Paper emphasised the need for a common external policy (European Commission 2006). The 'wake-up call' (Ferrero-Waldner 2006) initiated a focus on energy security by incorporating it in all external policies and stepping up energy cooperation with Turkey, 7% (€22 million) of the Commission's post-2007 external budget was allocated to 'energy', and an energy unit was created within DG RELEX. Finally, by agreeing to the 'Third Energy Package', Member States accepted the Commission's path towards a common energy policy, codified in the Lisbon Treaty: the new DG Energy consisted of energy and foreign policy personnel, appointing separate Commissioners for Energy and Climate Change, and the DG Energy leading energy policies' external dimensions (Youngs 2011, pp. 44–46). However, according to the Commission (European Commission 2015b), 'the absence of a common stance *vis-à-vis* non-EU countries' is one of the three current challenges to the EU's energy security.

1.4.1.5 Multi-level Governance Deficiencies

European energy policy involves many players at various governance levels and challenges such as competing interests, implementation challenges and lowest common denominator decisions. Specifically, competing national interests, conflict amongst EU departments as reflected by overlapping energy and climate policies, and divergence between EU institutions and groups of member states, play a significant role. Additionally, the International Energy Agency (IEA) (2014) found that asymmetric implementation of directives is a major challenge and creates a more divergent internal market.

1.5 Impact on the EU's Energy Security

1.5.1 Period of Russian Advantage (2000–2008)

For the Commission, the harmonisation of the internal market necessarily involves a common internal and external energy policy; thus building collective energy security, while supporting the development of the RESC with itself at its centre. In 2000, the Commission (European Commission 2000) was concerned that without the tools to 'negotiate and exert pressure' (ibid.) the EU remained vulnerable to external shocks. Therefore, it developed a strategy for supply security and reducing external dependence, identifying environmental and climate concerns, and development of the internal market as the main concerns. As an exclusive Member State competence, the lack of political consensus made common action challenging. To mobilise the Member States, the Commission launched a debate, resulting in a Green Paper drawing up an external long-term strategy, and the 'Second Energy Package' which completed the internal electricity and the gas markets in 2003.

Efforts to increase external coordination started before the Ukraine and Georgia conflicts in 2006. For example, the EU–Russia energy dialogue established in 2000, but, it 'degenerated into a technical talk-shop between semi-empowered, semi-interested technocrats' (Talseth 2012, p. 3). In 2003, the European Security Strategy

(ESS) referred to energy dependency as a ‘global’ (Council 2003, p. 3) not a key EU challenge, neglecting geopolitics. Nevertheless, the 2005 UK Presidency managed to achieve an agreement on coordinating external energy relations (Youngs 2011, pp. 42–43). The 2005/6 Ukraine crisis and the gas shortages in Ukraine and Georgia accentuated the need for an external strategy, as media coverage highlighted the EU’s vulnerabilities and, the public became aware of Russia’s use of energy as a political tool (Jegen 2014, p. 8), with the actions being interpreted as a ‘clear warning of Moscow’s willingness to use its energy resources to exert political influence’ (Smith 2007, p. 1). A subsequent Green Paper in 2006 re-established the debate and created a new energy policy, based on ‘sustainability’, ‘competitiveness’ and ‘security of supply’, including a regular Strategic Energy Review (SER) (European Commission 2006). However, a struggle was evident (Smith 2007, p. 2), as competing national interests as well as German and French resistance, prevented successful ‘unbundling’ (Amineh and Guang 2012, pp. 14–15). Nevertheless, many Member States started to develop group affiliation to the RESC. Although pushed by Russian behaviour, the strategy is not directly linked to Russia, instead the challenge of energy insecurity is approached from a broader perspective, based on the energy triangle.

These moves were criticised as a ‘brief flurry’ (Smith 2007, p. 1) stemming from the re-emergence of ‘economic nationalism’ (Vos 2006). Furthermore, the EU-15 questioned whether energy solidarity should extend to new members and Poland was not supported in pressuring Russia to ratify the Energy Charter (Smith 2007, pp. 1, 5). Rather Russia used its monopoly and the ‘China option’, to prevent being forced to ratify the Charter (Lo 2008, p. 138). The EU’s discord can be explained within an emerging RESC; since security cannot yet be guaranteed in the short and medium-term, as energy security is essential to national security, states do not challenge a monopolistic supplier.

Commissioner Ferrero-Waldner (2006), the Commission and the Benelux states emphasised that energy policy should be incorporated in the EU’s broader policies and the European Neighbourhood Policy (ENP) (Benelux States 2007; Commission of the European Communities 2006). The consequent prioritising of energy forced Member States to consider the external dimension of energy security, emphasised in the first SER, which highlighted key challenges, e.g. predictability and reciprocity, an energy supply solidarity mechanism and strengthened European coordination (Commission of the European Communities 2007, pp. 18–19). Moreover, the first Commission-driven energy action plan (2007–2009) was based on diversification of suppliers, crisis response mechanisms, transparency and an assessment of energy import patterns (Youngs 2011, p. 46). The Commission, as its central institution, pushed the development of the RESC from policy areas related to energy, such as climate and internal market policies, thus, indirectly increasing collective and comprehensive energy security.

High oil prices in the mid-2000s, Russia’s periodic conflicts with Ukraine, consequent disruptions of supply and the threat of terrorist attacks on pipelines have all pushed energy to the top of the EU’s foreign policy agenda. During this period, the Sino-Russian relationship was dominated by Russia’s ‘mood swings’, with no direct EU–China energy link. The ‘China factor’ did not play a very significant role for European energy security, although a strategic rivalry with China was expected in Africa and Central Asia (Meidan 2008). However, the delayed detection of the significance of external energy security and the tendency of 'old' Member States to trust Russian supply prevailed.

1.5.2 Period of Growing Chinese Advantage (2008–2014)

The 'Third Energy Package' led to the modernisation of energy networks, establishing intra-EU-connections; European oversight; the inclusion of new technologies and energy sources; new supply routes; and improved frameworks for supply and transit countries (European Commission 2009a). This caused further institutionalising of the RESC and dismantling of incoherent liberalisation policies. In 2009, the Member States accepted the 'drive for a common energy policy and approved an explicit link between climate and energy policies' (Jegen 2014, p. 7), thereby progressing towards collective security and the RESC. Convery (2009) argues that the development of an energy policy that focused on a competitive, secure and sustainable supply was driven by Moscow's actions and the Kyoto Process. Thus, the Commission could create a coherent, broadly supported framework (Jegen 2014, p. 8). Furthermore, since the introduction of the 20-20-20 targets in the Climate and Energy Package (2009) the EU is 'increasingly defining energy choices by setting [concrete] targets' (Amineh and Guang 2012, p. 19) and burden sharing. The linkage was reaffirmed in 2013/14 with the '2030 Framework for Climate and Energy', through drastic emission cuts, binding targets and the promotion of renewable energy production (European Commission 2014a, 2015a). This indicates a shift towards collective security and the slow de-securitisation of energy policy, which could in part be achieved thanks to the EU's increasing energy independence due to domestic renewable energy production.

The Lisbon Treaty codified energy as a shared competence, and the strengthened position of the High Representative was partially supported to increase unity on energy policy. Some responsibility was transferred towards the centre, highlighting the partially developed RESC, but energy policy remains dependent on the Member States. This Europeanisation can be explained in part by geopolitical concerns and external factors (Youngs 2011, p. 46). These factors included the changing Sino-Russian patterns, the large-scale energy and infrastructure deals between Russia and China since 2008, the increasing assertiveness of Chinese foreign policy since 2007 and the shifting of attention towards building common measures and policies (He and Feng 2012), which in turn contributed to the RESC and increased collective security.

The disruption to gas supplies to Ukraine in 2009 highlighted the need for a 'Third Energy Package', resulting in further liberalisation, including the unbundling of energy generation, transmission and distribution; increased oversight and cooperation amongst national regulatory agencies; and the establishment of a weak Agency for the Cooperation of Energy Regulators (ACER) (European Commission 2009b). Despite its necessity from a collective security perspective, the incomplete de-securitisation of energy still resulted in national energy security taking precedence, e.g. disagreements over unbundling, and the failed ‘Gazprom clause’, and 25 infringement procedures in 2009 due to protectionism, thus, the EU failed to *ex ante* prevent Russian market domination (Youngs 2011, pp. 49–50). In contrast, the more unified Russian ‘2020 Energy Strategy’ that was published in 2010, cited Russia indirectly as the ‘most immediate geopolitical concern’, and justification for a pan-European energy market and good relations with non-EU suppliers as well as transit countries (Amineh and Guang et al. 2012, p. 16).

In response to the annexation of Crimea, in 2014 the Commission drafted the EESS and an Energy Union. The former clarifies vulnerability to supply shocks and disruptions; the need to reduce dependency on certain suppliers, particularly Russia; energy types and routes (European Commission 2014c, p. 2); and the need for a collective approach through a real internal market, greater cooperation and ‘more coherent external action’ (European Commission 2014c, p. 3) and solidarity. Donald Tusk, President of the European Council, had already suggested facing Russia collectively in a Financial Times article in spring 2014 (Tusk 2014). The Commission’s (European Commission 2015b) institutional solution, the Energy Union, is the logical next step in light of previous policies. Developments including the ‘increasing European uncertainty over Russian energy supply … [due to] Russia’s current rapprochement to China … directly threaten European energy security’ (Brow 2014, p. 2), made this institutional solution possible. Thus, Sino-Russian energy cooperation accelerated Europeanisation, i.e. the institutionalisation of energy policy, towards the full establishment of an institutionalised European RESC. However, Western sanctions gave Russia incentives to close its long-negotiated deal with China. Interestingly, the EU prioritises punishing Russia, over its own energy security; although an imprudent reaction, the EU simultaneously creates collective structures in order to increase its energy security.

A clear shift in policy is evident; the EU’s position becomes more dominant, as the Member States realise that only collectively and through cooperation at the EU level can real security be achieved (Amineh and Guang 2012, p. 19). The Energy Union can be understood as a response to penetration of the EU’s RESC through the bilateral Sino-Russian energy relations, the new ‘high’ in their relationship, the conclusion of the 2014 gas deal, and a general ‘perception that the EU and China might be competitors in the geopolitical arena for access to foreign markets’ (Ibid. 2012, p. 1). As China is the only real alternative large-scale recipient of Russian resources, without it, any threat of Russia moving away from Europe is unrealistic (Lo 2008, p. 140). However, the more Russia played the ‘China card’, the greater European efforts were to diversify supply. Thus, as the EU gradually reduces its dependency, Russia is becoming a victim of its own strategy.

1.6 Conclusion

To summarise, it is evident that two phases, Russia’s advantageous position (2000–2008) and Chinas’ increasingly advantageous negotiation position (2008–2014), have had an impact on European energy security, mainly due to the perceived competition for Russian energy resources and Russia's use of energy as a policy tool. Before 2003, this was not an issue but Chinese growth provided alternative export options for Russia. Initially, this was not perceived as a threat by the EU, but the supply disruptions in 2006, 2008 and 2009 as well as the invasion of Georgia (2008) and the annexation of Crimea (2014) have shown the incalculable behaviour of Russia. Consequently, the patterns of Sino-Russian energy relations are important for European energy security, as the closer the energy relationship is between Russia and China, the more likely a deal between the two, and the stronger Russia's negotiation position is *vis-à-vis* the EU. In fact, every instance of penetration gave the EU renewed impetus to develop a common policy and a central RESC with single decision-making authority: an Energy Union. Meanwhile, the EU encountered the discussed difficulties but the Sino-Russian energy cooperation patterns, especially the second one, gave the EU the additional impulse to overcome its internal challenges and accelerate Europeanisation.

Since then the EU has taken some considerable steps towards collective energy security. Most noticeable was the final decision to establish an Energy Union, which is now a special Commission project headed by Maroš Šefčovič and the presentation of the Clean Energy for All Europeans package in December 2016. Further, increased diversification of energy suppliers, and in 2016, the energy cooperation noticeably with China ('EU–China Energy Roadmap') and as well as the new rule on Intergovernmental Energy Agreements with third-states, will increase the EU's energy security and dampen the impact on Sino-Russian energy relations on the former.

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Chapter 2
The EU and China: Energy Policy Interdependence: Interactions Between Internal Energy Policies of the EU and China

Thomas Sattich and Duncan Freeman

2.1 Introduction

Both internal European Union (EU) and Chinese energy policies are intended to create the framework for a major transformation of their energy systems. In the EU, the successful implementation of new energy policies largely depends on the capability of EU policy-makers to reconcile more or less conflicting policy requirements and interests in a heterogenic patchwork of power systems and ownership structures. But there is more to energy policy within the EU than the bloc's internal geoeconomics: the imbalance of domestic energy resources and energy demand increase the interdependencies between Europe's energy system and those of other parts of the world. The interdependencies concern not only physical energy supplies but also other aspects of the energy system. At the same time, China's energy policy faces a similar complex set of internal and external challenges.

This chapter addresses these interdependencies through the interactions of EU and Chinese domestic energy policy. Arguably, there are countries and regions that have a closer relationship with Europe's energy sector than China, but the global impact of China's search for domestic solutions to energy problems increasingly encompasses the EU and vice versa: not only are the energy sectors of both parties increasingly interacting globally (e.g. demand for gas in Central Asia, trade and investment in the renewables sector, global oil markets), but at the same time there is a growing understanding that collaboration in fields such as research and infrastructure could be mutually beneficial. These external aspects of the relationship between the EU

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and China have been extensively studied, but the mutual impact of domestic policy remains relatively unexplored. This chapter considers EU and Chinese policy in the case of two sectors: renewables and grids. Analysis focuses on internal policy to achieve energy goals and its impacts on investment and trade in each sector.

Against the background of depleting fuel reserves (see Hall and Klitgaard 2012), intensifying struggles for accessible energy (see Klare 2009, pp. 263–269), hazardous environmental effects having their root in the way we utilise energy (see Coley 2008, pp. 77–139), the European Commission has called for nothing less than a profound transformation of the EU's energy system (see e.g. Commission). The envisaged changes include decarbonisation, increased use of renewables, increased energy efficiency, a more integrated energy market and increased security of supply. Different EU policies (e.g. European Union 2003, 2009) are intended to create the political and regulatory framework for this *energy transition*,[1] and recent initiatives such as the 2030 climate/energy package, the Energy Union and the Energy Roadmap (European Council 2014; Commission 2015a) are supposed to keep its initial dynamic up. For more than a decade, China has also made increasing commitments to policy targets related to transformation of its energy system (see, for instance, National Development and Reform Commission (NDRC) 2015, 2016).

Despite clear ambitions to make strong commitments, the successful implementation of new EU and Chinese energy policies hence depends on the capability of policy-makers to reconcile more or less conflicting interests, that is making decisions which allocate costs and benefits in ways that foster Europe's and China's *energy transition*.

Yet, the increasing complexity of Europe's and China's energy systems, and their growing interdependence with the energy systems and sectors of other regions make this a difficult task. Not only will the envisaged measures redistribute energy assets between sectors and Member States, the EU's and China's energy policy is also embedded in the international energy system and is dependent on policies adopted by other global energy actors. Their domestic energy policies will thus have both internal and external effects. Policy adopted in the EU will have an impact on China and vice versa.

Taking stock of the various characteristics of power systems in Europe and China and the economic interests behind them (the power sector) is thus imperative. This chapter offers a preliminary assessment of the internal energy policies and interests in the EU and China, and the impact of internal policies in one party on the other through the intermediary of specific energy sectors.

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[1] A transition can be defined as a gradual, continuous process of change where the structural character of a society transforms. Transitions are not uniform and nor is the transition process deterministic: there are large differences in the scale of change and the period over which it occurs. Transitions involve a range of possible development paths, whose direction, scale and speed government policy can influence, but never entirely control (Rotmans et al. 2001, p. 16).

2.2 EU's Internal Energy Policies

European energy policy dates back to the origins of the integration process, but only in 2009 did the EU officially receive the formal competence to actively pursue a European policy. Compared to earlier periods of European integration, the will to shape an overarching and truly European energy policy clearly increased and now represents one of the most dynamic EU-level policies, with an ambitious agenda of transforming energy infrastructure and markets into a Europe-wide, sustainable and cost-effective structure.

Numerous pieces of legislation are designed to create the political and regulatory framework for this transformation. The sectorial dynamics resulting from these EU policies affect the systems of electricity generation, transportation and storage in Europe, and the more effective the implementation of new measures the more the structure of Europe's power system will change in the years to come. Yet notwithstanding this increased importance of the EU as the origin of common, European energy policies, EU energy policy remains a complex field, with at least three dimensions to it:

- Horizontally, rather different policy fields emerged over the decades, reflecting the historical development of the European energy sector. While, for example, the field of *energy security* and *sustainability* dates back to the 1970s with their increased environmental consciousness and oil crisis (see Ganser 2015), *competitiveness* rather reflects later initiatives to finalise the internal market.
- Vertically, Article 194, 2 of the Lisbon Treaty defines energy policy as a shared competence which (formally and informally) leaves Member States much room to pursue their own policies; the range and impact of EU energy policy are thus limited and depend on the capability of Member States to find compromises.
- Diagonally, different policy-making procedures are still in place for the various elements of EU energy policy, reflecting the historical development of European energy policy through various channels such as environmental policy and market integration. Moreover, informal procedures of interest representation such as networks and lobbying further complicate policy-making processes in Brussels.

The implementation of new policy initiatives therefore involves intense negotiations to conciliate contradictory interests, something that traditionally has been far from easy to achieve. Furthermore, in view of strategies such as the formation of national champions, Member State governments still play a decisive role in when it comes to energy policy. It thus is not always clear where national policies end and where EU-level energy policy begins. Depending on the specific sector under investigation, any attempt to analyse the interactions between European and Chinese energy policy therefore must take national policies into account.

Furthermore, European energy policy goes beyond the narrow borders of the EU. The EU is, for example, the world's biggest importer of energy, and its competence to ensure security of energy supply in the Union, defined by Article 194 1b, thus by definition includes the formulation of strategies which affect non-EU regions. And with instruments such as trade regulations or enlargement, development and neighbourhood policy, the EU has various instruments at hand which have an impact on geographic areas beyond the EU and even beyond Europe. Given the blurred separation between the national and the EU level, and the strong relationships between individual Member States and third countries, the activities and various (geopolitical) perspectives of individual countries must also be taken into account.

For all these reasons, developing energy policies which align all—or at least most—relevant actors behind a European approach is a demanding task. Over the last three decades, several focal points emerged:

– Liberalisation of energy markets and their integration into Europe-wide markets (e.g. for electricity or gas);
– Reduction of greenhouse gas emissions, increasing renewables (e.g. wind and solar power) and energy efficiency;
– Security of supply and diversification of Europe's sources of energy.

Public focus has shifted from one issue to another in recent years, but the three policy areas are also intertwined, particularly in the field of infrastructure. Moreover, currently a so-called *Energy Union* is supposed to bring all the different *dimensions* of EU energy policy together under one consistent and overarching strategy. Nevertheless, in view of the multi-faced shape of *European energy policy*, individual sectors need to be treated as individual cases, before any statement about the interactions between European and Chinese energy policy can be made. The reminder of this section therefore analyses European energy policy and its impact on three different sectors in more detail.

2.3 China's Internal Energy Policies

President Hu Jintao and Premier Wen Jiabao in 2003 began a shift in the thinking of the Chinese government on broad questions of economic development, energy and environmental impacts, including climate change. The concepts of scientific development and a harmonious society with "people-centred" development that Hu and Wen advanced began a move away from the previous policy that focused only on GDP growth figures above all else (Central Committee of the Chinese Communist Party 2006).

In 2004, the State Council approved the Medium- and Long-Term Energy Development Plan Outline 2004–2020 and the NDRC formulated the China Medium- and Long-Term Energy Conservation Plan in the same year (State Council 2004; NDRC 2004). The latter plan set comprehensive energy efficiency targets for the Chinese economy and specific industry sectors. In addition to these policy plans, the government has adopted a number of laws that demonstrated increasing focus on energy and climate change. In 2005, the Renewable Energy Law was adopted, and in 2008 the revised and strengthened Energy Conservation Law became effective. In

August 2008, the Circular Economy Promotion Law, which sets basic principles on efficiency and recycling, was passed and became effective in January 2009.

The 11th Five-Year Plan for 2006–2010, for the first time in one of China's Five-Year Plans, set clear targets to reduce energy intensity per unit GDP by 20% by 2010 (NDRC 2006). In 2007, the government issued the National Climate Change Programme setting out in broad principles on how climate change was to be tackled in the period up until 2010.

More recently, President Xi Jinping has called for China to undergo a revolution in energy production and consumption (Xinhua 2014) and the Chinese government has set long-term targets for the transformation of the energy sector (State Council 2014; Whitehouse 2014; NDRC 2016). China's energy policy is defined by a complex set of interconnected considerations that include economic development, energy security, efficiency and sustainability, and climate change mitigation. The Chinese government adopts multiple means to achieve its domestic energy policy goals. The government has adopted administrative and legislative instruments to set and enforce energy targets and uses industrial policy to shape economic development in the energy and other sectors, thus encouraging those sectors that will increase energy efficiency while discouraging those that are inefficient in their energy use. This includes policies such as targets for enforced closure of coal-fired power stations or inefficient industrial plant, as well as subsidies for encouraged sectors such as renewable energy. At the same time, China has increasingly experimented with market mechanisms such as emissions trading. Nevertheless, the government continues to adopt a highly interventionist approach to the energy sector, including through active industrial policy under the umbrella of its economic planning system embodied in Five-Year Plans and other related policy documents such as the 12th Five-Year Plan (2011–2015) and 13th Five-Year Plan (2016–2020).

The complexity of the domestic policy related to energy in China is increased by the presence of multiple actors at central and local government levels that do not always have convergent interests and policies. While the central government sets national policy, which should in principle be adhered to by authorities at all levels, local governments pursuing their own interests and goals frequently have a greater impact on actual outcomes. Similarly, China's energy sector is made up of enterprises that seek to advance their own interests and to influence government policy or which may conflict with each other. These may be both state-owned enterprises (SOEs) and non-state enterprises with various types of ownership structures, which also have links to government at central or local level.

Given China's role in the global energy system, for instance, it is the largest producer, consumer and importer of coal (Oxford Institute for Energy Studies 2014; Institute for Energy Economics and Financial Analysis 2015), an expanding importer of oil and gas that has become the largest market for several producing countries, the leading investor in and installer of renewables as well as having many of the most important companies in this sector (REN21 2015), and also has the most extensive nuclear construction programme; the internal economics of energy in China have a global impact. Thus, regardless of any externally directed policy adopted by the Chinese government on energy, the domestic complex has external as well as internal outcomes, which may affect the EU and its capacity to achieve its own energy policy goals.

2.4 The Policy Interactions Between Europe's and China's Energy Sector

2.4.1 Renewables

The renewable sector is one where domestic policy in both the EU and China has had a significant mutual impact. In the case of solar photvoltaic (PV) especially, this has been mediated primarily through trade, but the impacts on wider energy policy have been considerable.

2.4.1.1 Renewables in Europe's Energy Sector

Increasing the share of renewables such as wind and solar power in the European electricity system is one of the long-standing goals of EU energy policy. Since in 1997 the EU set out the aspiration to obtain 12% of electricity from renewable sources by 2010, EU legislation has encouraged Member States to develop framework conditions to stimulate the deployment of electricity generation capacity based on renewable energy. And since then, the promotion of renewable energy has moved gradually up the European agenda.

This policy has shown results. According to the EU's last progress report on the development of renewable energy in Europe, technology deployment and production rates are in line with the trajectory foreseen in the *National Renewable Energy Action Plans*, and total installed capacity for renewable electricity generation has increased significantly. As a result of this development, renewables now account for approximately 26% of total EU gross electricity generation (as of 2013; see European Commission 2015b, p. 7).

Wind and solar power are the main drivers behind this development: starting from very modest levels around the year 2001, installed capacity of these two technologies shows remarkable EU-wide average annual growth rates of 54.39% for wind and 98.59% for solar power between 2001 and 2012. And since growth rates are proportional to the inverse of energy output (Höök 2012, p. 32), the contribution of these two forms of power generation to power consumption grew by a factor of 8.25 (wind) and 71.43 (solar) in the same time period (Chart 1).

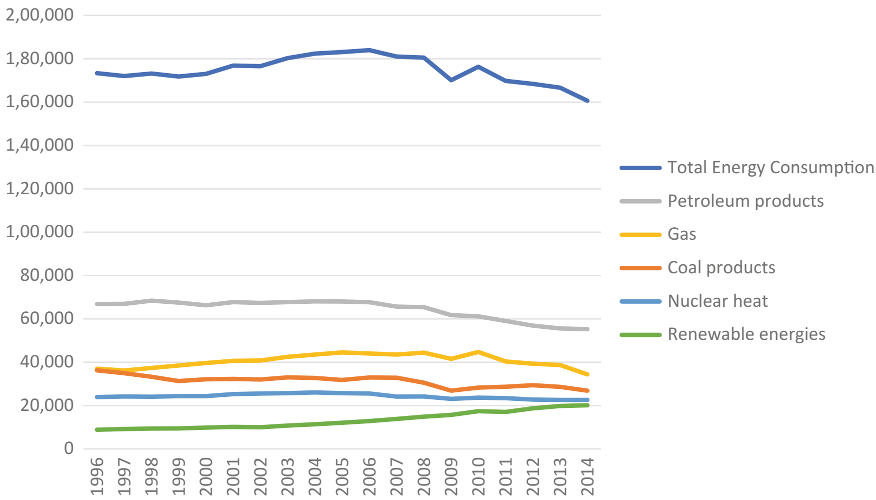

Chart 1 EU-28 gross inland energy consumption, 1996–2014 (10,000 tons of oil equivalent). *Source* Eurostat

2.4.1.2 Renewables in China's Energy Sector

As policy documents already cited show, the expansion of China's renewable energy sector has been a key feature of government policy for more than a decade. Government policy on renewables in China covers wind, solar PV, biomass, wave energy and hydropower. Nuclear power is also considered part of this policy and is included in the non-fossil energy sector in China. In the past decade, both wind and solar PV have been central to the policy. For these two sectors, the policy encompasses both industrial production of technology such as solar PV cells and wind turbines and their deployment. China is now the world's largest single investor in and installer of renewable energy capacity (Frankfurt School-UNEP Centre, Bloomberg New Energy Finance 2015, 2016). As a result, the share of renewables in China's energy production has increased considerably in the past decade. According to Chinese government statistics, in 2013 non-fossil fuels (hydro-, nuclear and wind power) accounted for 9.8% of China's energy consumption (National Bureau of Statistics 2014) (Chart 2). Current policy in China calls for continued rapid expansion of the role of renewables in energy supply.

The policy treatment has not been uniform for all renewable sectors. For instance, by the early 2000s the Chinese government decided to give priority to wind over solar PV on the grounds that it was a more mature technology with greater potential for industrial application. This led the government to provide support to the wind power industry at the national level for both production and installation.

China rapidly became a major producer and installer of wind turbines. Despite the development of the industry in China into a world leader, in 2014 five of the top ten wind power equipment manufacturers in the world were Chinese (REN21

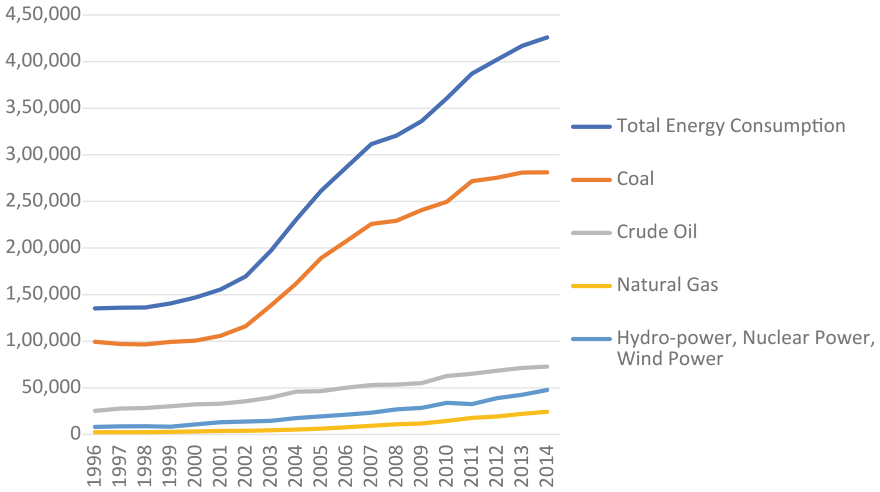

Chart 2 China total energy consumption (10,000 ton standard coal equivalent). *Source* National Bureau of Statistics

2015), its direct external impacts have not been great. Chinese companies faced a domestic market which for many years has generally been the largest in the world, such that by 2014 China accounted for 30.7% of global installed wind power capacity, and have had little incentive to seek markets abroad (British Petroleum 2015). Chinese wind turbine manufacturers have only made small investments in research and development (R&D) and production outside China including some in the EU, such as the acquisition by Goldwind in 2008 of a shareholding in Vensys in Germany and the purchase of the bankrupt Darwind in the Netherlands by XEMC Windpower in 2009. Thus, the external impact has been limited, especially in the EU, including in trade between the EU and China (Commission 2014b). On the other hand, there has been increasing investment by Chinese companies in wind farms outside China, including in the EU.

The development of China's solar PV sector has been very different. Development of the industry relied on local government support for establishment of manufacturing facilities in alliance with locally based companies' producers turned to foreign markets, notably in the EU, where governments were providing large subsidies to installation of solar PV. The period of rapid expansion of production capacity in China coincided with the high levels of subsidies provided by several governments in the EU, notably Germany (Frankfurt School-UNEP Centre, Bloomberg New Energy Finance 2015, 2016). China came to dominate global solar PV production and trade, especially the EU market (Commission 2014b).

Much attention focused on trade policy aspects of this development, but it also had impacts in the EU on achievement of renewable energy targets. From an energy policy point of view, the EU policy was aided by low-cost imports from China. The advantages of large-scale, vertically integrated manufacturing of Chinese producers in driving costs down have allowed EU Member States to reduce subsidies in period of financial difficulty while continuing their shift to renewables (Frankfurt School-UNEP Centre, Bloomberg New Energy Finance 2015, 2016). More recently, reduction of subsidies in many Member States has cut the size of the EU market. At the same, a shift in policy in China has vastly increased the size of the domestic market, so that in 2013 it became the largest in the world (British Petroleum 2015). In 2014, the installed solar PV capacity in China increased by 59.9%, and it accounted for 15.6% of total installed capacity, second only to Germany (British Petroleum 2015). Reduction of the market in the EU, combined with the growth of the market in China resulted in a rapid decline in Chinese exports of solar PV cells and modules to the EU from their peak in 2010 (Commission 2014b).

There has been some minor investment by Chinese companies in the solar PV manufacturing sector in the EU, although this has generally been for access to technology rather than to produce in the EU itself. On the other hand, there have been increased investments in solar PV farms by Chinese companies seeking to raise their returns through internationalisation.

2.4.2 Electricity Transmission: From National Systems to a Super Grid?

The electric power grid has been described as the greatest engineering achievement of the twentieth century (see Koç 2015, p. 10). Both the EU and China have invested in development of their domestic systems. As yet, this has largely taken place in isolation, but increasing links are being created, notably through investment from China in the EU.

2.4.2.1 The Power Grid in Europe's Energy Sector

Historically, the EU (Community) began the development of a *common carrier system* for electricity with the Single Market Programme in the 1980s (Commission 1988, p. 72). Since the European Commission in 1988 proposed declaring certain large-scale energy infrastructures as being of *Community interest* and hence entitled to special treatment (Commission 1988), a number of policy initiatives have targeted Europe's power transmission infrastructure. Towards the end of the twentieth and the beginning of the twenty-first century, the development of energy transmission infrastructure and technology in Europe has, however, not kept up with the growing ambitions of EU energy policy.

The deployment of new electricity transmission infrastructure did not keep pace with the EU's market integration policy nor with the increasing renewables with their particular technical demands or the call for increased energy security. In response to this mismatch, the EU has implemented a number of programmes to accelerate grid development. The need for such programmes first arose from the goal of creating the internal electricity market, because the historical gradual, bottom-up approach to the development of cross-border power transmission infrastructure resulted in only low interconnection capacity between national power systems. To foster competition between the horizontally separated yet vertically integrated—often national—utilities, programmes have been developed to stimulate the construction of new interconnectors.

Moreover, several initiatives aimed at the unbundling of existing monopolies by separating grid operation and power generation into independent entities. Yet to this day, the effectiveness of these measures is doubtful. Growing numbers of renewables constitute a complicating factor in this regard, leading to the question how to reconcile increased sustainability with the aim of power market integration and the underlying grid infrastructure (see Glachant et al. 2013, pp. 68–70). Hence, questions concerning the electricity transmission infrastructure, conditions for grid access, grid reinforcement and charges to renewables generators for use of networks received more attention (Jansen and Uyterlinde 2004, p. 93); as a result, the provisions on grid access and operation nearly doubled in length from Directive 2001/77/EC on the promotion of renewable electricity (Article 7) to Directive 2009/28/EC on the promotion of renewable energy (Article 16).

Energy security became an integral part of European grid development policy: So as to increase grid robustness against technical failures caused by the notoriously volatile renewables, the EU argued for integration of regional energy systems (Commission 2015a, p. 5). Member States are therefore asked to enhance regional cooperation when developing their energy policies (Commission 2014a, p. 13) and to develop adequate technical infrastructure such as redundancies, networks and alternative supply routes (SWP 2015, p. 3). This policy has also a component which goes beyond the European Union as such, as the integration with power systems around the EU (North Africa, the Balkans, Norway, Eastern Europe) is integral part of various programmes (i.e. neighbourhood policy).

2.4.2.2 The Power Grid in China's Energy Sector

The development of China's electricity transmission grid has been a major part of energy policy over many years. Investment in grid networks on a national scale has been fundamental to maintaining supply of energy to China's rapidly growing economy. At this basic level, the problem of providing adequate electricity supply has been solved and China is no longer plagued by electricity cuts and brown-outs as had been the case in the past. Grid development policy increasingly focuses on issues of efficiency and environmental and climate change impacts. In the past 30 years, China's grid system has undergone massive expansion, but also reform. Reform has included separation of generation and transmission, as well as in electricity pricing, although pricing remains largely set by government planning authorities (International Energy Agency 2006).

After a hiatus of several years, the government has issued a series of documents which place reform of the electricity sector on the agenda (National Energy Agency 2015). Security of supply and wider sustainability issues are at the centre of this plan. Structural reform is not the only element to current policy, which also focuses on infrastructure and technology. China has committed itself to major investment in development of smart grids in order to achieve its policy goals. At the same time, China continues with ambitious plans to expand the grid, including both high voltage (HV) and ultra-high voltage (UHV) transmission lines. The latter include long-distance lines that would transfer electricity from energy-rich regions in the west and north to consuming regions in the east and south, although these remain controversial on both technical and economic grounds. While these UHV networks would make easier transmission from major coal-producing areas in China possible, and thus potentially maintain reliance on coal, they would also allow large-scale transmission of renewable energy, including hydro-, solar and wind power from their main resource locations.

China's policy on development of the electricity grid has both domestic and external impacts. State Grid is the largest grid company in China, controlling about 80% of the network. It is naturally at the forefront of domestic developments in areas such as smart grids and UHV transmission. State Grid has also become increasingly active outside China, especially as an investor in grid networks, including in Europe. In recent years, there have been several Chinese investments in grid companies in the EU (Financial Times 2012; Reuters 2013, 2014; Cassa Depositi e Prestiti Spa 2014). One of the main reasons for this is return on investment. Electricity pricing controls in China result in low profits for transmission, and State Grid seeks higher returns by investing in grid networks outside China, normally through acquisition of minority shareholdings in transmission companies. In this way, State Grid has benefited from the EU policy of opening energy markets and privatisation of utilities in its search for higher returns. At the same time, State Grid brings financing to grid systems that otherwise may have difficulty in funding investment. In addition, China's large-scale domestic investment in smart grid technology and UHV transmission creates the potential for these to be exported. Government support and the scale of the domestic Chinese market provide competitive advantages for exporters of these technologies. As in other aspects of energy policy, China's goal is not only concerned with energy itself, it is also industrial policy intended to support sectors in which China will have not just strong domestic industries, but also ones which will be globally competitive.

Although it is not a purely domestic policy, this is likely to be facilitated by China's "one belt, one road" initiative, and its application in the EU where it is proposed that China would participate in the so-called Junker Plan. The proposal is that China's involvement would focus on infrastructure, notably in connectivity, including energy. Another possible extension is the proposal from China for the creation of a global energy grid (China Daily 2016) which has been espoused by State Grid and also by President Xi Jinping at the United Nations (UN) (Xi Jinping 2015). As such, this represents an extension on a global scale of domestic energy policy.

2.5 Discussion: Direct and Indirect Interactions Between the EU's and China's Internal Energy Policies

Broadly speaking, energy policies in China and the EU have the same goals. But the policy instruments used to achieve the goals are not always the same and policy outcomes in the EU and China may be very different. While it may often appear that the policies and their outcomes operate in parallel, this is not the case. Policy outcomes are not only domestic but also external. Both EU and China have policies that deal with external aspects of energy, notably in terms of securing supply. This may have domestic impacts on the other party, for instance, when they compete for energy resources. Furthermore, the EU and China have made energy a key pillar of their bilateral relationship and have initiated numerous cooperative projects in the energy sector. Some of these, for instance in joint research projects, may have potential long-term impacts on the energy systems on both parties.

In addition, although the domestic policy frameworks may be seen as existing in parallel, even here there may be interactions, as when the outcomes of policy on one side impact the other. When this occurs, the internal energy policy in both the EU and China may have an impact on the other. As this paper suggests, the impact may be mediated through different sectors of the energy system such as renewable energy or the electricity grid. Domestic outcomes have external consequences, especially where major elements in the global system such as the EU and China interact even at a distance. These impacts may be either positive or negative for the policy goals in the other party, either supporting or hindering their achievement. This chapter suggests a framework for a systematic analysis of these and related questions, and how the interaction between China and the EU may occur.

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Chapter 3
The One Belt, One Road Project as a Response to Eurasia's Energy Crisis: An Exploratory Study

Preksha Shree Chhetri

3.1 Introduction

Energy, as we can all agree, is the lifeblood of today's economy. Over time, it has been shown to be of great significance to a country's stability and development. Both Europe and Asia are in dire need of new energy sources as current sources are either fast depleting or posing new threats in the form of environmental concerns. In the case of Europe, its energy security is dependent on its bilateral political relations with Russia. Additionally, Russia is not only the largest supplier of energy to Europe but also holds a hegemonic position when it comes to controlling pipelines for energy transportation in the region. In Asia, the future of the continent's emerging powers and developing countries are dependent to a large extent on a stable energy supply but demand is far exceeding the suppliers' ability to supply. All in all, Eurasia badly needs to find an alternative as far as energy is concerned. As such, it is the aim of this chapter to explore the various possibilities in securing Eurasia's energy security. Against this backdrop, this chapter studies the One Belt, One Road (OBOR) initiative and seeks to answer the question of whether China's OBOR initiative can play an important role in solving Eurasia's energy crisis and explains how the OBOR can build alternative gas pipelines going from Russia to Europe, thus reducing Eurasia's dependence on the two big state-owned transportation networks, which so far have monopolised the energy pipelines in the region. Furthermore, the chapter also explains how OBOR is perfect for a growing Asia which needs infrastructural development in order to sustain its growth. The individual countries of Asia do not have the means to build new transportation infrastructure, but being a part of the OBOR initiative could help solve this. Assuming China's OBOR is indeed what it claims to be; a plan to integrate trade corridors by developing the necessary infrastructure throughout Eurasia for the overall economic

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benefit of the region, the main objective of this chapter is to show how building and integrating energy pipelines throughout Eurasia can help secure Eurasia's future energy needs.

3.2 Preamble to OBOR's Energy Dynamics

The energy crisis in Eurasia is multifaceted. In the past, energy security in Eurasia has been threatened by a variety of factors ranging from natural disasters to bilateral political differences and economic disputes. This chapter aims to present the reality of the energy situation in Eurasia and how it can be improved with the help of the OBOR project—an initiative of the People's Republic of China (PRC). The OBOR project itself has many facets to it as it comprises the twin projects of the Silk Road Economic Belt (SREB) and the Maritime Silk Road (MSR), which also includes gas and energy pipelines. Though the OBOR is a large-scale project encompassing trade in goods, services and investments, this work will specifically highlight its energy dynamics by focusing on the gas and energy pipelines which aim to fulfil the objectives of deeper and wider integration of countries along the historical Silk Road. The first section of the work will focus on Europe and its energy crisis, and since Russia is the biggest supplier of energy to Europe, a large portion of this section is dedicated to understanding Russia's energy supply and the problems therein. In the process, the chapter will also discuss the best strategy for Europe to take care of its energy crisis—a strategy of integration and diversification. Though both integration and diversification are important for Europe, the chapter aims to draw additional attention towards diversification and portray how the OBOR project fits perfectly within Europe's quest for the diversification of its energy supplies. In the next section, the work will discuss the energy crisis in Asia and the best way to deal with it; here too, the chapter will highlight the role of OBOR as an infrastructure building project especially since one of the major problems in Asia has always been infrastructural weaknesses in every field, be it for facilitating trade or energy transportation. Asia has a vast source of natural resources but not enough capability to build devices to exploit it to its advantage. As such, OBOR can play a significant role as it aims to build transportation corridors throughout Asia to connect the continent with Europe. Individual countries in Asia do not have the ability to invest in infrastructure; hence, it would be in the best interests if all the countries could join the OBOR project in order to fully exploit their natural resources and improve their economic conditions through their export. The section on Asia will focus primarily on China, India, Pakistan and Southeast Asia. In the last section, the paper talks about new sources of energy, which are of particular importance in light of the deteriorating condition of the global environment. The prospect of discovering shale gas in Asia and accessing and marketing Asia's other untapped natural sources of energy will also be discussed.

3.3 International Analysis of the OBOR Initiative

The notion of a "Eurasian Union" (Kuchins 2014) is not new; it was first proposed by Kazakhstan's President Nursultan Nazarbayev in 1994 but the notion gained attention only a few years ago after the President of China raised the issue on a visit to Kazakhstan. Attempts to integrate the trade networks in Eurasia have been undertaken several times in the past. A project called the Transport Corridor Europe Caucasus Asia (TRACECA) initiated by the European Union (EU) in 1998 is one of the most significant contributions in this regard. Russia too had attempted to integrate trade corridors in Eurasia via railway lines and constructed the world's then longest stretch of rail, the Trans-Siberian Railway in 1916. Compared to all the previous attempts, China's plan is more comprehensive as it connects Eurasia not only via roadways but also via sea lanes and gas pipelines.

China takes a rather idealistic stance and claims that the only motive behind the OBOR is the economic growth of the region, but such a claim is difficult to believe especially for Asian countries laden with colonial history and exploitation. Such a large-scale infrastructural project that plans on building railway tracks and gas pipelines by physically permeating national boundaries is bound to intimidate the less developed and politically weaker partnering countries. As such, many countries are apprehensive. India, which is a regional competitor, has not been able to decide if OBOR is indeed what China claims it to be. Especially after a project called China–Pakistan Economic Corridor (CPEC) was started, India has become all the more suspicious about China's intentions in the neighbourhood. As far as the USA is concerned, it has always been apprehensive about a strong Eurasia. In fact, any attempt to integrate Europe and Asia has always been opposed by the USA. For instance, when Russia attempted to integrate Eurasia by forming the Eurasian Economic Union (EAEU), some of the strongest criticism came from the USA. The former Secretary of State Hillary Clinton stated that any attempt at integrating Eurasia is "a move to re-Sovietize the region" (Clover 2012) at a press conference in Dublin. She also added "we know what the goal is and we are trying to figure out effective ways to slow down or prevent it".

While both sceptics and idealists present equally convincing arguments, this chapter chooses a middle way. It agrees that OBOR is not without its flaws but at the same time it also believes that this project with its sole focus on developing infrastructure has the potential to solve some of Eurasia's most pressing problems, such as the energy crisis.

In order to understand the ways in which the OBOR initiative can help solve Eurasia's energy situation, it is important to understand the different academic perspectives on Eurasian integration in general, and the OBOR initiative in particular. Hence, a brief introduction on the literature of these topics will be outlined in this section. The Eurasian landmass was many centuries ago called "[t]he heartland of the world" by Halford Mackinder due to its geopolitical position. Halford's doctrine suggested that the heartland enjoyed the world's most advantageous geopolitical location and that the geopolitical actor that dominated the heartland would have the necessary geopolitical and economic potential to ultimately control the "World Island" and the planet (Ismailov and Papava 2013). After many decades, there seems to be a revival of Eurasia's Silk Road, this time in terms of gas pipelines. Closer ties between the countries along the historical Silk Road will benefit not only the landlocked greater Central Asian countries but also India, Pakistan, Iran, China, Azerbaijan and Russia (Norling and Swanstorm 2007). The USA was also very much aware of the importance of this region. The 1990 document on national security strategy published by the first Bush administration noted that "for most of the century, the United States has deemed it a vital interest to prevent any power or group of powers from dominating the Eurasian landmass" (Scott and Westenley 2008). After a century of almost constant conflict and ideological mishaps, countries located along the ancient Silk Road have started trading with each other to an extent that few would have envisaged during the Cold War (Norling and Swanstorm 2007).

While Eurasia is important in terms of the foreign policy of the major powers, academically this concept has not received much attention. There is very little literature available on Europe's standpoint regarding the integration of the Eurasian landmass, and academic work on the ongoing initiatives to strengthen trade in Eurasia is lacking. The Chinese OBOR project is a very recent development; having started only in 2013, therefore, there has not been a substantial amount of academic work in this area. As such, it is the aim of this research to fill this gap and provide a clear picture of the possibility of securing Eurasia's energy security with the help of the OBOR initiative.

3.4 Energy Situation in Europe

In the last decades, Europe's energy security has been threatened either by upheavals in the global energy market or by spikes in oil prices. Most recently, Europe's energy security was threatened by the Russia–Ukraine energy crisis of 2009. The biggest challenge, however, came in the form of the sovereign debt crisis, which had a huge impact on EU's energy trade. Besides these occasional challenges, the ever-declining production of energy domestically in Europe alongside growing energy demands has resulted in an increased dependence on Russia for energy.

Russia is the biggest supplier of energy to Europe. In 2014, 72% of Russia's exports went to European countries, particularly Germany, Netherlands, Belarus and Poland (EIA 2015a, b). Russia has been one of the most important suppliers of energy to the EU but there are many problems with this arrangement. First and foremost, EU countries are not equally dependent on Russia for their energy supply and hence they lack a common framework to guide their energy security. Secondly, Russia's domestic and export pipeline network is almost entirely owned and run by Transneft (EIA 2015a) which is close to fully state-owned; this means Moscow has the ability to strategically manipulate energy supplies to suit its own interests. 80% of the gas that Europe receives from Russia passes through the oil and gas pipelines that run through Ukraine and even Belarus or Turkey; as a result, Europe's energy supply is not only dependent on its own political relations with Russia but also on Russia's relations with the countries through which energy is exported to Europe. Furthermore, Russia faces an acute problem of corruption in its energy sector. Fast-growing environmental awareness could also undermine Russia's position as an energy supplier since the demand for non-carbon-based energy is currently increasing. As such, for Europe having Russia as its prime supplier is not an ideal.

At present, Europe does not have many options when it comes to improving its energy situation. The best way forward would be to devise a two-pronged approach of integration and diversification (Mankoff 2009). The strategy of integration would include the following two approaches; firstly, integrating all EU members' gas markets so that energy is imported by the EU as a whole and not by individual countries, and secondly, integrating Russia into Europe's energy security framework in a way that is mutually beneficial to both countries (Mankoff 2009). Since Russia is currently the most significant supplier of energy to Europe, the first and the most immediate solution would be to develop ways of improving Russia's energy markets, which at present face a range of challenges. In 2013, some 33.5% of the EU-28's imports of crude oil were from Russia (Eurostat 2015). Though not immediate, Russia's inability to meet the energy demands of Europe would definitely create trouble for Europe in the future, hence the strategy of diversification, wherein Europe should strive to discover new energy sources and figure out ways of accessing these sources. After Russia, Iran is the second-largest supplier of Europe's energy; however, diversifying its energy markets to include Tehran would definitely perturb the USA, a risk not many in Europe would be willing to take. As such, a smart way of going about diversification would be to locate new sources of energy in Asia and to join China in its efforts to integrate trade networks across Eurasia. Playing an active role in infrastructure development in Eurasia would definitely help the EU as it does not even have access to the nearby energy reserves of the Caspian region because of Russia's stronghold on the transit corridor, which is responsible for exporting energy from the Caspian Sea to Europe. The Caspian region, though rich in energy reserves, is heavily dependent on Russia for exports, as the region lacks the infrastructure required to export energy itself. However, if Europe could access the energy reserves of the Commonwealth of Independent States (CIS), its dependence on Russia would lessen. Furthermore, it would not have to consider buying energy from Iran, thereby jeopardising its relationship with the USA.

3.5 Energy Situation in Central Asia

In the winter of 2008, Tajikistan faced terribly cold weather with temperatures dropping as low as −20 °C. This abnormal decrease in temperatures had many repercussions on the life and economy of the people of Tajikistan. Besides freezing winter temperatures, the Central Asian Republics also encounter regular disagreements on the issue of water shortage for hydropower from the Syr Darya and the Amu Darya—two vital rivers in Central Asia. Though the solution to Central Asia's energy situation depends in great part on a water-sharing agreement between the five Central Asian Republics, building adequate transport infrastructure in order to foster energy security should be an added focus for these countries. The OBOR, which aims at integrating trade and energy corridors throughout Eurasia, could be a great asset to Central Asia. Moreover, as it is physically connected with the western region of China, Central Asia could also benefit in future from China's huge shale gas reserves, which China is sooner or later bound to tap into.

Currently, most of Central Asia's energy comes from hydropower. Almost 90% of the electric power in Tajikistan and 80% in Kyrgyzstan are produced by hydroelectric stations. In Kazakhstan, the primary fuel for thermal power stations is coal and the only nuclear power station in the region is located in Akatu in Kazakhstan. In Turkmenistan, only natural gas is used. Uzbekistan uses natural gas and other mineral resources such as lignite and coal. Central Asia has a huge potential for developing its own energy, especially renewable energies such as wind or solar. Uzbekistan is already constructing the first on-grid photovoltaic power park in the region with Asian Development Bank (ADB) loans (Nabiyeva 2015). The Central Asian region also has an abundance of energy reserves, which include coal, gas and oil totalling thirty billion tonnes of oil equivalents (toe). Since the OBOR aims to link Central Asian countries to the rest of Europe and Asia, it could be a good option for Central Asia to join the project and integrate its energy security with the rest of the countries in Europe and Asia.

3.6 Energy Situation in Asia

Asia is home to many developing and emerging economies with growing industrial sectors; therefore, the demand for energy is extremely high and important. Most of the countries in Asia are characterised by rapid urbanisation and a growing domestic economy. Without an adequate supply of energy to boost industrial activity, Asia will continue to be home to poor and underdeveloped countries. One important reason why countries in Asia suffer from energy scarcity is because they do not possess the modern infrastructure required for energy generation and suffer from high levels of theft and corruption in the energy sector. Currently, Asia accounts for nearly 30% of the global energy demand. China, Japan and India are among the main energy consumers in Asia, (Konrad Adenauer Stiftung 2013). The soaring energy consumption in Asia can also be measured by the demand for oil. Asia has been forecasted to contribute almost 60% of the global oil demand which will be due solely to the increase in demand from the transportation sector (Konrad Adenauer Stiftung 2013).

Asia is home to the two most populous countries in the world, China and India, and in addition, the ten Southeast Asian countries together have a total population of 600 million, which far exceeds the total population of the 28 members of the EU put together. India, which is one of South Asia's largest countries, has an electricity grid known for its large transmission and distribution losses, which total between

35 and 45%. In 2013, India consumed 3,509,000 barrels of oil (bbl) per day and it is the fourth largest consumer of oil after the USA, China and Japan. If it continues in this way, India will be unable to fulfil the energy demands of its huge population by 2020. Up until 2014, Saudi Arabia was the largest supplier of crude oil to India, though it was overtaken by Nigeria in 2015 (Verma 2015). India's pollution levels compel it to generate more environmentally friendly solar or wind energy and lessen its dependence on coal, as it is a carbon-based source of energy. Similarly, China's energy demands are huge. The "rise of China" has probably been the most frequently used phrase in foreign affairs in recent times. China's large population and growing enthusiasm for consumer goods, which require energy for their manufacture and use, has had a tremendous impact on its energy consumption. China is the world's second-largest oil importer after the USA.

As far as Southeast Asia is concerned, there is great variation in the energy markets of the ten countries that make up the region. Several countries in Southeast Asia have extensive domestic energy resources. Therefore, if infrastructure was to be developed, Southeast Asian countries would be able to help each other in order to secure their energy supply. For example, Indonesia has large deposits of energy, particularly coal, and several other countries have considerable oil and gas resources. In the absence of adequate infrastructure, much of the region is becoming increasingly reliant on energy imports, however. Oil production in Southeast Asia is already declining as most of the oil fields in countries such as Indonesia, Malaysia, Thailand and Vietnam are mature. Since demand is expected to grow strongly over the next twenty years, imports will increase significantly. This will impact the economy, and the only way to soften the blow would be to prepare infrastructure in such a way so that even if countries in Southeast Asia have to import, they at least have the infrastructure ready for transportation.

3.7 One Belt, One Road as an Answer to Europe and Asia's Energy Crisis

As explained earlier, Eurasia includes all the countries that are situated on the Eurasian geographical plate and China's OBOR project aims to connect all these countries via trade corridors such as highways, railways and pipelines as well as maritime routes, connecting ports. Currently, the EU does not even have access to the nearby energy reserves of the Caspian region because of Russia's stronghold on the transit corridor. Another major problem in Russia is that Gazprom and Rosneft, two of the world's largest energy-producing companies, are largely state-controlled and control access to the export pipelines. As such, small companies and independent gas firms like Novatek and Itera can only supply to neighbouring CIS states or the domestic Russian market. Under such circumstances, if these small oil companies could avail of foreign investment, for example, from the Silk Road Economic Fund, it would be mutually beneficial for both these small companies and the region as a whole. Easily accessible Russian gas fields are increasingly rare, and the country's new production sources are all located in remote places, which are difficult to access. Currently, Russia does not have the capital required to invest in these new locations; hence, it would be in the best interest of all actors if Russia got on board with the OBOR plan in order to build adequate infrastructure to tap energy from these new fields. As far as corruption in the Russian energy sector is concerned, developing and enforcing clear EU values in the regulation of transit could help.

In order to understand how the OBOR project could help Asia, let us consider the case of the China–Pakistan Economic Corridor (CPEC), which is an important part of the OBOR project. Pakistan is the second-largest South Asian country and faces a major energy crisis, with, for instance, urban areas suffering from eight hours of power cuts per day and rural areas encountering sixteen to eighteen hours of load shedding. The country currently generates 15,500 megawatts (MW) of electricity but its demand totals 21,000 MW. However, it is positive about the future thanks to the construction of the CPEC, which aims to provide Pakistan with sufficient energy for it to maintain a stable economy. During the Pakistan–China Economic Corridor Secretariat's inauguration in Islamabad, Pakistan's Federal Minister for Planning and Development, Prof. Ahsan Iqbal, stated in his opening speech that the CPEC would not only act as a trade corridor but also as an energy and telecommunications corridor (Geo Television Network 2013). In April 2015, China and Pakistan signed 51 memoranda of understandings (MoU) relating to the CPEC. According to a BBC News report, coal, wind, solar and hydropower projects totalling $15.5 billion USD are supposed to be initiated by 2017 adding 10,400 MW of energy to Pakistan's national grid. As a part of the 46 billion USD Chinese investment in Pakistan under the CPEC, a solar power park named after Pakistan's founding father, Quaid-e-Azam, was constructed in Punjab. The area, which is spread over 200 hectares, was equipped with almost 400,000 solar panels. The Chinese company, which built the farm, started selling electricity to the national grid in August 2015 (Ebrahim 2015). The area where the solar farm was constructed was previously a desert but over time has been transformed into a mini-city accommodating almost 2000 workers. The entire plan is due to be completed in 2017 and once completed will produce electricity equivalent to that produced by an average-sized coal-fired power plant, which is enough to support 320,000 households. Alongside the energy project, the construction of the Gwadar port in Balochistan, which is directly connected to Xinjiang via the CPEC, is going to play an important role in enhancing Pakistan's infrastructure leading to many benefits (Ebrahim 2015).

3.8 The Role of Shale Gas in Increasing China's Credibility in Central Asia

Shale gas is one of the most rapidly growing forms of natural gas in the present era. It is an unconventional source of energy and is growing in popularity and value. Since it is a natural gas, the added benefits of being more environmentally friendly compared to carbon-based sources of energy increase its importance. It is a gas present in shale rocks and though present since time immemorial, it gained attention only a few years ago thanks to the development of technology capable of extracting it, such as hydraulic fracturing and horizontal drilling. The USA is making the most of its shale reserves which have saved it from the consequences of its otherwise declining oil supply. The US Energy Information Administration estimates that, based on current usage levels, American shale gas reserves will last for over 120 years. The US Department of Energy report states that the shale gas production potential of three to four trillion cubic feet (Tcf) per year may be sustainable for decades (United States Energy Information Administration 2017).

China has been criticised tremendously for its use of carbon-based energy sources and its greenhouse gas emissions. Due to domestic and international pressure, China is targeting the use of cleaner energy sources in its 12th and 13th Five-Year Plans. China is showing active interest in shale gas and is already taking steps to develop relations with leading US shale gas producers. In 2009, the China National Offshore Oil Corporation (CNOOC) acquired a 33% stake in Chesapeake Energy's oil and gas assets in the Eagle Ford and Niobrara shale reserves (Roth 2012). Shale gas has also been discovered in many of China's provinces, such as Sichuan. Sinopec's Fuling shale gas exploration project in Chongqing has been calculated to have an annual production capacity of almost five billion cubic metres (CCTV 2016). In addition, according to the Ministry of Land and Resources, China has about 26 trillion square metres of shale gas reserves, the largest of any country in the world.

3.9 Conclusion

In an era marked by interdependence, environmental consciousness, economic competition and an insatiable thirst for energy, international relations have become very complex. Torn between historical differences and the need for consolidation, countries need to take prudent steps to secure their national interests while keeping in mind the global need to protect the environment. The OBOR project can therefore be a boon or a bane depending on the decisions that big and small countries take. Since China is the main actor behind the OBOR, it can either fulfil its economic aspirations by dominating smaller countries or unite with other Asian countries and help them realise their full potential in the energy sector. The EU too could help its Central Asian neighbours by supporting China's vision of an integrated Eurasia. Together, the countries in Europe and Asia can make the most of the OBOR initiative for a better and securer Eurasia, at least in the energy sector. There are obviously reservations about China's growing dominance in this project, but prudent steps by other major countries like India can help this project become a success and at the same time help reassure the remaining small nations that China will not be allowed to act in a hegemonic manner as far as decision-making is concerned. The countries of Asia are developing at a decent rate but what they want is "region-wide connectivity"

(Bhattacharyay and De 2009). Hence, it is in the best interests of all the countries in Asia to work together to develop proper infrastructure for better connectivity.

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Chapter 4
Securing Energy Insecurity? China and the EU's Quest for Energy in the Caspian Sea Region

Stratos Pourzitakis

4.1 Introduction

Over the last decade, energy security has become a priority for the EU and China with security of energy supply at the centre of scholars' and policymakers' attention. Located at the crossroads of Europe and Asia, the Caspian Sea has emerged as an energy hot spot for major energy players due to the region's vast energy resources. Both Beijing and Brussels seek to strengthen their energy foothold in the Caspian albeit through the implementation of different strategies. One should, however, remain critical of China's and the EU's strategies as it should not be taken for granted that they necessarily improve their energy security.

This chapter will study the strategies of China and the EU in the Caspian Sea region as a response to their concerns on security of energy supply. Both actors have been overly interested in accessing Caspian oil and gas through vast pipeline networks and bilateral agreements, sometimes failing to address concerns over economic sustainability. After all, contrary to the recent trend in Europe where a counterproductive interest in pipelines has been developing, pipelines and major energy agreements are not a panacea (Tsafos 2015).

After analysing the concept of energy security and the energy security challenges faced by the two actors, the paper will examine their quest for oil and gas in the Caspian Sea region, analysing the strategies adopted, the actors involved and also the challenges faced by the two actors. It needs to be stressed that Iran will not be part of this research, due to complexities stemming from the issue of its nuclear programme. Finally, the paper will shed light on the impact of the energy strategies of China and the EU in the Caspian Sea applying a model which has been based on

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the Risky External Energy Supply (REES) index, provided by Le Coq and Paltseva (2009), and it will introduce new elements that will enhance our understanding of the issue.

4.2 The Concept of Energy Security

According to the traditional definition, energy security is the uninterrupted availability of energy sources at an affordable price (Yergin 2006). This definition, although not incorrect, is somewhat monolithic, if not obsolete, as it excludes the reality of international relations. In his paper "Energy Security as Multidimensional Concept" Bauman (2008) sketches the complexity of energy security identifying the following dimensions of energy security: (1) Energy security as part of the domestic policy of a country, (2) The economic dimension of energy security, (3) The geopolitical dimension of energy security, and (4) Energy security as a security issue (Bauman 2008).

In turn, Johansson (2013) conceptualises energy security, approaching it from two different perspectives. First, he analyses energy security as an object which can be exposed to security threats. Within this framework, issues such as security of energy supply and energy demand become of primary interest. On the other hand, he studies energy security as a subject of security, one that can generate security challenges to states and individuals (Johansson 2013). Similarly, according to Xu (2006), the literature on energy security falls into two categories, one putting emphasis on the energy and one on security. Xu identifies the "'adequate' and 'reliable' energy supply at a 'stable' price" as a conceptual starting point, claiming that although secure access to energy supply is very important, it is not the only issue as energy security is also about other topics, such as energy markets and energy efficiency (Xu 2006).

4.3 China's Energy Security Strategy in the Caspian Sea Region

Since early 2000, Chinese breakneck economic growth has led to skyrocketing energy needs, with Chinese elites viewing energy security as a necessary condition for the survival of the Chinese Communist Party (CCP). Strategic approaches remain the dominant trend in the country's energy policymaking process, although market-based principles have been gaining increasing attention among Chinese energy policymakers and scholars (Cao and Bluth 2013).

For a large number of Chinese key players within the energy policymaking field the American-controlled Malacca Strait is China's energy security Achilles heel. This concern stems from speculation that in the event of a Sino-American military standoff, the US navy might potentially block Chinese energy shipments at this particular waterway. In 2005, referring to the so-called "Malacca dilemma" (马六甲困局), Hu Jintao stated that "c*ertain powers all along encroached on and tried to control the navigation through the Straits*" (Davis 2014).

In order to bypass the bottleneck of the Malacca Strait, China has been pursuing an aggressive energy strategy towards the Caspian Sea region, which is sitting on vast oil and gas energy resources. Without doubt, Russia is the most important player in the region with the two countries maintaining a "strategic partnership" and a multifaceted energy partnership. In 2014, Russian energy exports accounted for 11% of Chinese oil imports, while China is connected to Russian oil reserves through the Eastern Siberia–Pacific Ocean (ESPO) oil pipeline which is projected to reach 1.6 million barrels per day (bbl/d) (Energy Information Administration 2015). Until recently, bilateral trade in gas was very limited, yet in 2014 the two sides signed a series of groundbreaking agreements on the construction of the Siberia-1 gas pipeline, which has an annual throughput of 61 billion cubic metres (bcm) and from 2018 will provide a supply of 38 bcm of Russian gas annually for 30 years.

Things, however, are far from rosy due to long-standing mutual mistrust and investment impediments. For example, the ESPO oil pipeline has come at considerable economic cost for Beijing, as it had to concede to an "oil for loans agreement" between the China Development Bank and two Russian companies, Rosneft and Transneft, in the event of emerging financial problems. The agreement provisioned the supply of 15 million tonnes of oil per year (mto p/y) from 2011 until 2030. Yet from 2009 when pricing disputes over the agreement first occurred, concerns were spurred in China over Russia's reliability (Jakobson et al. 2011). Furthermore, at the end of 2014, the two countries signed a non-binding memorandum of understanding (MoU) for the construction of an additional pipeline known as the Power of Siberia-2 that would bring 30 bcm/year of gas from the Altai region in West Siberia to Western China. The agreement, however, was immediately questioned by experts, such as Skalamera (2014) who stressed that, after the Power of Siberia-1 agreement, the Power of Siberia-2 did not make economic sense given the high investment costs and because it was provisioned to deliver gas to a remote area, where energy needs were very low (Skalamera 2014). Eventually, the lack of economic sustainability of the project and the decline in China's gas consumption, which fell by 8.5% in 2014, led Chinese equity firms to put this specific project on hold in July 2015 (Tully 2015).

In parallel, Kazakhstan–China energy trade relations have been flourishing in recent years due to the China–Kazakhstan pipeline, which has a capacity of 400,000 bbl/d and which brings oil from Kazakhstan's Caspian shore to Xinjiang in China (Energy Information Administration 2015). On the other hand, profitability does not appear to have been the primary concern for China, with Chow and Hendrix (2010) criticising the Kazakhstan–China pipeline as economically unattractive given its limited capacity and its underperformance; the pipeline has been operating at approximately 50% of its capacity (Chow and Hendrix 2010). In 2007 and 2008 when the capacity of the pipeline was 200,000 bbl/d, the transported volume of oil reached 102,600 and 115,000 bbl/d respectively (Erickson and Collins 2010). The same was the case even after 2011 when the capacity of the pipeline was expanded to

400,000 bbl/d, with China importing 208,000 and 235,000 bbl/d in 2013 and 2014, respectively (United Press International 2014).

Over the last ten years, China's energy relations with Turkmenistan have flourished, with Turkmenistan supplying China with approximately half of its pipeline gas imports. In April 2006, the two countries signed an agreement on the construction of the Central Asia–China gas pipeline which has a capacity of 55 bcm/y and starts at the Turkmen–Uzbek border, running through central Uzbekistan and southern Kazakhstan, before reaching Xinjiang (China National Petroleum Corporation 2016a). In parallel, the two sides have an agreement for the delivery of 30 bcm/y gas from Turkmenistan to China for 30 years via the Central Asia–China pipeline, as well as a production-sharing agreement for the development of gas fields at the Amu River (China National Petroleum Corporation 2016b). It needs to be stressed that Beijing maintains a privileged position given that it is the only foreign investor in energy enjoying direct access to a major onshore gas field in Turkmenistan.

Again, China's involvement in Turkmenistan has been objected to on economic grounds, as well as due to the questionable reliability of Turkmenistan as an energy supplier. Upon the announcement of the pipeline, there was suspicion that it would not operate to full capacity. In particular, industry analysts raised concerns that, during the pipeline's first stage of operation, low demand in Xinjiang would keep Chinese gas imports at a low level (Olcott 2013). These concerns were not alleviated by market-driven initiatives but when Russia failed to purchase the total amount of Turkmen gas in 2009 (Pourzitakis 2015). Furthermore, China accepted Ashgabat's standard requirement that importers purchase its gas on its boarder hence bearing all the transit risk as well as the transportation costs (Dickel et al. 2014, p. 25). Whereas this is a potential drawback, for other interested importers such as the EU, China has also been willing to undertake this cost in the name of security of energy supply. Finally, on the eve of the 2008 global financial and economic crisis, Beijing assisted the cash-strapped Turkmen government with loans of $8 billion dollars, a common practice in Chinese resource diplomacy (Cooley 2015). As Andrei Grozin, Director of the Central Asia Department at the CIS Institute in Moscow pointed out "since 2009 Turkmenistan had been living thanks to Chinese loans" (Tynan 2010).

4.4 The EU Energy Security Strategy in the Caspian Sea Region

The EU energy security agenda is dominated by concerns about overdependence on Russian gas exports. Among others, Brussels is focusing on the diversification of its energy supplies, with the Caspian Sea region receiving the lion's share of its attention. The EU energy security strategy is closer to market-based principles but this does not come without a cost, as Correljé and Van der Linde (2006) suggest that the EU security of energy supply faces serious challenges due to the contrast between the EU approach to energy security, and the geopolitical approaches adopted by the majority of energy exporters, including the Caspian states.

As far as the Caspian Sea region is concerned, the EU maintains closer oil trade ties with Russia, Kazakhstan and Azerbaijan, which supplied in 2013 approximately 40% of the EU's oil imports (European Commission 2016). The biggest challenge for the EU's energy security strategy, however, concentrates on the high reliance on Russian gas imports especially after multiple gas crises between Russia and Ukraine. Against this backdrop, increased diversity within the European energy mix and closer energy ties with the Caspian Sea states have become a top priority for the EU (European Commission 2015).

On the other hand, it is important to highlight that even when gas shipments to Ukraine were cut off, both Ukraine and Russia ensured that transit energy shipments to Europe would not be threatened (Dickel et al. 2014, p. 69). Besides, one should not neglect the fact that energy security refers not only to security of supply but also to security of demand, as energy exporters and transit countries, including Russia need to ensure energy revenues which usually play a vital role in their economy. What is more, we need to keep in mind that pipeline gas supplies from Russia to the EU are based on contracts between Gazprom and EU companies. These contracts have a duration ranging between 10 and 35 years and they include take-or-pay clauses of 85% until 2008 and 70% thereafter. As a result, European companies are committed to buying more than 125 bcm of gas in 2020 and approximately 70 bcm in 2030. Failing to meet these purchase commitments would have grave consequences for the EU companies as they would be subject to arbitration claims equal to tens of billions of euros (Dickel et al. 2014, p. 10, 71). Therefore, the EU strategy of diversification of energy supplies is limited to a fraction of the EU's gas imports from Russia, equal to 15–30% and consequently it can be hardly considered as a game-changer in the EU energy landscape. All in all, Russia will remain dominant in the EU gas market despite deliberations on ending Europe's excessive reliance on Russian gas.

Attempting to reduce dependence on gas shipments from Russia, the EU has shifted its interest towards the Caspian Sea region to focus on two countries, Azerbaijan and Turkmenistan, as well as on the Southern Gas Corridor, a pipeline project which seeks to bring gas mainly from the Caspian and possibly from the Middle East. The Southern Gas Corridor will bring together a series of smaller projects, such as the Trans-Adriatic Pipeline (TAP) and the Turkey–Greece–Italy Interconnector (ITGI), supplying Europe with 10 bcm/year by 2018, an amount that is expected to reach 31 bcm/year by 2026. Initial plans envisage the supply of Azeri gas to Europe via the construction of the specific pipeline network facing obstacles due to technical and legal challenges provoked, among others, by conflicting national interests among the EU Member States and territorial disputes between Caspian countries. Furthermore, analysts cast doubt on the impact of the Southern Gas Corridor once the TAP project was preferred over Nabucco. Their concerns focused on the TAP's relatively limited size and because, with the exception of Greece and Bulgaria, no other southeast European country will have access to the imported gas that will come from the Shah Deniz basin (Dickel et al. 2014:40). The solution here will be connecting EU Member States via more vertical pipelines with reverse-flow capabilities.

In addition, Brussels is seeking to bring Turkmenistan on board with the Southern Gas Corridor project and in April 2008, the European Commission and the Turkmen government signed a MoU on a strategic energy partnership with Ashgabat indicating willingness to reserve 10 bcm/y of gas for Europe (Boonstra 2010). Theoretically, Turkmen gas can be brought through the Trans-Caspian Pipeline (TCP) allowing it to enter the Southern Corridor. In 2011, the EU opened talks with Azerbaijan and Turkmenistan to facilitate the implementation of the project. Bringing Turkmen gas to the EU, however, is not a simple task due to numerous legal and technical challenges. In particular, territorial disputes among littoral states have been impeding the construction of the TCP despite the common interest of Azerbaijan and Turkmenistan to bypass this issue (Coffey 2015). Moreover, entering the Turkmen gas market is a difficult task because the EU is a latecomer in Turkmenistan, with a starkly different foreign policy agenda to that of Moscow and Beijing, something that undermines the credibility of the EU in the eyes of the Turkmen leadership. For example, during recent visits by EU delegations, the Turkmen leadership lamented the lack of concrete offers, while in September 2012 the Turkmen President Berdimuhamedow snubbed the EU Energy Commissioner Günther Oettinger who was visiting Turkmenistan (Fitzpatrick 2013). An additional obstacle is Turkmenistan's requirement that its clients to purchase its gas on its border incurring the transit risk (Dickel et al. 2014, p. 25).

Moreover, the realisation of an energy partnership between Brussels and Ashgabat has been impeded by the poor performance of Turkmenistan in the fields of human rights and good governance. The two actors have signed a Partnership and Cooperation Agreement which has not come into force as it has yet to be ratified by France and the UK due to Ashgabat's record on human rights, and Turkmenistan has also not activated it. More recently, however, the EU has intensified its diplomatic efforts in Turkmenistan turning a blind eye to serious human rights abuses and democracy problems in the name of energy security. Although the new EU Central Asia strategy that was released pledged to place greater focus on "serious challenges to human rights", it is clear that the EU gives greater priority to energy than human rights when it comes to its relationship with Turkmenistan (Boas 2012). This might undermine the normative status of the EU and its liberal energy security approach, though on the other hand it does meet the EU's strategic goal of reducing its energy dependence on Russia. Besides, the same document implicitly identifies energy security as a strategic goal of the EU in the region, considering it more important than human rights and democratic governance (Council of the European Union 2015).

4.5 Measuring Energy Security in China and the EU

In order to assess the strategies of China and the EU in the Caspian region, the paper will go one step further and measure the energy security that is realised by their strategies. There is a growing interest within academia in quantifying energy security and a large number of scholars use the Shannon–Wiener concentration index or the Herfindahl–Hirschman index to analyse this (Cohen et al. 2011).

Based on the latter, Le Coq and Paltseva (2009) introduced the Risky External Energy Supply (REES) index which estimates how much the security of external supply matters for a country that imports a specific fuel (Le Coq and Paltseva 2009). In line with this line of argumentation, this article will use the REES and for country *a* which imports fuel *f* the amount the security of external supply matters is calculated using the following equation:

$$\mathbf{REES}_a^f = \left[\sum_i (\mathbf{NPI}_{ai}^f / \mathbf{NPI}_a^f)\text{^}2 * \boldsymbol{F}_{ia}^f * \boldsymbol{r}_i * \boldsymbol{d}_{ia} \right] * \mathbf{NID}_a^f * \mathbf{SF}_a^f \tag{4.1}$$

The components of the above equations are analysed as follows:

1. NPI_{ai}^{f} : The net positive imports of fuel *f* from country *i* to country *a*
2. NPI_{a}^{f}: The sum of the net positive imports over all suppliers of country *a*
   With respect to the first two variables, data has been retrieved from a number of databases, namely the BP Statistical Review of World Energy, UN Comtrade Database and Eurostat.
3. F_{ia}^{f}: The fungibility of imports of fuel *f* from country *i* to country *a*. For fuels which can be easily substituted (oil via tankers, liquefied natural gas), the value will be 1 while less fungible flows of energy (oil and gas transported via pipelines) will be given the value of 2. In case an energy transportation route uses multiple means, such as pipelines and tankers which result in different fungibility levels, then the price of fungibility will be the weighted average of the fungibility prices.
4. ri: The political risk index of the supplier country. The paper will use the Organisation of Economic Cooperation and Development (OECD) index, mainly for data availability reasons. The specific country risk classification system assigns countries values between 0 and 7. As higher prices in the REES index reflect less energy security, we will calculate our political risk index as:

$$\mathrm{ri} = \frac{\textbf{OECD country risk classification}}{7} \tag{4.2}$$

5. d_{ia}: The distance between countries *i* and *a*. In their paper, Le Coq and Paltseva (2009) give to d_{ia} the price of 1 if the distance between the capitals of two countries is less than 1500 kilometres (km), the price of 2 if the distance is between 1500 and 4000 km and the price of 3 if it is above 4000 km. This paper goes one step further putting the actual transportation routes within the above mentioned categorisation and using online radius calculation applications where necessary.
6. NID_{a}^{f}: The net import dependency of country *a* on fuel *f*.
7. SF_{a}^{f}: The share of fuel *f* in country *a* (Le Coq and Paltseva 2009)
   Note that higher values of the index correspond to riskier supply and hence, the lower the price of the index the more energy security is achieved.

4.6 Results

Reviewing the prices and the components of the Chinese gas REES index underscores that the establishment of the Central Asia–China (CAC) pipeline has been a game-changer for Beijing. Until 2010, Chinese penetration of the Caspian Sea gas market was very limited and consequently the REES prices were low. As far as the REES oil index is concerned, there is a moderate increase in the oil supply risk due to the increase in oil imports from both Kazakhstan and Russia (Fig. 4.1).

The energy deals between China and Turkmenistan have led to a vast inflow of gas from Turkmenistan and to a very high respective supply risk. This stems mainly from the fact that the share of Turkmen gas has monopolised the Chinese gas market. On the one hand, it is important that Beijing has been able to increase its usage of gas, which is more environmentally friendly, while avoiding the transportation risks posed by the "Malacca dilemma"; on the other hand though the Chinese gas market is highly dependent on Turkmenistan as a gas supplier. The close economic relations between the two countries and the privileged status that Beijing enjoys in the country might moderate concerns about the high supply risks as depicted by the REES index, yet "putting all one's eggs in one basket" is a strategy with serious drawbacks even in the case of China–Turkmenistan relations. On the other hand, it should also be mentioned that in 2013 and 2014, Beijing decreased its exposure to Turkmenistan by adding pipeline gas from Uzbekistan, which is transported via the same pipeline network. High dependence on Turkmen gas can be also mitigated by LNG imports that come from other countries (i.e. Qatar and Australia). In addition, the REES index of LNG is close to zero due to the very limited role of Sakhalin LNG in the Chinese energy mix.

In the case of the Chinese oil REES index Chinese exposure to supply risks has remained very low despite the almost tenfold increase in oil imports and the fourfold increase in the share of Chinese oil imports from Kazakhstan. Similarly,

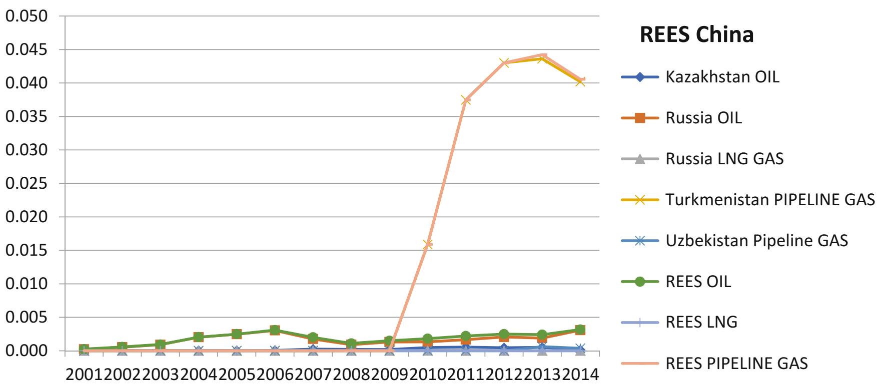

Fig. 4.1 China's REES index

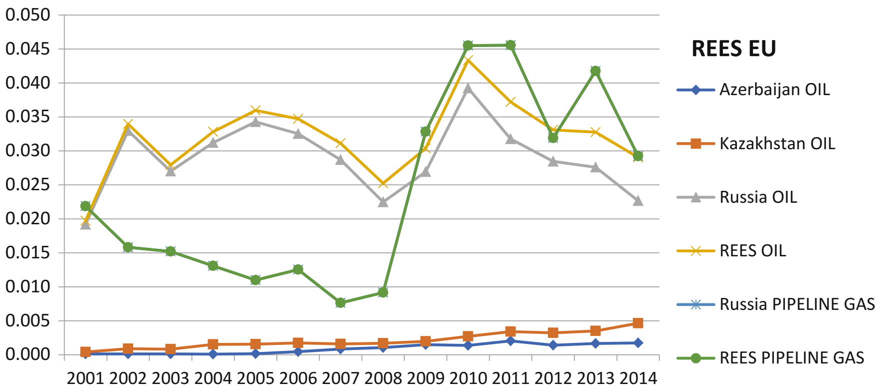

Fig. 4.2 EU's REES index

the Russian oil supply risk has increased significantly yet not to alarming levels. This should come as no surprise as imports from Russia were 30 times higher in 2014 compared to 2001, while the share of Russian imports has increased from 3 to 11%. This signifies a higher dependence on Russian oil, a trend that is expected to increase in the following years. However, the increase in Russian oil supplies should be welcomed by the Chinese leadership because it denotes closer oil trade ties with Caspian Sea states in order to hedge against the "Malacca dilemma".

Another issue that needs to be explored is the role of political risk and the fungibility of the imported fuel in China's energy security. China's strategy of focusing on the Caspian Sea energy market entails energy partnerships with countries that face high political risks. This may also be the case with Middle Eastern and African energy suppliers, yet the lack of fungibility of the oil and gas that comes from Caspian suppliers as opposed to oil and gas that is shipped via sea routes highlights a problem in the Chinese strategy.

The situation is fundamentally different with respect to the EU. Since Russia has been the only important gas supplier for the EU in the Caspian region, the REES for pipeline gas was identical with the REES index for Russian gas. From 2001 until 2008, the respective supply risk was low and featured a downward trend, although Russian gas imports remained relatively stable. One reason for this contradiction is the decrease in the share of net gas imports from Russia combined with a threefold increase in gas imports from Norway. Of equal importance was the decline in political risk in Russia by 50% during the same period of time (Fig. 4.2).

After 2008, Russian gas exports increased by almost 50% despite a sharp decline in total EU gas imports that exceeded 30%. As a result, during the same period of time, the respective REES index skyrocketed from 0.0092 in 2008 to 0.0465 in 2011. Since then however, and following the initiation of the EU strategy for reduced dependence on Moscow, the Russian gas supply risk started to trend downwards, albeit with some volatility. This can be attributed to a variety of reasons, including a limited decrease in the share of Russian gas versus EU gas imports, with the exception of 2013. Other reasons that can be identified are the relatively stable levels of political risk in Russia and a decrease in the share of gas consumed in the EU by 15% between 2010 and 2014. All in all, the EU–Russian gas supply risk has declined by 36% over the period 2011–2016, in line with the EU's goal of reducing their energy exposure to Russia.

With respect to oil, the oil REES index reflects the importance of Russia as an oil supplier. From 2010 onwards the oil REES index for Europe has experienced a decline that reached almost 50% in 2014, returning to its 2008 levels. Again, this is in line with the EU strategy to reduce dependence on Russia which remains, however, the EU's dominant oil supplier. In parallel, EU imports of oil from Kazakhstan and Azerbaijan increased in tandem with the respective REES index. It also needs to be stressed that compared to Kazakhstan and Azerbaijan, importing oil from Russia is considerably more advantageous in terms of country risk and fungibility.

4.7 A More Comprehensive REES

Working with the REES index has enabled us to derive interesting insights into EU and Chinese energy security strategy in the Caspian Sea region. There are, however, other issues which can be further explored with respect to the energy security strategies of the two actors. To this end, additional components can be added in order to more accurately depict the energy security of China and the EU vis-a-vis the Caspian Sea region. These additional parameters are:

1. An amity–enmity index (AMI) AMI_{ai}^{f}, which will delineate the amity or enmity patterns between country a which imports fuel f and the respective supplier state i. The specific parameter will take a price from a set of values (1–3) based on the cordiality of bilateral relations. The AMI_{ai}^{f} will aggregate the following components: the share of imports and exports in total trade (a_{i1}), whether there are ongoing territorial disputes between the states (a_{i2}), if there are embargoes in place (a_{i3}), whether there is a history of military conflicts (a_{i4}), the number of organisations where the two actors co-exist (a_{i5}) and the number of official visits at the highest level (a_{i6}). In each case, the observation will be divided into three categories and it will be given a price from 1 to 3. Hence, the amity–enmity index between country a and country i for fuel f. will be the aggregated sum of these components:

$$\mathbf{AMI}_{ai}^{f} = [\boldsymbol{a}_{i1+}\boldsymbol{a}_{i2}+\boldsymbol{a}_{i3}+\boldsymbol{a}_{i4}+\boldsymbol{a}_{i5}+\boldsymbol{a}_{i6}]/6 \tag{4.3}$$

2. The distance between energy suppliers and importers will be adjusted according to the safety of transportation. It goes without saying that a 500 km pipeline bringing gas to the EU from Norway does not pose the same risk as a 500 km pipeline from Russia, passing through Ukraine. As a result d_{ia} will be multiplied by an index that will reflect the safety of transportation and will be labelled as

safety of transportation index ($\mathbf{st}_{ai}^{f}$) for imports of fuel f from country i to country a. The index will have the following components and each one will take fixed values ranging from 1 to 3:

I. Proximity of the transportation route to military conflict zones (a_{i1})
II. The number of terrorist and/or pirate attacks on energy transported via the specific transportation route (a_{i2})
III. The percentage of the transportation route that crosses disputed territories (a_{i3})

Thus, the security of transportation index for country a that imports fuel f from country i will be equal to:

$$\mathrm{ST}_{ai}^{f} = (\boldsymbol{a}_{i1}\boldsymbol{a}_{i2} + \boldsymbol{a}_{i3})/3 \tag{4.4}$$

3. An important addition is the price of the imported energy, an issue which is of critical importance in energy security. What is important is to examine deviations from market prices. Given that there is a global oil price, this is applicable only in the case of gas, for which there are different prices across different regions, as well as different contracts with respect to pricing. What can be done here is to calculate the price of the imported fuel as a percentage of the average global price. Hence, we suggest the introduction of a price index $\mathbf{PI}_{a,i}^{g}$ for country a importing gas from country i which will calculated as

$$\mathbf{PI}_{a,i}^{g} = \frac{\boldsymbol{P}_{a,i}^{g}}{\mathbf{PR}_{g}} \tag{4.5}$$

$\mathrm{PI}_{\mathrm{a,i}}^{\mathrm{g}}$ is the price of the imported natural gas from country i to country a and PR_{g} is the regional gas price. Since there are three gas markets with different pricing mechanisms (US, Asia–Pacific and Europe), the denominator for the abovementioned ratio will differ for China and the EU; it will be the German Import Price index, cost, insurance and freight (CIF) and UK National Balancing Point (NBP) for EU gas imports and the Japanese LNG CIF for Chinese gas imports.

After incorporating these amendments, the REES index for country a that imports oil (o) from country i will be calculated as follows:

$$\mathbf{REES}_{a}^{o} = \left[\sum_{i}(\mathbf{NPI}_{ai}^{o}/\mathbf{NPI}_{a}^{o})^{\wedge}2 * \boldsymbol{F}_{ia}^{o} * \mathbf{AMI}_{a}^{o} * \boldsymbol{r}_{i} * \boldsymbol{d}_{ia} * \mathbf{st}_{ai}^{o}\right]\mathbf{NID}_{a}^{o}\mathbf{SF}_{a}^{o} \tag{4.6}$$

Similarly, the REES index for a country a that imports gas (g) will be equal to:

$$\mathbf{REES}_{a}^{g} = \left[\sum_{i}(\mathbf{NPI}_{ai}^{g}/\mathbf{NPI}_{a}^{g})^{\wedge}2 * \boldsymbol{F}_{ia}^{g} * \mathbf{AMI}_{a}^{g} * \boldsymbol{r}_{i} * \boldsymbol{d}_{ia} * \mathbf{st}_{ai}^{g} * \mathbf{PI}_{a,i}^{g}\right] * \mathbf{NID}_{a}^{g} * \mathbf{SF}_{a}^{g} \tag{4.7}$$

4.8 Conclusions

The Caspian Sea region plays a pivotal role in Chinese and EU energy security strategies. It is fair to claim that the energy security concerns of China and the EU suffer from fallacies, while it is also important to highlight their tendency to securitise energy. Addressing these concerns, both have been seeking to foster their energy foothold, albeit with different strategies and with the EU clearly lagging behind China. However, despite the promising effort in terms of security of energy supply, both actors need to take into greater consideration the reliability of their suppliers and the economic sustainability of their pipeline diplomacy. While there are some signs that Beijing has been moving in this direction, the energy security discourse in the EU does not focus on economic terms when comparing Russian gas supplies with those from Southern Gas Corridor.

Attempting to assess the actual energy security brought to China and the EU from their Caspian energy strategy, this chapter has used the REES index which provided us with some useful insights. To this end, the introduction of additional elements in the REES can facilitate future research on how to measure energy security. Quantifying energy security may pose serious methodological challenges; however, it offers highly analytical insights and helps us explain energy choices and assess future outcomes.

Appendix

See (Tables 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13 and 4.14).

Table 4.1 Net positive imports of oil and gas from country *i* to China/The sum of the net positive imports over all suppliers of China

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Kazakhstan oil	0.00	0.00	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.000
Russia oil	0.00	0.00	0.003	0.008	0.010	0.012	0.008	0.004	0.006	0.004	0.006	0.008	0.007	0.012
Russia LNG	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.001	0.000	0.000
Turkmenistan pipeline gas	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	0.986	0.778	0.663

Table 4.2 Fungibility of imports of oil and gas from country *i* to China

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Kazakhstan oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Russia oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Russia LNG gas	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Turkmenistan pipeline gas	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Uzbekistan pipeline gas	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Table 4.3 Political risk index of the supplier country

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Kazakhstan oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Russia oil	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Russia LNG gas	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Turkmenistan pipeline gas	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Uzbekistan pipeline gas	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Table 4.4 Distance between countries *i* and China

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Kazakhstan	0.86	0.86	0.86	0.71	0.61	0.57	0.57	0.57	0.57	0.71	0.71	0.71	0.71	0.71
Russia oil	0.86	0.86	0.71	0.57	0.57	0.57	0.46	0.43	0.43	0.57	0.46	0.43	0.43	0.43
Russia LNG	0.86	0.86	0.71	0.57	0.57	0.57	0.46	0.43	0.43	0.57	0.46	0.43	0.43	0.43
Turkmenistan	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.89	0.86	0.86	0.86	0.86	0.86	0.86
Uzbekistan	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.89	0.86	0.86	0.86	0.86	0.86	0.86

Table 4.5 Net import dependency of China on fuel *f*

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
China oil import dependence	0.23	0.25	0.30	0.37	0.37	0.39	0.44	0.47	0.51	0.54	0.55	0.55	0.56	0.59
China gas import dependence	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.05	0.11	0.24	0.26	0.32	0.31

Table 4.6 Share of oil and gas in China

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
China oil consumption %	0.22	0.22	0.21	0.21	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
China gas consumption %	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.06

Table 4.7 REES index for China

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
REES oil	0.0002	0.0006	0.0009	0.0020	0.0025	0.0031	0.0020	0.0011	0.0015	0.0018	0.0022	0.0025	0.0024	0.0032
REES LNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
REES pipeline gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.037	0.043	0.044	0.041

Table 4.8 Net positive imports of oil from country *i* to the EU/The sum of the net positive imports over all suppliers to the EU

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Azerbaijan oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kazakhstan oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Russia oil	0.002	0.005	0.005	0.009	0.010	0.009	0.011	0.008	0.011	0.014	0.014	0.012	0.013	0.008
Russia pipeline gas	0.004	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.013	0.014	0.020	0.013	0.022	0.012

Table 4.9 Fungibility of imports of oil and gas from country *i* to the EU

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Azerbaijan oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Kazakhstan oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Russia oil	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Russia pipeline gas	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Table 4.10 Political risk index of the supplier country

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Azerbaijan	1.00	0.89	0.86	0.86	0.86	0.82	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
Kazakhstan	0.86	0.86	0.86	0.71	0.61	0.57	0.57	0.57	0.57	0.71	0.71	0.71	0.71	0.71
Russia oil	0.86	0.86	0.71	0.57	0.57	0.57	0.46	0.43	0.43	0.57	0.46	0.43	0.43	0.43
Russia pipeline gas	0.86	0.86	0.71	0.57	0.57	0.57	0.46	0.43	0.43	0.57	0.46	0.43	0.43	0.43

Table 4.11 Distance between countries *i* and EU

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Azerbaijan Oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Kazakhstan Oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Russia Oil	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Russia Pipeline Gas		2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13

Table 4.12 Net import dependency of EU on fuel f

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
EU oil import dependence	0.73	0.74	0.75	0.76	0.78	0.76	0.78	0.76	0.77	0.78	0.79	0.84	0.81	0.82
EU gas import dependence	0.48	0.51	0.52	0.54	0.57	0.60	0.60	0.62	0.63	0.62	0.67	0.66	0.65	0.67

Table 4.13 Share of oil and gas in the EU

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
EU oil consumption %	0.36	0.37	0.36	0.39	0.39	0.40	0.39	0.39	0.40	0.38	0.38	0.37	0.36	0.37
EU gas consumption %	0.20	0.20	0.20	0.23	0.24	0.24	0.24	0.25	0.25	0.26	0.24	0.24	0.24	0.22

Table 4.14 REES index for the EU

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
REES oil	0.0002	0.0006	0.0009	0.0020	0.0025	0.0031	0.0020	0.0011	0.0015	0.0018	0.0022	0.0025	0.0024	0.0032
REES LNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
REES pipeline gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.037	0.043	0.044	0.041

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Part II
Renewable Energy Solutions in Trade, Investment & Urbanisation

Chapter 5
The Rise of Trade Remedies in the Renewable Energy Sector and the Need for Bilateral Agreement Between the EU and China

Fang Meng

5.1 Introduction

The increasingly prevalent use of supportive industrial policies designed by the governments to promote domestic renewable energy development represents a remarkable contradiction between two important goals within the global governance regimes, which are encouraging national environmental policies and removing protectionist trade barriers (Wu and Salzman 2014). The design and enactment of industrial policies in renewable energy have the vast potential to mitigate climate change given the crucial role that renewable energy development can play in reducing greenhouse gas emissions. However, many industrial policies import tariffs, local content requirements and domestic subsidies could become the subject of trade disputes if believed to violate international trade rules as administered by the WTO. Therefore, whenever a trade conflict arises, Member States are entitled to take action either through the dispute settlement system or initiate investigation unilaterally.

The use of unilateral measures to challenge renewable energy supportive policies has not been widespread until the recent decade. It is estimated that around 41 unilateral trade remedies cases have been initiated since 2008 on biofuels, solar energy and wind energy products (UNCTAD 2014). Although the normal tariffs have been lowered multilaterally under the WTO regime, the imposition of high trade remedy tariffs would easily offset the benefits, given that tariffs can be nearly prohibitive in some cases (Lester and Watson 2013). However, the pursuit of remedies against renewable energy aims primarily for protecting domestic firms, but come at the cost of hampering the diffusion of renewable energy (Hughes and Meckling 2015). In addition, the efforts made to address climate change can be slowed down because the development of renewable energy cannot achieve an optimum level with the presence of high tariffs.

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This work focuses on the EU's imposition of remedial duties on the Chinese solar imports since 2012. The second section of the chapter discusses the rationales underlying the use of industrial policies for renewable energy, and the following section sets out the basic legal framework of trade remedy rules as prescribed under the WTO. The fourth section of the work describes the escalating tensions between the EU and China, particularly in the production of solar panels as well as their implications. The last section proposes to reach a bilateral agreement in which the use of trade remedies between the EU and China can be regulated to avoid abuse for protectionist purposes. To build a cooperative relationship between the EU and China for the prospect of renewable energy development and green economy transition is of critical importance.

5.2 Rationale for Renewable Energy Industrial Policies

The controversial nature of industrial policy is testified to by the very fact that there is no universally agreed definition of this term yet (Warwick 2013). Industrial policy is based on the idea that governments should actively and intentionally intervene to encourage the development of key domestic manufacturing sectors (Wu and Salzman 2014). It is perceived in the majority of analysis that industrial policy means being "selective, targeting or sectoral" and favours particular industries or sectors over others (Chang 1994). In the case of renewable energy development, the adoption of industrial policy tends to favour domestic industries over foreign ones. The use of industrial policy is proclaimed to be back in favour after its popularity having waned for many years (Rodrik 2010). Governments applying a toolbox of industrial policies for the development of renewable energy have grown in prevalence in recent decades, which can be explained from three different perspectives.

5.2.1 Environmental Goals

Renewable energy has played, and will continue to play, a crucial role in reducing greenhouse gas emissions and combating climate change. Developing renewable energy, as an alternative to emission intensive fossil fuels is bolstered by an increasing number of countries. However, certain environmental costs of production in fossil fuel are not reflected in the market cost, which could clearly lead to renewable energy being financially uncompetitive (Owen 2006). Meanwhile, markets fail to account for positive externalities resulted from the deployment of renewable energy, which is partly responsible for renewable energy developing falling short of its potential (IRENA 2016a). To level the playing field between renewable energy and fossil fuels is of critical importance in tackling climate change. According to the Stern Report, climate change is the "greatest and widest-ranging market failure ever seen" (Stern 2007). Standard economic analysis posits that government intervention is warranted whenever the market fails to provide desirable public goods or to tackle externalities of various kinds. As a consequence, solving climate change requires the use of well-thought industrial policies. Industrial policies designed to incentivize renewable energy development have the potential to address a range of market failures in energy market and the environment as a whole.

5.2.2 Social and Economic Goals

Social and economic goals belong to the second category of the underlying renewable energy industrial policy rationale. Targeted industrial policies for renewable energy would address an economy-wide failure of not generating adequate economic growth, by strengthening domestic renewable energy industries (Charnovitz 2014). A transition to a green economy featured with low-carbon growth and prosperity can be achieved through the development of renewable energy. The WTO Secretariat has applauded such policies as seeking to "stimulate economic growth, spur job creation and promote exports and diversification" (World Trade Report 2013). According to statistics, global renewable energy employment increased by 2015 to reach 8.1 million people active in the industry, with a continuing rise of the total number of jobs. This constitutes a stark contrast with depressed labour markets in the broader energy sector (IRENA 2016a). As the largest renewable energy employer, solar PV had 2.8 million jobs worldwide (IRENA 2016b). Shaping a favourable policy framework is a key driver for deploying renewable energy and bringing associated social and economic benefits.

5.2.3 Energy Security

Renewable energy industrial policies can also be understood in light of energy security concerns. Energy security is defined as the uninterrupted availability of energy sources at an affordable price, which has many aspects. Long-term energy security mainly deals with timely investments to supply energy in line with economic developments and sustainable environmental needs, while short-term energy security focuses on the ability of the energy system to react promptly to sudden changes within the supply-demand balance. The development of renewable energy would greatly diversify the energy mix and facilitate the realization of an affordable and sustainable energy supply on a large scale.

5.3 The Legal Framework of Unilateral Trade Remedies Under the WTO Regime

Many if not all, industrial policies designed for renewable energy, such as import tariffs, local content requirements and domestic subsidies, could become the subject of trade disputes if believed to violate the WTO rules by other members. It is useful to touch upon the legal framework under the WTO that deals with the use of trade remedies. It is not the aim of this chapter to touch upon the WTO-consistency of renewable energy industrial policy measures, which is highly context-specific. This chapter examines how trade remedies come into play when conflicts arise due to the use of industrial policy in renewable energy area and whether the use of remedial measures should be limited.

5.3.1 Overview of Trade Remedies

Trade remedies have traditionally been used to protect declining industries in industrialised countries, such as steel and consumer electronics (Barry 2001). However, a new and worrying trend in recent years is the targeting of renewable energy products, such as solar panels, wind turbines and biofuels. This new trend has been intensified by the frequent use of remedies particularly among major renewable energy producer countries (Lester and Watson 2013). Another noticeable change is that some emerging and developing economies now form the majority of trade remedy users although the US and the EU were the heaviest users back in the 1980s and 1990s (Plasschaert 2016).

The crucial importance of renewable energy industrial development constitutes a big motivation for countries, both developed and developing ones, to resort to trade remedies to protect domestic interests. However, the cost of unilateral trade remedies can be evidenced by the fact that they always result in a higher price for the renewable energy goods on which tariffs are imposed (Wu and Salzman 2014). In most if not all cases, it is consumers in the importing countries that have to bear the cost of higher tariffs, which can impose negative impacts on consumer demand of renewable energy products.

5.3.2 WTO Rules on Unilateral Trade Remedies

There are two forms of trade remedies—the countervailing duty (CVD) and the anti-dumping duty, which are highly relevant in this chapter since the two are widely employed as countermeasures to industrial policies. The third form, namely safeguard measures, has rarely been used as a trade remedy and thus will not be discussed in this chapter.[1]

The WTO defined the rules that the use of anti-dumping and CVD remedies is subject to in the Uruguay Round.[2] The remedial measures can be taken against imported products when the domestic firms can establish the existence of dumping or illegal subsidization and can prove that, as a consequence, the domestic industry suffers "material injury".[3] To be specific, the term "anti-dumping action" refers to measures designed specifically to protect the country's own producers of a given product against unfair dumping practices carried on by exporters of the like product in another country (Bentley and Silberston 2007). "Countervailing action" serves the purpose of protecting country's domestic producers of a given product against the unfair trade effects of subsidization of the like product by another country (Bentley and Silberston 2007). A CVD shall remain in force only as long as and to the extent necessary to counteract subsidization, which is alleged to cause injury.[4] Anti-dumping duty shall be terminated on a date not later than five years from its imposition unless the authorities can prove evidence, which testifies to the extension of duty.[5]

It is argued that the WTO rules governing the imposition of unilateral trade remedies, procedurally and substantively, are too weak to prevent the abuse for protectionist purposes (Kasteng 2013). Therefore, a significant degree of discretion is left open for Member States. As Mavroidis, Messerlin and Wauters note, "this drift has always been in one direction, making it easier to prove the existence of dumping and injury and of a causal link between dumping and injury" (Mavroids et al. 2008). This explains why unilateral trade remedies have become increasingly popular for dealing with the pressure of trade liberalization and buttressing industrial policies (Bown and McCullob 2012). Compared with the WTO dispute settlement system, unilateral trade remedies offer a much faster, direct and politically appealing responsive means to unfair industrial policies (Wu and Salzman 2014). Political resistance to the reform of WTO trade remedy rules has been strong, and the current stalemate in multilateral negotiation rounds implies the difficulty to make amendments.

5.4 The EU and China Solar Panels Trade Tensions

The EU and China are two critically important actors in the transition towards a green economy. The EU has been a leading player in the development of renewable

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[1] The WTO safeguard provisions prove to be more difficult to be used to obtain relief, thus, safeguard measures are not frequently used as a trade remedy. See, Bown (2002) 'Why are Safeguards Under the WTO So Unpopular?' in World Trade Review.

[2] See the SCM Agreement, which governs the use of CVD measures and Agreement on Implementation of Article VI of the General Agreement on Tariffs and Trade 1994 (Anti-dumping Agreement), which governs how to use anti-dumping duties.

[3] See SCM Agreement Article 7 and Anti-dumping Agreement Article 3.

[4] See SCM Agreement Article 21.1.

[5] See Anti-dumping Agreement Article 11.

energy industries and assumed a long-time leadership in combating climate change. As a latecomer, China's solar manufacturing industry has experienced astonishingly fast growth since its accession to the WTO in 2001 and has become the world's largest producer of solar panels within a decade's time (Chen 2015). It is estimated that around 80% of China's solar panel exports have gone to the EU market, which constituted 63% of the EU market in 2009 and 80% in 2011 (EU Prosun 2015). This makes the EU the biggest market for Chinese solar products. Undoubtedly, the competition between the EU and China in improving solar manufacturing capabilities has become increasingly intense.

Against this background, leading European solar panel manufacturers filed a complaint in July 2012 that China "was demolishing competition" by exporting the panels with prices below market value (Traynor 2012). The European Commission initiated an investigation into potential Chinese dumping of solar panels on 6 September 2012 (European Commission 2012). The decision is to carry out anti-dumping measures concerning around $2 billion worth of imports from China, making it the largest case of its kind ever (Bradsher 2012). Following this move, some European companies filed another complaint to the European Commission seeking countervailing duties against Chinese imports as redress for allegedly illegal Chinese government subsidies (Chaffin 2012). Despite the divergent views held by EU members in terms of trade actions imposed on solar imports from China, the European Commission recommended imposing provisional anti-dumping duties, averaging 47% on Chinese solar panels in May 2013. These duties were reduced to 11.8% for two months due to the opposition from some EU members (Spiegel 2013). Countries like France or Germany have been urging the EU and China to come together on an amicable solution in a timely manner (ICTSD 2013). After the EU decided to impose duties on Chinese solar panels, China responded immediately by announcing an investigation into the dumping and subsidization of wine products imported from Europe (Jones 2013). In addition, China decided to open anti-dumping and anti-subsidy probes on solar-grade polysilicon imported from the EU (Zhang 2012).

The growing pile of trade frictions over renewable energy is of itself rather clear. Instead of putting an end to trade remedy measures after more than three years, the European Commission decided to keep punitive duties in place (Xinhua 2016). It is noted that a majority of EU countries opposed this plan to extend anti-dumping duties on Chinese solar panels, although they do not represent a majority of the EU's population, thus falling short of the blocking "qualified majority" (Blenkinsop 2017). It again shows the divergent standpoints held by EU member countries towards targeting Chinese solar imports, which at least gives some hope in the two sides reaching a common ground.

Overall, the effects of unilateral trade remedies on the renewable energy sector are particularly visible and negative. The remedial measures could increase the likelihood of "tit-for-tat" trade collisions in the renewable energy sector, which is reflected by the ongoing solar disputes between the EU and China (Horlick 2013).

5.5 Policy Options and Conclusions

Trade in renewable energy goods is bound to increase, which is likely to give rise to a larger number of trade disputes in the future (Peat and Barthelemy 2015). Although making amendments to the current WTO trade remedy rules through multilateral negotiation is an ideal option, the feasibility of it is highly questionable given the stalemate in the current Doha Round. This chapter explores the possibility outside the WTO regime and focuses on the two important actors: the EU and China. This following part discusses whether and how to develop a mutually beneficial relationship between the EU and China regarding the imposition of trade remedies against renewable energy products.

5.5.1 Rationale for a Bilateral Agreement Between the EU and China

There is a possibility that bilateral trade frictions resulted from the frequent use of trade remedies are pushing the EU and China to risking a renewable energy trade war with enormous damages occurring not only within two sides but also other economies in global trade (Emmott and Martina 2013). The escalation of mutual trade investigations, complaints and the prospect of trade remedial measures testify to the fact that the interest of the EU and China are dangerously at odds (Graaf 2015). Unilateral trade remedies, which imply high duties on renewable energy products, would affect the use of renewable energy to the detriment of the environment and thereby come into conflict with national and international climate and environmental objectives. The commitments that the EU and China have formally pledged in its "nationally determined contribution" (NDC) require considerable efforts to be made to bolster renewable energy development.[6]

The benefits of limiting the use of remedial tariffs against renewable energy are clearly enormous in a multitude of ways. More trade in the sector will mean more competition, lower prices and higher quality, which also bolster the diffusion and promotion of renewable energy technologies to the advantage of climate change endeavours. Meanwhile, it reduces the trade frictions between the EU and China and contributes to a stable and healthy trading relation. Therefore, the EU and China need to reach a common ground so as to limit the abusive use of trade remedies against renewable energy. This part proposes to establish a bilateral agreement between

[6]The Paris Agreement Article 4 paragraph 2 stipulates that each party shall prepare, communicate and maintain successive nationally determined contributions that it intends to achieve. For instance, China lists specific goals as "to achieve peak carbon dioxide emissions by approximately 2030, or sooner as best efforts allow; to increase the share of non-fossil fuels in the primary energy mix to approximately 20%…" The EU and its Member States are committed to "a binding target of an at least 40% domestic reduction in greenhouse gas emissions by 2030 compared to 1990" (United Nations 2015, p. 4).

the EU and China that specifically deals with the imposition of trade remedies in renewable energy area.

5.5.2 *The EU–China Bilateral Agreement on the Imposition of Renewable Energy Trade Remedies*

In the proposed EU–China Bilateral Agreement on the Imposition of Renewable Energy Trade Remedies, a few points are brought to the fore to subject the use of remedies measures into a more stringent discipline as compared to the WTO rules. The current WTO rules of trade remedies are controversial and lenient, leaving a large scope of policy space for its Member States to make use of trade remedies. The EU and China could formulate a more stringent process of initiating trade remedies in the renewable energy sector than that currently outlined in the WTO rules.

The level of unilateral trade remedies against renewable energy should be limited

Limits should be placed on the level of unilateral trade remedy tariffs on renewable energy products. A lesser duty rule for trade remedy investigations has already been used by the EU, which obliges the EU to impose a trade remedy that is not higher than the dumping or subsidy margin and the injury margin (NBT 2013a, b).[7] It is critically important for the two sides to negotiate an explicit limit on the level of remedial tariffs that are permitted against renewable energy products. Otherwise, there is always a possibility of setting remedial tariffs level higher than necessary to be prohibitive.

The duration of unilateral trade remedies against renewable energy should be limited

A time limit for the unilateral trade remedies on renewable energy should be introduced under this agreement. The normative period of trade remedy imposition lasts as long as five years under the WTO rules, which is deemed to be unnecessarily long given how fast technological development of renewable energy can be. Therefore, the EU and China should consider the adoption of a shorter time period so that the negative impact of remedial tariffs can be curtailed. The extension of remedial tariffs is subject to strict review after the expiration of the imposition period.

The scope of unilateral trade remedies against renewable energy should be limited

It is advocated that the EU and China should agree to a list of renewable energy products that could be entirely exempted from unilateral trade remedies. This can narrow the scope of renewable energy products that can be imposed with higher

[7] See, National Board of Trade (2013).

tariffs when imported. Admittedly, it could be politically controversial to reach a common ground on what renewable energy products enjoy a total exclusion from trade remedies. No one will really know the answer until a government voices the idea. However, having a bilaterally agreed list as a "safe harbour" for a certain number of renewable energy products that bear significant value from trade, social and environmental perspectives is at least worth a try.

A public interest test should be inserted

The incorporation of a public interest test in the application of trade remedies requires any investigation to be initiated only after the examination of the consistency between remedial measures and public interest. It grants the authorities the option to conclude whether it is in the public interest to apply trade remedial measures on the basis of all the information submitted. Remedial measures will be denied if it is not considered to be in the public interest. The public interest principle can operate as a safety valve in trade remedy cases and assist in avoiding the automatic imposition of trade remedies.

The test of community interest[8] has been included in the EU trade remedy regulation and formalized into a necessary part of the investigation. The EU authorities have to take into account these interests such as employment opportunities, competition preservation, investment certainties and external trade policy considerations (Bentley and Silberston 2007). This provides valuable lessons for incorporating a similar public interest test in the EU and China agreement.

In comparison to the community interest under the EU rules, public interest test in the EU–China Bilateral Agreement needs to give more weight to environmental interest such as the imperative to address climate change. The intrinsic importance of these non-trade objectives and values needs to be recognized so as to protect them against trade remedial measures. Fully engaging the public interest test in the investigation process offers a possibility to avoid trade remedies being abused to the detriment of wider social, economic and environmental interests.

5.6 Conclusions

The use of trade remedies against renewable energy goods is widespread and growing, particularly among these major producer countries. However, it is widely acknowledged that imposing trade remedies would, in most if not all cases, bring tensions to trade relations and reduce trade volume and competitiveness. A priori, this can easily put the policies that aim for trade interests and these for climate interests at conflict. As two influential actors in international climate and trade regimes, the EU and China should start to play a leading role in preventing rampant abuses that turn trade restrictive remedial measures into barriers for renewable energy scaling up.

[8] See, Council Regulation EC No 384/96 on protection against dumped imports from countries not members of the European Community.

This chapter proposes to bring the EU and China to reach an agreement that specifically deals with trade remedies against renewable energy products. The design and nature of the rules in this agreement are of critical importance. This chapter puts forward a few specific points: the level, scope and duration of imposing trade remedies by either the EU or China need to be subject to explicit requirements. In addition, the incorporation of a public interest test that recognizes the intrinsic importance of non-trade values such as combating climate change in trade remedy investigation is deemed as necessary.

It is almost certain that there will be emerging obstacles to the goal of a new bilateral agreement; however, identifying a strategy that is pragmatically feasible as proposed in this chapter is worth a try.

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Chapter 6
Renewables, Energy Storage, and Smart Grids

Prudence Dato, Tunç Durmaz and Aude Pommeret

6.1 Introduction

The problem of global warming means the world economy must move from a fossil fuel present to a future where energy will mainly be produced from non-fossil fuels. Accordingly, this chapter presents an economic analysis of the energy transition. It focuses in particular on the integration of renewable power generators, such as solar panels and wind turbines. The fact that many renewable sources of energy are inherently intermittent and unpredictable, however, makes their integration challenging. This suggests that one cannot ignore energy storage and smart grid opportunities when studying microgrid penetration. Therefore, we study the optimal renewable energy (RE) and microgrid penetration for a household (HH) that is able to access smart devices, such as smart meters, batteries and so on.

Existing literature on renewables in the energy mix features two rather separate trends. On the one hand, macro-dynamic models à la Hotelling take RE sources as abundant, ignore intermittency and focus on the cost issue (see Hoel and Kverndokk 1996; Tahvonen 1997). Another strand of the literature studies the design of the electricity mix (fossil fuels and renewables) when intermittency is taken into account (see Ambec and Crampes 2012, 2015), or when storage takes care of peak electricity

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(see Crampes and Moreaux 2010) and excess nuclear production during periods of low demand (Jackson 1973). A recent literature survey on the economics of solar electricity (Baker et al. 2013), nonetheless, emphasizes the lack of economic analysis of a decentralised clean energy provision from renewable sources. We fill this gap by considering a two-period setting that accounts for intermittency and energy storage.

Smart grids and demand-side management have received considerable attention in particular in the media (The Economist 2009; The Telegraph 2015a, b). Without smart grids, the lack of transparency on the distribution side of the system is apparent to consumers: Most people do not know how much electricity they have used until they are presented with the electricity bill, nor are they aware of the proportion of electricity produced from different sources of energy and the emissions generated in the process. Moreover, smart grids make it easier to coordinate intermittent and dispersed sources of power, such as rooftop solar panels and backyard wind turbines. Electricity at different periods is an a priori gross complement in the consumer utility function. Demand-side management policies, such as the use of smart meters, will be modeled as policies increasing the substitutability of electricity at different periods, incentivising agents to consume or store electricity when it is cheap. We account for two levels of smart grids. The first one is smart meters: If consumers are equipped to receive information on spot prices, they become more reactive to peak-load pricing and take better decisions (Borenstein and Holland 2005; Joskow and Tirole 2007). The second-level concerns energy storage.

In this work, we analyze what constitutes an efficient mix of investment in intermittent renewable, storage, and central grid electricity provision. We study the consequences of demand-side management which our model allows us to do in a simple way. First, we consider smart meters, which serve to observe the electricity price that is uncertain ex ante. Second, the HH can store energy to use thereafter. We derive the optimal microgrid capacity in terms of solar panels and storage devices and study the consequences of microgrid penetration for grid consumption and peak electricity. Finally, we derive the conditions that favor smart meter adoption and show that a smart meter is beneficial once it can allow the user to take advantage of a sufficiently low electricity price.

The remainder of this chapter is structured as follows. The model is presented in Sect. 6.2. In Sect. 6.3, we study the optimal investment decision for solar panels and storage devices both when the HH is equipped with a smart meter and when it is not. We then analyze in Sect. 6.4 the consequences for energy consumption and the purchasing of electricity from the grid. In Sect. 6.5, we discuss the relevance of smart meter adoption. Finally, we draw conclusions based on our findings in Sect. 6.6.

6.2 The Model

We consider a two-period model. The HH invests K_1 (e.g., solar panels) during the first period to generate RE whose total usage cost is rK_1. Thanks to this investment, it generates K_1 kilowatt-hour (kWh) of electricity in the first period. During the second period, the RE generation depends on the state of nature, which can have two outcomes, depending on the weather. Sunny weather has the probability of P_s and bad weather occurs with the probability $P_n = 1 - P_s$. In the latter case, there is no solar power generation. Existing storage capacities allow for the storage and transfer of energy to the second period. Cost of storage is accounted for through a loss of energy during the restoration process. Denoting energy storage in the initial period by S_1, the amount that can be used in the second period will be ϕS_1, where $\phi < 1$ is the round-trip efficiency parameter.

We assume that the microgrid is connected to a central grid. The unit cost of electricity on the grid is c_1 in the first period, but it depends on the state in the second period. Let P_l ($P_h = 1 - P_l$) denote the probability of a low (high) price on the grid. When there is sun (resp. no sun) and the price on the grid is low, the cost of electricity will be $c_{sl} g_{sl}$ (resp. $c_{nl} g_{nl}$) where g_{sl} (resp. g_{nl}) and c_{sl} (resp. c_{nl}) are the amount of electricity purchased and the unit cost, respectively. Similarly, when there is sun (resp. no sun) and the price on the grid is high, the total cost of purchasing electricity from the grid will be $c_{sh} g_{sh}$ (resp. $c_{nh} g_{nh}$).

At each period, the HH has an instantaneous gross surplus over energy consumption. For $j = s, n$ and $i = l, h$, let $u(K_1 + g_1 - S_1)$ and $u(\mathbf{1}_s(j)K_1 + \phi S_1 + g_{ji})$, where $\mathbf{1}_s(j) = 1$ if $j = s$ and 0 otherwise denote these surpluses in the first and second periods, respectively. It is assumed that $u' > 0$ and $u'' < 0$ where u' and u'' denote the first- and second-order derivatives, respectively.

6.3 Microgrid Connection to the Main Electrical Grid

In this section, we analyze the optimal solar panel and energy-storage investment decisions and electricity purchases from the electricity grid by a HH that is equipped with a smart meter allowing the HH to observe the electricity price.[1] We suppose that the HH cannot provide electricity to the grid.[2] In the HH program, this introduces two additional positivity constraints on electricity purchases ($g_1^m \geq 0$ and $g_{ji}^m \geq 0$).

[1]In Sect. 6.3.2 we will study the case of no smart meters.

[2]There are still countries (e.g., Hong Kong and many countries in Africa) where excess power generated by RE systems cannot be fed to the grid. In Africa, specifically, big power companies are against the regulatory framework that would allow electricity provision to the grid. Furthermore, and unsurprisingly, there are also politicians who encourage them to do so due to the economic ties the parties have with each other (Renewable Energy World 2013). A general case of electricity provision by the HH to the grid with some implications such as transmission congestion is left for future research.

$$V^m = \max_{\{K_1, S_1, g_1, g_{ji}\}} \quad u(K_1 + g_1 - S_1) - c_1 g_1$$
$$+ \sum_j \sum_i P_j P_i \big[u\big(\mathbf{1}_s(j) K_1 + \phi S_1 + g_{ji}\big) - c_{ji} g_{ji}\big] - r K_1$$
$$\text{s.t.} \quad \overline{K} \geq K_1 \ (\nu_1), \ \ K_1 \geq 0 \ (\nu_3), \ \ S_1 \geq 0 \ (\nu_2),$$
$$\overline{S} \geq S_1 \ (\nu_4), \ \ g_1 \geq 0 \ (\nu_5) \text{ and } g_{ji} \geq 0 \ (\nu_{ij}).$$

Let the 'm' superscript denote the optimal value for the decision variables for the case where the HHs only have access to smart meters. The FOCs with respect to K_1, S_1, g_1 and g_{ji} yield

$$u'\big(K_1^m + g_1^m - S_1^m\big) + P_s \sum_i P_i u'\big(K_1^m + \phi S_1^m + g_{si}^m\big) - r = \nu_1 - \nu_3, \tag{6.1a}$$

$$\phi \sum_j \sum_i P_j P_i u'\big(\mathbf{1}_s(j) K_1^m + \phi S_1^m + g_{ji}^m\big) - u'\big(K_1^m + g_1^m - S_1^m\big) = \nu_4 - \nu_2, \tag{6.1b}$$

$$u'\big(K_1^m + g_1^m - S_1^m\big) - c_1 = -\nu_5, \tag{6.1c}$$

$$u'\big(\mathbf{1}_s(j) K_1^m + \phi S_1^m + g_{ji}^m\big) - c_{ji} = -\nu_{ji}, \tag{6.1d}$$

respectively. Plugging the FOCs for g_1^m and g_{ji}^m in Eqs. (6.1.a) and (6.1.b) gives

$$c_1 + P_s \sum_i P_i c_{si} - r = \nu_1 - \nu_3 + \nu_5 + P_s \sum_i P_i \nu_{si}, \tag{6.2a}$$

$$\phi \sum_j \sum_i P_j P_i c_{ji} - c_1 = \nu_4 - \nu_2 - \nu_5 + \phi \sum_j \sum_i P_j P_i \nu_{ji}. \tag{6.2b}$$

We consider the case where solar panels and storage are relatively cheap. Thus,

$$c_1 + P_s \sum_i P_i c_{si} - r > 0, \tag{6.3}$$

$$\phi \sum_j \sum_i P_j P_i c_{ji} - c_1 > 0. \tag{6.4}$$

In light of these equations, several potential scenarios emerge. For example, one can encounter a scenario where it is optimal to use all the storage capacity and, yet, install no solar panels. Additionally, one can also consider a case in which it is optimal to exhaust the whole capacity for solar panels but store no energy. Furthermore, solar panels and storage device installations can also take interior values. Figure 6.1 illustrates various cases for investment and grid purchase decisions by considering different electricity prices on the grid in the first period. Without attempting to calibrate the model, the parameter values we use are $r = 0.05$; $\phi = 0.49$; $P_s = 2/3$; $P_l = 1/2$; $c_1 = 0.1$; $c_{sl} = 0.05$; $c_{sh} = 0.25$; $c_{nl} = 0.1$; $c_{nh} = 0.3$; $\overline{K} = 4$ and $\overline{S} = 4$.

When the price on the grid in the first period is sufficiently low, the figure shows that it will be optimal to store energy to reach the full capacity by purchasing elec-

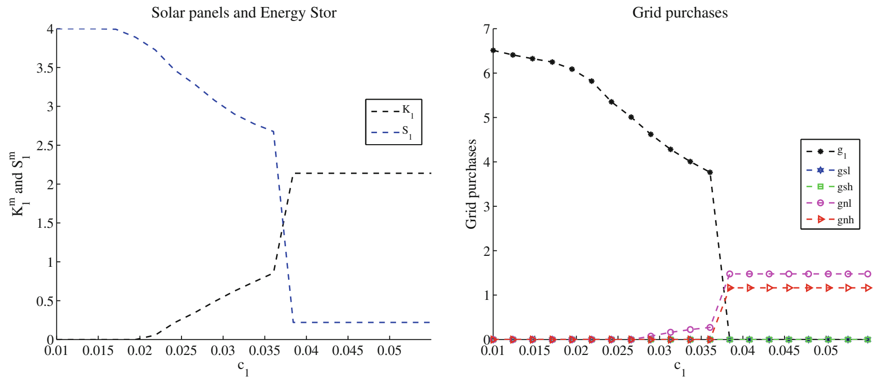

Fig. 6.1 Case for an interior solution

tricity only from the grid. In this case, there will be no investments in solar energy. For a sufficiently high storage capacity, it can be seen that there will be no electricity purchases from the grid in the second period. For higher prices in the first period, we can see that new scenarios emerge.

6.3.1 Interior Solution

We first focus on the case with interior solutions, that is, $\upsilon_1 = \upsilon_2 = \upsilon_3 = \upsilon_4 = \upsilon_5 = 0$. This implies $g^m_{sh} = g^m_{nh} = 0$.[3] From an analytical point of view, removing access to a smart grid is equivalent to replacing two constraints, namely $K_1 \leq \overline{K}$ and $S_1 \leq \overline{S}$, with two constraints on the grid purchases in the second period. The economic intuition is as follows. If it is not possible to provide excess electricity to the grid when there is sun and the price on the grid is high, there is no incentive to buy an infinite amount of solar panels. On the other hand, when there is no sun and the electricity price is high, then there is no incentive to have an infinite amount of storage capacity. Note $g^m_{nl} > g^m_{nh} > g^m_{sh}$ and $g^m_{nl} > g^m_{sl} > g^m_{sh}$ must always be true.

Using interior solutions, Eqs. (6.2a) and (6.2b) read

$$c_1 + P_s \sum_i P_i c_{si} - r = P_s P_h \upsilon_{sh} \tag{6.5}$$

$$\sum_j \sum_i P_j P_i c_{ji} - c_1/\phi = P_h \sum_j P_j \upsilon_{jh} \tag{6.6}$$

Replacing Eq. (6.1d) with υ_{ji} in Eqs. (6.5) and (6.6), S_1 and K_1 can be calculated using the following system of equations:

[3]This is due to the fact that assuming $g_{sh} = 0$ only will lead to infinite solutions for S^m_1 and K^m_1.

$$c_1 + P_s(P_l c_{sl} + P_h u'(K_1^m + \phi S_1^m)) = r, \tag{6.7a}$$

$$P_n(P_l c_{nl} + P_h u'(\phi S_1^m)) + P_s(P_l c_{sl} + P_h u'(K_1^m + \phi S_1^m)) = c_1/\phi. \tag{6.7b}$$

Equation (6.7a) shows that the marginal cost of solar panels should equal the sum of the avoided marginal cost of buying from the grid in the first period, the avoided marginal cost of buying from the grid when there is sun and the price on the grid is low, and the marginal benefit of consuming energy generated by the HH when there is sun and the price is high, i.e., $u'(K_1^m + \phi S_1^m)$. Equation (6.7b) indicates that the marginal cost of storage, c_1/ϕ, the opportunity cost of forgone consumption in period 1 adjusted for the storage loss, should equal the expected avoided marginal cost of buying from the grid plus the expected marginal benefit of consuming energy generated by the HH. For $g_{jl}^m > 0$, the optimal number of solar panels and energy storage are calculated from

$$u'(\phi S_1^m) = \frac{c_1/\phi - P_n P_l c_{nl} + c_1 - r}{P_n P_h} \tag{6.8}$$

$$u'(K_1^m + \phi S_1^m) = \frac{r - c_1 - P_s P_l c_{sl}}{P_s P_h}, \tag{6.9}$$

6.3.2 Microgrid Problem in the Absence of Smart Meters

In this section, we consider the optimal decisions of a HH that is not equipped with a smart meter. Hence, the HH neither observes the second-period electricity price nor sells to the grid. Consider a price tariff with c_1 and c_2 being the first- and second-period price, respectively. The HH solves the same program as in Sect. 4.3.1 for $P_i = 1$, $P_j = 1$ and $c_{ji} = c_2$. For an interior solution for K_1, S_1 and g_1 and assuming that $c_1 + P_s c_2 - r > 0$ and $\phi c_2 - c_1 > 0$, we must have $g_s^o = g_n^o = 0$ where the 'o' superscript denotes the optimal decisions for the current problem. Thus, there will be no purchase from the grid in the final period. The optimal values for solar panels, K_1^o, and energy storage, S_1^o, can be calculated from

$$c_1 + P_s u'(K_1^o + \phi S_1^o) = r \tag{6.10}$$

$$P_s u'(K_1^o + \phi S_1^o) + P_n u'(\phi S_1^o) = c_1/\phi \tag{6.11}$$

As this is a special case of the model presented in Sect. 4.3.1, the interpretation of the equations will be similar to that of Eqs. (6.7a) and (6.7b). The following proposition summarizes the results obtained in this section:

Proposition 6.1 *In the absence (resp. presence) of a smart meter, there exist interior solutions for solar panel investment, storage, and electricity purchase in the first period and there is no electricity purchase during the second period at any price (resp. if the price is high).*

6.4 Electricity Consumption and Grid Activity

In this section, we compare purchases from the central grid with and without smart meters.

Proposition 6.2 *For* $P_n > max(P_n^1, P_n^2)$, *where* $P_n^1 \equiv \frac{c_1/\phi - r + c_1}{c_{nl}}$ *and* $P_n^2 \equiv \frac{c_{sl} - r + c_1}{c_{sl}}$, *more electricity is purchased from the grid with smart meters. In particular,* $g_1^o < g_1^m$ *and* $g_{ji}^m \geq 0$ *while* $g_j^o = 0$.

Proof The proof is provided in Appendix A.

In the reverse case, $P_n < \min(P_n^1, P_n^2)$, $g_1^o > g_1^m$ and more electricity will be purchased from the grid without smart meters. In the second period, consumption from the grid for the no smart meter case is zero. As $g_{jh}^m = 0$, grid electricity consumption for the smart meter case reads $P_l \sum_j P_j(g_{jh}^m) \geq 0$. Thus, when the expected grid electricity purchases of a HH that is equipped with a smart meter is sufficiently low, the expected grid purchases in the case of no smart meter will be higher and vice versa. The intuition is as follows: when the probability of having sun is sufficiently low and it is not optimal to consume from the grid when the price is high, the HH will find it beneficial to store more by purchasing a higher amount of electricity in the first period. Furthermore, the fact that electricity can be purchased from the grid when the price is low also adds to grid purchases. Conversely, when the probability of having sun is sufficiently high, purchases from the grid in the first period will be lower with smart meters. This is mainly due to the fact that the possibility of no sun is sufficiently low and the HH will purchase from the grid only when the price is low.

Figure 6.2 provides an example. The parameter values leading to interior solutions for solar panels, storage devices and first-period grid purchases are $r = 0.5$; $\phi = 0.59$; $P_l = 1/2$; $c_1 = 0.275$; $c_{sl} = 0.32$; $c_{sh} = 0.7$; $c_{nl} = 0.55$; $c_{nh} = 0.7$, $\overline{K} = 6$, $\overline{S} = 5$. In running the simulations, we use 50 linearly equally spaced points between 0.3875 and 0.4541 for P_n. While $\max(P_n^1, P_n^2) = 0.438$, $\min(P_n^1, P_n^2) = 0.2969$. In line with Proposition 6.2, when $P_n > \max(P_n^1, P_n^2)$ the expected total grid purchases will be higher in the smart meter case. Even though $P_n < \min(P_n^1, P_n^2)$ is a sufficient condition for a higher level of grid purchases in the case of no smart meter, it is identifiable that a higher level of grid purchases will be expected with the use of the smart meter when $P_n > 0.438$.[4]

6.5 When to Install Smart Meters

In this section, we analyze the conditions under which it is beneficial to install a smart meter given its usage (or investment) cost, $r^m > 0$. Let V^o denote the maximum value

[4]In the figure, 'Extra grid purc.' corresponds to the expected electricity purchase with smart meter in excess of the grid purchase without a smart grid.

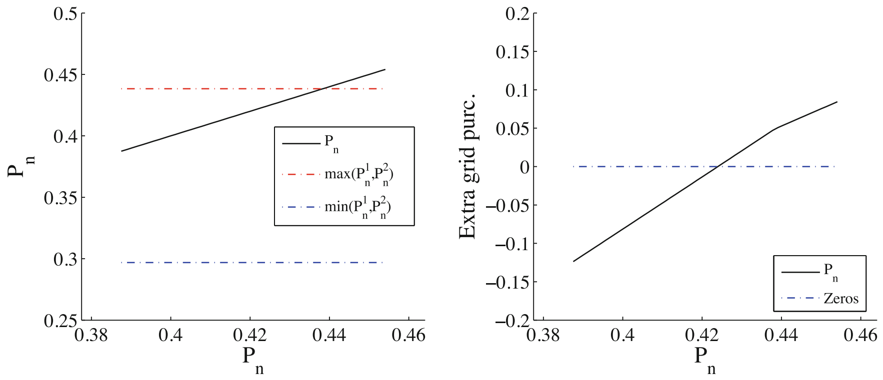

Fig. 6.2 Grid activity with/without a smart meter

function for the case of no smart meter when the solution is interior. Recall that for an interior solution $g_{sh}^m = g_{nh}^m = 0$ and $g_s^o = g_n^o = 0$ with and without smart meters, respectively. Furthermore, when the price is high, there are no grid purchases in the second-period irrespective of whether there are smart meters or not. This suggests that the HH may not benefit from the installation of the smart meter when the price on the grid takes high values.[5] Yet, the installation of the smart meter will be beneficial when the expected avoided cost (or saving) from its use is sufficiently high. This urges us to investigate the behavior of the maximum value function, V^m, with respect to the low price on the grid. The following proposition characterizes the smart meter installation decision. For simplicity, $c_{jl} = c_l$. The reasoning is unaltered for the general case.

Proposition 6.3 *There exists a price on the electric grid* $\hat{c}(r^m)$ *such that* $V^m - r^m \geq V^o$ *if, and only, if* $c_l \leq \hat{c}(r^m)$, *with* $\frac{\partial \hat{c}(r^m)}{\partial r^m} < 0$.

Proof The proof is provided in Appendix B.

One takeaway from this section is that the smart meter will become beneficial once it can allow the user to take advantage of a sufficiently low electricity price. When the second-period low price is not sufficiently low, it may be suboptimal to install a smart meter. Figure 6.3 illustrates this case.

6.6 Conclusion

Climate change, congested central grids, and lack of access to electricity in developing countries are problems that can be mitigated by the penetration of RE into the electricity supply mix together with microgrids. The intermittent nature of renewables

[5]Focusing on the cases where $K_1 = \overline{K}$ and $S_1 = \overline{S}$, the reasoning will remain the same unless $g_{jl} = 0$.

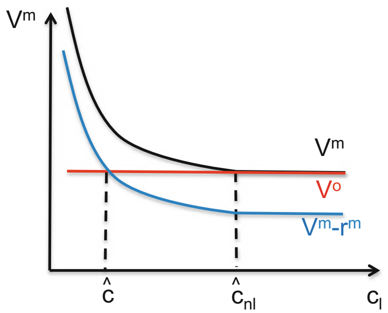

Fig. 6.3 Installation of a smart meter

coupled with the lack of reactivity of consumers to short-term fluctuations in electricity provision, suggest the need to utilize new technologies, such as energy-storage devices and smart meters. In this chapter, we analyze what constitutes an efficient mix of investment in intermittent RE, energy storage and central grid electricity provision and study the implications of such technologies for electricity purchases from the grid. We show that having access to smart meters can cause a higher amount of purchases from the central grid possibly leading to higher greenhouse gas emissions. In addition, smart meters are only desirable if they allow sufficiently large fluctuations in the electricity prices to be exploited. Finally, accounting for the possibility of the HH selling electricity to the grid, which may lead to transmission congestion, has been left for future research.

Appendices

The appendices can be found online at http://www.tuncdurmaz.com/appendix-renewables-energy-storage-and-smart-grids.html.

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Chapter 7
Greening Urban Housing: The Impact of Green Infrastructure on Household Energy-Use Reductions for Cooling

Ali Cheshmehzangi, Ayotunde Dawodu and Chris Butters

7.1 Introduction

The increase in the global population has inherently meant that the accompanying rise in energy demand must be met by an increase in primary energy and resource consumption. This situation is further compounded by the consumption of fossil-based fuel which is the primary source of energy globally and is identified as not only limited in supply but also detrimental to both the environment and human health (Yaghoobian and Srebric 2015). The best way to address this has been to reduce energy demand, find alternative means of producing energy (renewable energy) and improve the efficiency of fossil-based generation technologies (Boyle et al. 2003).

In addressing the first step (reduction), several authors suggest that reduction needs to occur on an urban scale through the transformation of urban infrastructure which transcends transportation and buildings and covers all other relevant infrastructure particularly green infrastructure (GI) (Escobedo et al. 2010; Gill et al. 2007; McPherson et al. 2013; Wong and Baldwin 2016). However, research into energy consumption, CO_2 emissions and plants is an emerging field that has only recently received notoriety (Churkina et al. 2010; Pataki et al. 2011; Pickett et al. 2011).

The urban GI come in many forms, such as parks, gardens, green roofs, community farms, woodlands, forest and wilderness areas, as well as more engineered options such as green roofs, green walls and rain gardens, can be effective in energy reduction and climate change mitigation on a micro-, meso- and macrolevel due to processes like evapotranspiration and vegetation capturing and storing carbon through biotic sequestration (Vidrih and Medved 2013; Cheshmehzangi and Griffiths 2014). The

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microclimate of a local area could be easily affected by the placement of trees creating shading and wind blockage, which would invariably influence energy use, thereby leading to reduced emissions. From a macro- or city-scale perspective, vegetation coverage would influence incoming solar radiation, surface roughness, albedo and relative humidity by altering the effects of local meteorology (Arnfield 2003; Nowak and Dwyer 2007). In addition, increasing or reducing humidity within a building impacts human comfort and is significantly dependent on location, i.e. hot or dry locations, and therefore, careful consideration of the type of GI methodology is required, methodology here meaning the use of green roofs and walls and other such processes (Yaghoobian and Srebric 2015). Other studies have addressed the impact of GI and its energy and carbon implications (Wang et al. 2014; Nuruzzaman 2015). However, this study takes a comparative look at GI and its effects on housing development in China versus European models. China is of vital importance in this regard as it is a major contributor to CO_2 emissions. Housing is also of significant importance due to China's large population and increasing urbanisation. Moreover, it is important to highlight the benefits of GI in the housing sector for various actors and users. The benefits are shortlisted for 'energy and climate change', 'health', 'environmental' and 'socio-economic'.

GI in housing sector plays a major role in achieving the better quality design and planning of housing units (Table 7.1). There are substantial advantages in terms of health, environmental and social factors, as well as energy and climate change issues. While policies can promote the benefits of GI in the housing sector for better environmental quality, they can also facilitate energy-related aspects of GI in practice. The planning system should emphasise the functionality of GI, beyond its ecological, aesthetic and socio-economic benefits. Balancing profitability with environmental considerations is essential for developers, and GI should play a positive role in not only advertising quality living environments, but more importantly, green and energy-efficient living. The owners/residents, as the end-users, should consider the importance of GI in their housing areas as a natural way of cooling and shading.

7.2 Method: Case Study Analysis

This section details the methodology employed in GI simulation for the comparative study of Chinese housing blocks versus European blocks, with the simulation executed using EnergyPlus™. In order to avoid key parameters related to the actual building's detailed design, the models considered are those that share the same materials used, orientation, wall thickness and construction methods. All trees are considered as 5 m high with the same shading effect. The simulation is based on the scenario of cross- or double-sided natural ventilation for each of the units. However, this is unlikely for high-rise blocks since nearly half of the units only feature single-sided natural ventilation.

Table 7.1 Priorities for and/or benefits for various actors and users of taking green infrastructure (GI) into consideration in the housing sector

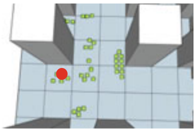
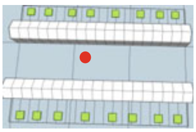
Benefits	Policymakers	Planners	Developers	Owners/residents
Energy and climate change	Promotion of GI as a natural way to tackle issues, such as urban heat island effect (UHIE)	Integrated planning for better microclimate urban design and enhancement of energy efficiency	Energy-use reduction as not only a selling point but also as the shared responsibility of developers	Energy-use reductions through cooling and shading; Cost effective in the longer term
Health	Promotion of GI for healthier urban living	Development of GI as a primary feature of healthy living environments	GI as multifunctional spaces in a typical development	More dependency on natural ventilation and cooling
Environmental	Preservation of greenfield and green spaces in city environments	Greening housing communities; Balancing the natural and built environments	Greening housing communities; Lessening environmental degradation	Better environmental quality for residents in the community
Socio-economic	Consideration of GI from multiperspectives and benefits	Enhancement of functionality of GI in practice	Provision of better accessibility to green spaces for users	Leisure or socialising feature of living environments

A unified context is proposed for all six cases in which the outdoor temperature is set at a constant temperature of 30 °C at 2pm. All models are simplified to feature the same level of occupancy (for energy-use simulation which is not shown here); same range of opening ratio (to building façade); same floor-to-ceiling height; and a similar spatial layout including at least three zones (with direct sunshine, with indirect sunshine and with no sunshine to the indoor spaces). It is important to note that these simulations are merely used for simulating the effect of GI (mainly trees and similar plantations) and not to fully assess the performance of buildings. Table 7.2 provides the findings of these simulations at two levels (lower and higher for low-rise models, and lower and middle for mid- to high-rise models). All simulations have been completed using the EnergyPlus™ programme. The findings are indicative for the purpose of this work and do not offer detailed information about temperature and energy use.

7.3 Results and Discussion

It is important to note that the effectiveness of (tree) plantation differs greatly between individual plantations and clustered plantations. The individual plantation layout,

Table 7.2 Comparative analysis of six cases studied: three existing Chinese cases and three European cases implemented in China as mock-up cases

Model	Model	Low-level: temperature range	High-level: temperature range
1. A typical Chinese low-rise urban housing (2-storey)		On ground floor: Minimum indoor: 24.3 °C Maximum indoor: 28.2 °C	On first floor: Minimum indoor: 24.9 °C Maximum indoor: 28.5 °C
	Floor area ratio (FAR) is approximately 1.5; surface coverage (SC) is medium to high; GI is limited to individual trees and small patches of green space		
2. A typical Chinese low to mid-rise model (6-storey slab housing block)		On first floor: Minimum indoor: 24.0 °C Maximum indoor: 27.8 °C	On fourth floor: Minimum indoor: 24.4 °C Maximum indoor: 28.6 °C
	Floor area ratio (FAR) is approximately 1.12; surface coverage (SC) is medium to high; GI is limited to clustered trees between slab blocks		
3. A typical Chinese high-rise housing model with high density (30-storey block)		On first floor: Minimum indoor: 25.4 °C Maximum indoor: 29.0 °C	On fifteenth floor: Minimum indoor: 25.5 °C Maximum indoor: 29.1 °C
	Floor area ratio (FAR) is approximately 4.0; surface coverage (SC) is low; GI is mainly clustered trees and large areas of green spaces		
4. A Parisian parameter model (8-storey block)		On first floor: Minimum indoor: 25.6 °C Maximum indoor: 28.6 °C	On fourth floor: Minimum indoor: 25.8 °C Maximum indoor: 28.8 °C
	Floor area ratio (FAR) is approximately 2.56; surface coverage (SC) is medium; GI is mainly individual trees or internal green spaces (if not services)		
5. A United Kingdom (UK) terrace housing row model (2-storey)		On ground floor: Minimum indoor: 25.0 °C Maximum indoor: 28.3 °C	On first floor: Minimum indoor: 25.2 °C Maximum indoor: 28.3 °C
	Floor area ratio (FAR) is approximately 1.0; surface coverage (SC) is low to medium; GI is limited to individual trees and patches of green in back gardens		
6. A typical European semi-detached model (2-storey)		On ground floor: Minimum indoor: 24.7 °C Maximum indoor: 28.1 °C	On first floor: Minimum indoor: 25.2 °C Maximum indoor: 28.8 °C
	Floor area ratio (FAR) is approximately 0.8; surface coverage (SC) is low; GI is mainly greenery and trees in back gardens and public space to the front		

mostly seen in the European models, provides a minimal cooling effect on surfaces. While the clustered plantation layout creates a larger shaded area, a negative impact is that it can potentially reduce the airflow. It is, therefore, suggested that a layout is created in which trees are clustered but airflows in between the individual trees are created, or by planting trees of various sizes (Akbari et al. 2001; Wong and Baldwin 2016). In all cases, the tree plantation was not effective for mid- to high-rise buildings, unless the building design included set-backs, upper gardens or balconies that can provide more shading for indoor areas. Some successful examples can be seen in Singaporean buildings, where the provision of public spaces on the upper floors often includes tree plantations and greenery.

Considering all six models in the context of China (including the three European models), we can then point out the advantages and disadvantages of each model on the basis of how GI can be utilised in common practice. The so-called common practice, however, mainly favours developers, for which the key issues of floor area ratio (FAR) and surface coverage (SC) appear to be very important. Table 7.3 points out these elements and elaborates on opportunities for development. In all cases, detailed design aspects (from the layout to internal design and façade design) can play a major role in utilising GI for housing communities.

7.4 Conclusions

GI at the neighbourhood or housing community level offers low-cost solutions to improve the urban microclimate and urban environmental quality. The reduction of surface coverage and balancing the density of built units will highly impact the quality of spatial planning and green spaces in city environments. With a focus on households, this study verifies the impact and effectiveness of GI in practice. The temperature difference between the simulated models—although not very significant—highlights the role of GI as a means of natural cooling and shading.

This study has listed a number of advantages that include not only reducing the cooling load but also increasing thermal comfort, while taking responsibility for the environmental impact. GI affects indoor environments through climate and air quality; it also affects human well-being and economic welfare (Bonta and Snyder 2008). This is based on reduced energy costs due to indoor air modifications, which for most households would be a primary incentive to adopt such techniques, keeping in mind that a change in temperature of 1 °C has an energy impact of up to 10% (Lehmann 2015). From a policy standpoint, various governments are increasingly encouraging the utilisation of GI for landscape design and cityscape design through local authorities and developers and household implementation by private homeowners. This is due to not only the environmental challenges outlined above, but in particular to the effects of Urban Heat Island Effect (UHIE) (Wang et al. 2014). The extensive use of GI by households could potentially help reduce urban air and surface temperatures thereby simultaneously addressing economic and environmental challenges.

Table 7.3 Advantages, disadvantages and opportunities for development for all six models

Model	Main advantages	Main disadvantages	Opportunities for development
1. A typical Chinese low-rise urban housing (2-storey)	Human-friendly scale and fairly compact at the same time; Walkable and permeable layout	Lack of land for significant green spaces; Almost no provision of GI in most cases	Mixed-use and greening opportunities; Turning internal courtyards into gardens
2. A typical Chinese low- to mid-rise model (6-storey slab housing block)	Provision of shading for most housing units; High-performance and reasonable density for housing units	Low-quality construction in most cases; Green spaces are either not functional or limited	Enhancement of spatial functionality of ground; More land dedicated to green spaces
3. A typical Chinese high-rise housing model with high density (30-storey block)	High provision of land use for green spaces (low SC for the buildings); Pleasant green environments internally	Excessive underground infrastructure; GI not very effective for upper floors	Green can be adapted on facades or in between floors; Maximising the overall permeability of GI
4. A Parisian parameter model (8-storey block)	Relatively high FAR and effective planning; Potential communal indoor spaces	Culturally not suitable; Variable orientation and East–West ventilation	Maximising GI for internal spaces; Using open spaces for more than just services
5. A UK terrace housing row model (2-storey)	Private green spaces for all units; Relatively balanced built and non-built spaces	Unprofitable density; Expensive units if applied to the context of China	Redesign of private spaces into communal spaces; Reduction of roads/streets between units
6. A typical European semi-detached model (2-storey)	Very low surface coverage; Private green spaces for all units	Unprofitable density; Expensive units if applied to the context of China	Redesign of private spaces into communal spaces; Reduction of roads/streets between units

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Part III
Innovation & Reciprocal Investment in EU-Asian Energy Sectors

Chapter 8
Chinese Investment in the EU's Energy Sector

Kin Pong Leung

8.1 Introduction

Chinese investment in Europe[1] has been growing rapidly in recent years, with less than $1 billion USD investment in 2000 compared to $18 billion USD recorded in 2014.[2] Cash-abundant Chinese companies have been investing across the European Union (EU) in a multitude of sectors, including real estate, energy, finance, industrial equipment, food, telecommunications and tourism. The interests of Chinese enterprises in the European energy sector are discernible given the extent and the scale of their investments which cover oil, gas, solar, wind, electricity grid, coal, hydropower and nuclear power.

Even though the energy sector accounts for 31% of total Chinese investment in the EU between 2005 and 2015, the literature that explores this topic is limited (Voss 2013; Wessing 2013). Voss' research focuses on a brief overview of Chinese investment in the energy sector in Europe, but lacks empirical data, while Taylor Wessing's report only discusses renewable energy. Aside from this the majority of the literature on Chinese investment focuses on the more general trend (Meunier 2014a, b, c; Hanemann 2014; Hanemann and Huotari 2015; Burgoon and Raess 2014; Clegg and Voss 2011, 2012; Knoerich 2012; European Chamber of Commerce in China 2013; Nicolas 2009) or takes a sub-regional focus such as an analysis of a specific country or group of countries, including Central & Eastern Europe for example (Torp et al. 2011; Burghart and Rossi 2009; Jacoby 2014).

[1] In this paper, we use the wording Europe and European Union synonymously when referring to European Union member state countries.

[2] The data is from the Rhodium Group.

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This research aims to fill the gap in the literature on Chinese investment in the EU's energy sector and looks to contribute to an understanding of the pattern, trend and motivations of Chinese investors during the period 2005–2015. The two main research questions addressed in this work are what are the trends of Chinese investment in the EU's energy sector and the motivations of the Chinese investors. The timeframe of this study is the period 2005–2015, the most recent 10 years since China's "Go Global" policy was launched in 2001. This study will rely on primary data as well as secondary resources such as books, journal articles and newspapers. A data set of 37 cases was selected, based on the original data of the Heritage Foundation and the author's elaboration. The first section of the work will provide an overview of the development of Chinese investment in the EU's energy sector in 2005–2015, mainly based on the statistical analysis of the data set and the second part will focus on the motivations of Chinese investors.

8.2 Data Collection

The main official sets of data on this topic are from Eurostat and Ministry of Commerce of People's Republic of China (MOFCOM). Other institutions such as the Rhodium Group, Heritage Foundation, Amadeus pan-European database and Thomson Reuters also have their own data sets which have been compiled based on individual transactions. The discrepancy, which exists between the official data, such as MOFCOM and Eurostat statistics and that from other institutions, is potentially caused by different accounting practices[3] and the complexity of offshore vehicles.[4]

The data collected in this study is primarily based on The Heritage Foundation China Global Investment Tracker.[5] The reason for choosing this data set is because of its public availability as well as relative accuracy. The data set is based on the compilation of individual investment transactions of Chinese outbound investment globally,[6] valued at more than $100 million USD. Twenty-eight Chinese investment

[3]Hanemann (2014) has conducted a comprehensive study on the discrepancies between MOFCOM and Eurostat.

[4]In order to benefit from the special taxation regime and flexibility of capital flow, some companies conduct the investment via subsidiaries overseas which might sometimes create confusion regarding the origin of the investment.

[5]The data was extracted in January 2016. For more information about the Heritage Foundation, refer to http://www.heritage.org/about/our-history/history.

[6]Chinese investment in this study is defined as investment originating from a company whose ultimate holding company is located in the People's Republic of China. In other words, investment made by Chinese-owned subsidiaries overseas is also included. The energy sector is defined as companies focused on energy exploration, extraction, refining and distribution, as well energy generation projects. The geographical location is based on the actual activity taking place, which should be within the territory of EU Member States. Therefore, Chinese investments in European companies whose operations are outside of the EU are not included in this analysis. This means that the operations within the EU's territory owned by companies outside of the EU will be included as will Chinese investment transactions in the EU's energy sector.

transactions in the EU's energy sector were extracted from this database. The author has added a further nine transactions which are not included in the Heritage Foundation data set due to undisclosed transaction amounts and their recent occurrence. In total, there were 37 Chinese investment transactions in the EU's energy sector between 2005 and 2015. A survey of news reports, statements from companies and other reports was conducted in order to conduct a qualitative analysis of the deals. Nevertheless, there are limitations associated with the data set due to slight discrepancies linked to different exchange rates as well as the exclusion of smaller amounts and undisclosed transactions. Despite these constraints, the data set is fairly comprehensive and can provide a reliable basis for analysis.

8.3 The Trend

8.3.1 Number of Transactions

As shown in Fig. 8.1, the number of cases of investment rose to ten in 2012, the highest number in the period. The number remained high in 2013 and 2014 with six and eight transactions, respectively, followed by a decline to three deals in 2015. It suggests that the number of deals has been growing in recent years with 31 deals in the period 2011–2015 compared with only 6 transactions in the period 2005–2010.

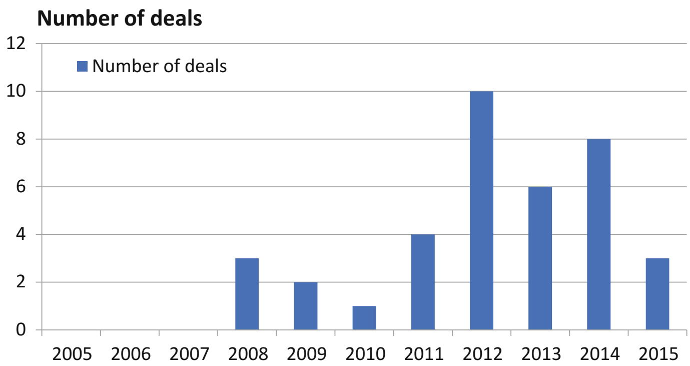

Fig. 8.1 Number of cases of Chinese investment in the EU's energy sector 2005–2015. *Source* Author's elaboration based on The Heritage Foundation's statistics

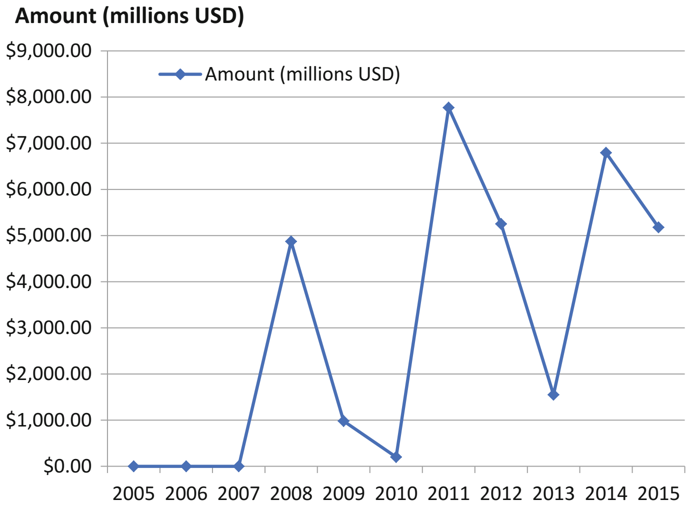

Fig. 8.2 Amount of Chinese investment in the EU's energy sector 2005–2015 (in USD). *Source* Author's elaboration based on The Heritage Foundation's statistics

8.3.2 Investment Amount

Between 2005 and 2015, the transactions in this data set totalled $32.5 billion USD, which is around 31% of the total investment made by Chinese investors in all sectors in the EU during the same period.[7] As shown in Fig. 8.2, the pattern is also rather sporadic but a long-term aggregate upward trend can be observed. While the investment amounted to $4.8 billion USD in 2008, it increased to $7.7 billion USD in 2011 with fluctuating patterns in the later years of 2012–2015. The amount of investment was especially large in the period 2011–2015 with $26.5 billion USD of transactions compared with $6 billion USD between 2005 and 2010.

8.3.3 Subsector

Figure 8.3 demonstrates the share of investment in different energy subsectors from overall Chinese investment in the EU's energy sector in terms of transaction amount for the time period 2005–2015. Electricity (30%)[8] and oil (26%) are the two main

[7] According to the Heritage Foundation China Global Investment Tracker Statistics, Chinese investment in the EU in all sectors totals $103 billion USD 2005–2015.

[8] Electricity refers to the electricity grid which usually has more than one source of power generation. For example, Three Gorges invested $3.5 billion USD for a 21% stake in Energias de Portugal in December 2011, which is a company offering a mixture of renewable power generation. In 2012, the company generated 34% of its total power from hydropower, 33% from wind power, 15% from

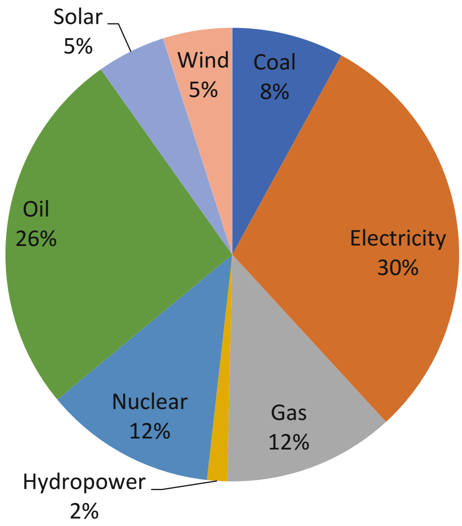

Fig. 8.3 Percentage of the type of energy invested in, per total Chinese investment in the EU's energy sector in terms of transaction amount between 2005 and 2015. *Source* Author's elaboration based on The Heritage Foundation's statistics

subsectors which received the largest amount of Chinese capital. They are followed by gas (12%) and nuclear (12%). Investment in coal (8%), solar (5%), wind (5%) and hydropower (2%) is smaller relative to former subsectors. However, the data suggests that Chinese investors are interested in not merely traditional oil and electricity grid companies, but seek diversification. While investments in electricity and oil remain important, Chinese investors are increasingly focusing on a mixture of different energy subsectors, including renewable energy such as solar and wind power.

While Fig 8.4 gives an overview of the aggregate amount of investment in the energy sector, Fig 8.4 depicts the share of investment per energy subsector for each individual year between 2005 and 2015. The figure demonstrates the evolving pattern of Chinese investment in different energy subsectors over time. Between 2008 and 2010, the majority of investments were predominantly related to oil, with more than 90% of the transactions concerned invested in this category. This changed from 2011 when the shares of other subsectors such as gas, electricity and coal grew and investment in the oil sector was greatly reduced. In 2015, we saw the first investment in the nuclear sector.

8.3.4 Analysis

Based on the statistics on the cases of investment, several trends can be observed. First, the energy sector in the EU is the largest recipient of Chinese investment in

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combined cycle gas turbines and 13% from miscellaneous sources. It is impossible to pinpoint which exact type of generation the Chinese investment went to. The companies concerned in this study are Energias de Portugal, REN, Eni, Enel, Ansaldo Energia and CDP Reti.

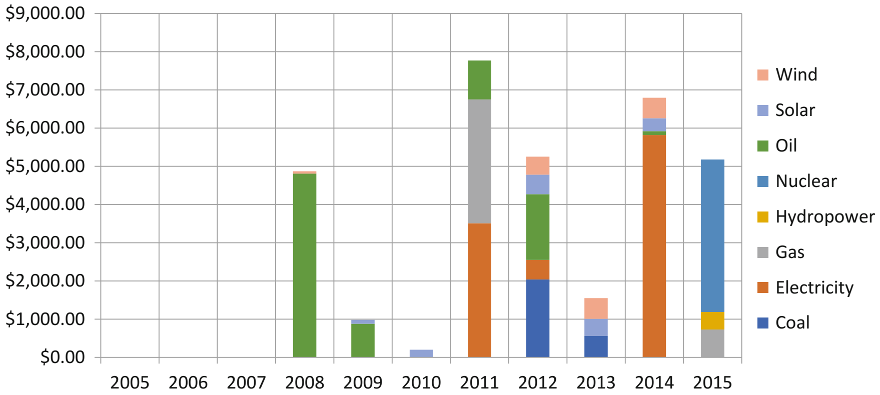

Fig. 8.4 Amount of Chinese investment in different subsectors of the EU's energy sector 2005–2015 (in USD). *Source* Author's elaboration based on The Heritage Foundation's statistics

the EU from 2005 to 2015, amounting to 31% of the total amount of investment in all sectors.[9] Academics and experts tend to believe that Chinese investment in Europe is mainly concentrated in branding, technology and know-how and that Chinese investors usually invest in resources-rich regions or countries such as Africa, Australia and Latin America when making energy-related investments (Clegg and Voss 2011; Dilip 2014; Knoerich 2012; Zhang 2013; Meunier 2014a, b, c). The above findings suggest that energy is actually an important sector for Chinese investment in the EU.

Second, the growth in investment has been particularly robust during the years 2011–2015. The number of transactions and amount invested increased more than fivefold to 31 deals ($26.5 billion USD) compared with six deals ($6 billion USD) between 2005 and 2010. This coincided with the general trend of Chinese investment in Europe; the year 2010 was the watershed for a rapid increase of Chinese investment in the EU's energy sector.

Moreover, Chinese investment shifted from conventional energy subsectors such as oil to more diverse alternative forms of energy such as gas, wind, solar, hydropower and nuclear. The shift started in 2011 when the Chinese government started to emphasise greener energy as well as energy diversification. Instead of acquiring raw materials directly as in the early period 2005–2010, during the later stage of 2011–2015 Chinese investors focused more on the technology and management know-how of EU energy firms. As Chinese companies were expanding in the renewable energy arena, wind and solar energy companies in China increasingly invested in Europe. In 2015, the first Chinese investment in nuclear energy in Europe was approved by the Romanian government, marking the beginning of Chinese investment in the EU's nuclear energy sector.

[9]According to the research conducted by the Rhodium Group, 28% of Chinese investment in the EU went to energy sector in the period 2000–2014 (Hanemann and Huotari 2015).

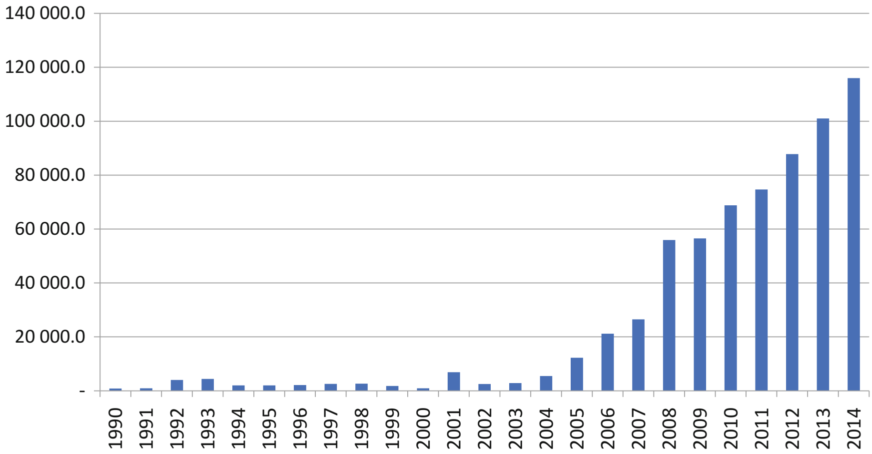

Fig. 8.5 Total amount of Chinese outbound investment in the world from 1990 to 2014 (in million USD). *Source* United Nations conference on trade and development (as of 24 June 2015)

8.4 Motivations of Chinese Investors

8.4.1 Broad Drivers

Chinese investment in the EU is a relatively recent phenomenon occurring from 2000 onwards. Before 2000 Chinese investment activity in Europe was negligible (Voss 2011). Outbound investment was encouraged from 1999 when the Chinese government announced its landmark "Go Global" policy to enhance the country's competitiveness and strengthen internationalisation. Figure 8.5, which depicts the annual amount of Chinese outbound investment overseas since 1990, shows that the amount of Chinese investment in other countries has increased tremendously since the "Go Global" policy in 2001, with the total annual flow of investment reaching $100 billion USD in 2013, compared with only $5 billion USD in 2005.

In addition, the global financial situation has also accelerated Chinese investment in Europe. Due to the trading boom China has seen since joining the WTO in 2001, the country has accumulated massive amounts of foreign reserves, rising from $250 billion USD in 2001 to more than $3 trillion USD in 2014, of which part was spent on purchasing European companies to diversify and avoid relying solely on US Treasury Bills. From 2005, the value of China's currency, the Renminbi (RMB), gradually appreciated,[10] while the Euro depreciated significantly following the sovereign debt crisis from 2010.[11] This major appreciation of the RMB against the Euro rendered

[10]The exchange rate between USD and RMB was 6.1130 on 29 October 2014, the lowest on record so far. The rate was 8.2765 in 20 July 2005 before the appreciation of RMB took place.

[11]The exchange rate between the EUR and USD peaked at 1.6 in 2008 but fell to 1.2 in 2010 and below 1.1 in 2015.

European assets much more affordable for Chinese buyers. Moreover, the crisis in Europe propelled some countries to eagerly privatise companies for cash,[12] providing cash-abundant Chinese investors with a good opportunity to cut interesting deals.

Company-level motivations

The majority of Chinese investments in the EU's energy sector were motivated by two main business considerations: (1) market-seeking and (2) strategic asset seeking. By investing in European companies, Chinese firms expanded their markets in Europe gaining new buyers of theirs goods/services (Clegg and Voss 2012). In addition to creating additional sales and distribution networks, Chinese companies also jointly invested in various renewable energy projects.[13] Furthermore, acquiring EU energy firms enabled Chinese investors to obtain access to the technology[14] that they did not previously possess as well as European or international management know-how[15] in energy enterprises.

Industry-level considerations

Oil, gas and coal

Chinese investors acquired a few European companies in oil, gas or coal energy sector. In 2008, the State Administration of Foreign Exchange (SAFE) acquired a small stake in BP and Total—an act that was mainly seen as a diversification of investment strategy (Wearden 2008). Sinochem's investment in Emerald Energy and its acquisition of Talisman Energy plus PetroChina's purchase of INEOS' oil refining business were related to the oil sector. In terms of gas, Gaz de France sold 30% of its gas and oil exploration and production business to China in 2011 to help boost its business in Asia (Sender and Anderlini 2008). Moreover, only three deals were made in the coal sector; two projects in Poland[16] and one project in Romania.[17] Chinese investment in the oil, gas and coal sectors was rather limited and decreasing in the years following 2012.

[12]The sale of Energias de Portugal (EDP) in 2011, Redes Energéticas Nacionais (REN) in 2012 and CPD Reti in 2014 in Portugal and Italy, respectively, are examples of such privatisation.

[13]For example, Sinomach's investment in Vepřek Solar Park in the Czech Republic in 2009. The solar power station, the size of a hundred soccer fields and with a capacity of 35 MW of electricity, was built with equipment manufactured in China's Jiangsu Province.

[14]An illustration of this was the 36% stake purchase of Italy's Ansaldo Energia by China Power Investment in 2014, which allowed the Chinese company to gain access to gas turbine technology (Pollina 2014).

[15]Examples include the Three Gorges' investment in EDP in 2011 and Chinese State Grid's investment in Italy's Cassa Depsiti e Prestiti Spa (CPD) Reti in 2014, allowing the Chinese partners to acquire management know-how and knowledge of the Latin American and European markets (Ma and Kowsmann 2011).

[16]China Power Investment's deal with Kompania Weglowa and China Energy Engineering's with Tauran.

[17]Huadian's construction of a 500-MW coal-fired plant with Complexul Energetic Rovinari.

Electricity grid

Europe's electricity grid has also been one of the main areas of investment for Chinese companies expanding internationally and acquiring management know-how. For example, the State Grid Corporation of China invested in Portugal's REN in 2012 and Italy's CDP Reti[18] in 2014 in order to obtain the management know-how of pan-European electricity networks. REN and Reti have extensive overseas electricity networks in Africa and South America, which helps Chinese companies gain knowledge of managing overseas operations. Technology know-how was also a target of Chinese investors as illustrated by China Power Investment's purchase of the Italian company Ansaldo Energia in 2014, in which the Chinese company acquired gas turbine technology.

Renewable energy

Chinese investment in renewable energy has been growing strongly, despite its relatively small share over the past ten years. The Chinese solar energy industry started to develop in 2003 with more than 100% annual growth (Liu et al. 2010). The manufacturing of solar photovoltaic (PV) equipment in China is mainly concentrated in the downstream parts, such as PV module packaging and PV cell production.[19] Due to the significant gap between technology levels and environmental governance, China's upstream PV industry still lagged behind and large volumes of polysilicon had to be imported to meet its PV cell production demand (Li 2012). With the help of government policies, Chinese PV cell manufacturers exported 98% of their production to the international market. The EU's environmental goal[20] created a boom in demand for PV cells and led to a surge in Chinese imports and investment in European markets. According to research conducted by the World Resources Institute, 86% of Chinese investment in the solar industry was made in electricity generation, sales and marketing support and manufacturing (Tan et al. 2013). Aside from this, Chinese companies were also involved in a number of large-scale solar panel projects in various EU countries.[21] In some cases, such as the acquisition of KSL Kuttle, technology transfer took place (Tan et al. 2013).

Around 5% of Chinese investment was made in the wind energy sector. A number of Chinese leading wind turbine manufacturers, such as Goldwind, invested in European companies, for example Germany's Vensys, in order to develop new wind turbine technology with fewer constraints in terms of access to intellectual property

[18]By investing in CDP Reti in Italy in 2014, the Italian government guaranteed Chinese State Grid was that stable dividends would be delivered to them annually (Sanderson 2014).

[19]The photovoltaic value chain mainly consists of polysilicon, wafer, solar cells, solar modules and system installation.

[20]The Europe 2020 is a 10-year plan for the EU's economy proposed by the European Commission in 2010. It set the environmental targets of a 20% reduction in greenhouse gas emissions compared to 1990 levels, a 20% share of renewables in the energy mix, as well as a 20% increase in energy efficiency by 2020.

[21]Such as the Vepřek Solar Park in the Czech Republic, Jiangsu Zongyi's investment in Italian solar projects, Hanergy's cooperation with Engensa, as well as Sinomach's project with Boska of Poland.

(Lewis 2013). Afterwards, when Chinese companies had successfully developed the technology, they concentrated on expanding their market shares in Europe. According to the World Resources Institute, 14% of the Chinese overseas investment in wind power went towards sales and marketing (Tan et al. 2013). A more significant proportion of 63% was made in electricity generation via greenfield projects or joint ventures. A number of large-scale wind turbine construction projects were made with, for example, Romania's Speranta & Succesul for the service and equipment procurement of a 200 MW wind farm project[22] and with Statkraft for three wind farms projects in the UK.[23] The investment from China in European renewable energy sector will continue to grow given the increasing awareness and regulation of the environment in both regions.

Nuclear

China first invested in nuclear energy in Europe in 2015, when China General Nuclear Power Corporation (CGN) entered a joint venture with Romania's Societatea Nationala Nuclearelectrica SA to build two nuclear reactors (Units 3 and 4) in Cernavoda, worth €7 billion EUR (Stapczynski and Guo 2015). This project was part of China's recent "Go Global" strategy in the field of Chinese nuclear technology with China increasingly adopting nuclear power at home from 2005.[24] The white paper issued by the Chinese government in 2007[25] and the 11th Five-Year Plan further accelerated the growth of the Chinese nuclear power industry (Zhou et al. 2011). It is expected that the number of nuclear power plants in China will continue to grow exponentially as China's 13th Five-Year Plan foresees the approval of an additional six to eight nuclear reactors annually from 2016 onwards. Chinese nuclear plant technology has been developed based on the French and Russian models, but China has also succeeded in developing its own model, such as Hualong One.[26]

In Europe, nuclear energy policy is rather complex because of the diverging national plans for nuclear power generation. Currently, there are 130 nuclear reactors in the EU generating 30% of the total electricity produced. While France generates 75% of its electricity from nuclear sources, the UK's figure is only 18%.[27] Following the Fukushima nuclear accident in Japan in 2011, concerns regarding the safety of nuclear energy led to the German government deciding to shut down all its nuclear

[22] The project was expected to utilise Ming Yang's innovative 2.0 MW large rotor diameter wind turbine generators.

[23] The three farms comprise ten turbines of 23 MW at the Alltwalis Wind Farm in the north of Carmarthen in Wales, 21 turbines of 52.5 MW at Baillie Wind Farm in the north of Scotland and 29 turbines of 66.7 MW at the Berry Burn Wind Farm located near Inverness in the north of Scotland.

[24] Currently, there are 30 nuclear power plants in operation in China and 24 reactors under construction.

[25] The white paper is entitled "China's Energy Policy".

[26] Hualong One, also known as Hualong-1 or HPR-1000, is a model developed by China General Nuclear Power Group originally based on the French 900 MW e-class M310 three-loop technology model design with replacement of the intellectual property right-limited components design.

[27] This figure is from the World Nuclear Association, http://archives.thestar.com.my/archives/2011/5/31/business/germannuclerpower.jpg.

power reactors by 2022. France also followed Germany by passing an energy transition law which would reduce the output of nuclear energy in France from 75 to 50% by 2025 (Stothard 2015). Nevertheless, a number of countries in Western Europe and Central and Eastern Europe continued to pursue nuclear power generation. According to the statistics of the World Nuclear Association, Bulgaria, the Czech Republic, Hungary, Poland and Romania are planning to build 13 new nuclear reactors.[28] Additionally, the UK's government is also relying heavily on nuclear power as one of its main sources of energy in future with the planned construction of seven nuclear plants.

Given the ambition of the Chinese government to export its nuclear technology worldwide and its abundant financial resources, it is very likely that more Chinese investment in European nuclear projects will grow in the near future. The entry into the UK's market, with China's investment in the UK's Hinkley Power Station together with France's EDF, as well as the potential construction of a Chinese Hualong HPR1000 plant in Bradwell, UK, is particularly symbolic for China as this will enhance confidence in other countries and facilitate Chinese investment in more EU countries in the nuclear power arena. In addition to the UK and Romania, China has also signed various agreements on cooperation in nuclear energy with Hungary, the Czech Republic and Bulgaria.

8.5 Conclusions

Between 2005 and 2015, there were a total of 37 Chinese investment deals in the EU's energy sector, with their total transactions amounting to $32.5 billion USD. The proportion of these investments was far greater in the period after 2010 than before 2010. The reasons for these investments were multifaceted, including macro-environmental and business considerations and industry-related factors. This study also shows that Chinese investment has been shifting since 2011, from traditional energy sources such as oil, coal and gas to the more diverse and greener sources such as solar, wind, hydropower and even nuclear power. The shift came as a consequence of the changing landscape of the energy mix in both China and the EU. Greener energy will be the focus for both regions and it can be expected that China will invest even more in green energy, particularly in wind and solar energy, in the EU in future. The growing demand for nuclear energy in some European countries is likely to attract more Chinese investment in this area too.

This study contributes to the literature concerning the latest trends and developments in Chinese investment in the EU's energy sector and provides an empirical basis for further research on the topic. The in-depth study of cases of significant investment transactions in a specific energy sector can help us better understand the Chinese investors' rationale for investing in that particular sector. Another aspect for

[28]Data according to the World Nuclear Association, http://world-nuclear.org/information-library/country-profiles/others/european-union.aspx.

further research is how the EU's governments and citizens perceive the growth of Chinese investment in their energy sectors, which could result in different political, economic and social consequences.

Annex

See Table 8.1.

Table 8.1 List of Chinese investment in the EU's energy sector in 2005–2015

List of Chinese investment in the EU's energy sector in 2005–2015					
Year	Investor	Quantity in millions USD	Transaction party	Subsector	Country
2008	SAFE	$2010	BP	Oil	Britain
2008	SAFE	$2800	Total	Oil	France
2008	Xinjiang Goldwind Science & Technology Co.	$61	Vensys Energy AG	Wind	Germany
2009	Sinomach	$100	Vepřek Solar Park	Solar	Czech Republic
2009	Sinochem	$880	Emerald Energy	Oil	Britain
2010	Jiangsu Zongyi	$200		Solar	Italy
2011	CNPC	$510	INEOS Britain	Oil	Britain
2011	CNPC	$510	INEOS France	Oil	France
2011	CIC	$3240	GDF Suez	Gas	France
2011	Three Gorges	$3510	Energias de Portugal	Electricity	Portugal
2012	State Grid	$510	REN	Electricity	Portugal
2012	Huadian	$1300	Complexul Energetic Rovinari	Coal	Romania
2012	Hanergy	$510	Solibro	Solar	Germany
2012	China Power Investment	$740	Kompania Weglowa	Coal	Poland
2012	Sinopec	$1500	Talisman Energy	Oil	Britain
2012	Three Gorges	$470	Renovaveis	Wind	Portugal
2012	Sinopec Kantons	$221	Vesta Terminals BV	Oil	Netherlands
2012	Titan Wind Energy	Undisclosed	Vestas Wind System	Wind	Denmark

(continued)

Table 8.1 (continued)

List of Chinese investment in the EU's energy sector in 2005–2015

Year	Investor	Quantity in millions USD	Transaction party	Subsector	Country
2012	Guangdong Aiko Solar Energy Technology Co. Ltd.	Undisclosed	Scheuten Solar B.V.	Solar	Netherlands
2012	LDK Solar	Not applicable (N/A)	Sunways AG	Solar	Germany
2013	China Energy Engineering	$560	Tauran	Coal	Poland
2013	China Power Investment	$260	Enemalta	Solar	Malta
2013	Ming Yan	$540	Speranta & Succesul	Wind	Romania
2013	Sinomach	$190	Boska	Solar	Poland
2013	Hanergy Holding Group Ltd.	Undisclosed	Engensa Ltd.	Solar	Britain
2013	North China Power Engineering Co Ltd.	N/A	Energetikos Tinklu Institutas	Electricity	Lithuania
2014	SAFE	$2760	Eni, Enel	Electricity	Italy
2014	China Power Investment	$560	Ansaldo Energia	Electricity	Italy
2014	Gingko Tree	$170	Statkraft	Wind	Britain
2014	China-CEE Fund	$203	GEO Renewables	Wind	Poland
2014	State Grid	$2500	CDP Reti	Electricity	Italy
2014	China General Nuclear	$160	Electricite de France	Wind	Britain
2014	SAFE	$100	Saipem	Oil	Italy
2014	Znshine Solar	$340	MAP Environmental	Solar	Britain
2015	Gingko Tree	$730	Madrilena Red de Gas	Gas	Spain
2015	China Communications Construction	$470	Swansea Power	Hydropower	Britain
2015	China General Nuclear Power Corporation	$3978	SN Nuclearelectrica	Nuclear	Romania

Source Author's elaboration based on The Heritage Foundation's statistics

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Chapter 9
Climate Change Policies in China

Jian Guan

9.1 Summary

As the largest greenhouse gas emitting country in the world, China inevitably attracts global attention and blame, putting the Chinese government under great pressure. Although China's leadership attaches great importance to climate change and its consequences, it has not yet followed up the rhetoric of climate change mitigation with concrete policies reducing greenhouse gas emissions and other environmental hazards. Meanwhile, China also places great value on its international reputation. It is unwilling to enter into bigger conflicts with other developing countries on climate change issues. Therefore, China is currently faced with a major trade-off between "how to be a responsible great power" and "maintaining the continuous and stable growth of its economy".

9.2 Introduction

Among the emerging economies Brazil, Russia, India and China that are sometimes referred to as the BRICs, China has some unique characteristics. China has the largest population of these developing countries, but the second largest Gross Domestic Product (GDP) among all countries in the world. China is known for its massive landmass, diverse species and abundant natural resources. But because of its large population, China stands at the bottom of the worldwide rankings of nearly every per capita index. After 30 years of fast development, Chinese GDP is now the second highest in the world and ranks first for its dependence on foreign energy. However, when it comes to greenhouse emissions, China surpasses America, and the speed

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per person emission is increasing rapidly. Therefore, during international climate negotiations, China has received a lot of criticism from developed countries and born the pressure of developing countries. In international climate negotiations, China consistently advocates the principles of "common but differentiated responsibilities" and refuses to accept compulsory emission reduction targets. China is in great need of financial and technical support from developed countries. In terms of sustainable development, not only does China positively participate in the international climate negotiations, but it also implements related laws and regulations to promote energy conservation and emission reductions. This work aims to give an overview of China's climate policies between 1985 and 2015. The main methods adopted in this work are a review of domestic and international literature, and induction.

9.3 Analysis of Current International Literature

There is the abundant literature on the topic of climate change. Research on climate policies in China is also plentiful and is being studied by scholars from China and abroad. Barber B. Conable and David M. Lampton in their work "China: The Coming Power" (1992) state that China is a rising power and outline the consequences that come with this status. In "China in Copenhagen: Reconciling the 'Beijing Climate Revolution' and the 'Copenhagen Climate Obstinacy'" by Conrad (2012), the Copenhagen Summit and the China performance in the negotiation process are discussed. "The River Runs Black: The Environmental Challenge to China's Future" by Economy (2004) mainly focuses on the deterioration of China's environment and the resulting problems the country consequently faces. In "China's Strategic Priorities in International Climate Change Negotiations" (2007), Lewis states what is valued in the international climate change negotiations by China. Peter M. Hass starts from the angle of epistemic communities to analyse the climate change issue in his papers like "Do Regimes Matter? Epistemic Communities and Mediterranean Pollution Control" (1989) and "Introduction: Epistemic Communities and International Policy Coordination" (1992). We also accessed data from reports by The Intergovernmental Panel on Climate Change (IPCC 1995), and the website of the International Energy Agency (2016), World Meteorological Organization (2016), etc.

Chinese scholars take a broad view of the issue of climate change. Like Ding (2008) and Wang (2014), they introduce the science of climate change in China and elaborate on the history and development of climate change policy in China.

9.4 How to Solve This Issue

This chapter features four sections, the first of which contains a general review of China's greenhouse gas emissions, and the second will explore how China's climate change policy has developed and changed. The third part will examine and analyse why China's policy has evolved as it has, and in the fourth section several conclusions from this analysis will be drawn.

9.4.1 Introduction to China's Greenhouse Gas Emissions

The characteristics of China's greenhouse gas emissions can be generalised into the following points. First, the country ranks first in the world for its total amount of greenhouse gas emissions because of its low energy efficiency and high energy intensity. Second, greenhouse gas emissions have grown rapidly for more than two decades. Third, per capita emissions have also grown more and more, as shown in a report by the Joint Research Centre of the European Commission (JRC) and the PBL Netherlands Environmental Assessment Agency (PBL 2017). According to the report, China's per capita carbon dioxide emissions were only one-tenth of the USA in 1990, while in 2010, they were the same as Italy and higher than France and Spain. It was also highlighted that CO_2 emission equivalents per capita have already surpassed those of the EU28 in 2014 (PBL 2017, p. 18).

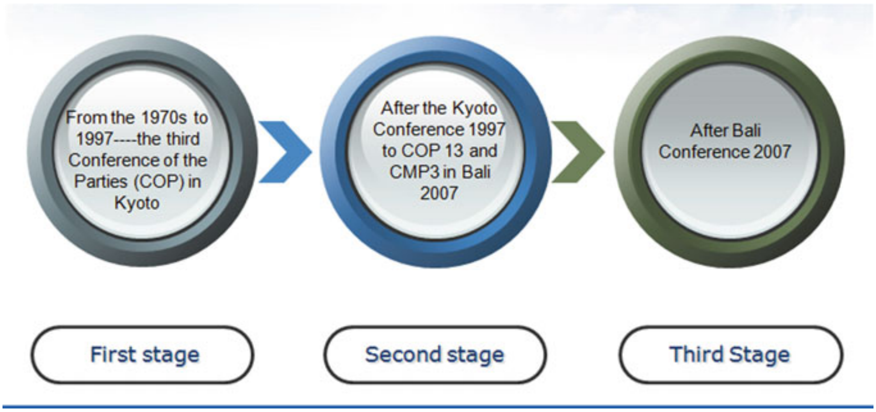
China has enjoyed rapid economic progress for more than thirty years. The high growth of its economy is closely related to its burgeoning energy needs. This growth also signifies that China's energy emissions will continue increasing along with the rapid increase in greenhouse gas emissions (Zhuang & Chen 2005). Carbon dioxide is the most prominent, with the greatest share of the emissions and increasing the most rapidly.

Since the last decade of the twentieth century, emissions of carbon dioxide in China have doubled in less than twenty years (PBL 2017, p. 18). Power generation has been increasing and has pushed up the emissions of carbon dioxide. It is estimated that in 2030, carbon dioxide emissions in China will be twice as much as now (The Guardian 2009a).

Renewable energy is important in China's energy policy. It has become and will always be the most important resource in China. The enforcement of the renewable energy law helps greatly promote solar energy, wind power and bioenergy, etc. (China Energy 2016). China also encourages forest planting to strengthen its carbon sink capacity. The percentage of forest cover has increased 1.5 times in thirty years.

9.4.2 The Development of Climate Change Policy in China

Perceptions on global climate change have been changing in citizens of all walks of life in China. People have begun to realise its importance since the Kyoto climate conference.



(1) Interaction with the international society as well as observation of environmental degradation has changed the understanding about environment, and the common people gradually realised its importance. The period from the 1970s to 1997 and the third Conference of the Parties (COP) in Kyoto can be considered as the first stage. China mostly connected environmental protection with climate change policy and linked it less with the social development. In the 1980s, China strengthened its observation of the climate system and carried out scientific research. On the other hand, the government has developed and adopted guidance documents and adjusted industrial policy. Furthermore, the Chinese government has started international cooperation in the climate field. However, climate change issues are considered environmental problems rather than issues of economic development, and the research was basically limited to a theoretical level.

(2) The second stage is the ten years following this; after the 1997 Kyoto Conference and up until the COP 13 and CMP3 in Bali, China was experiencing economic development at top speed if measured by double-digit growth rates of GDP. Because of the worry about the cost of emission reduction, China refused to make promises on this issue. Consequently, China received blame from developed countries (Giddens 2009). China adhered to the principle of common but differentiated responsibilities (CBDR) and insisted that it should be upheld in the negotiations. China never made a promise to cut greenhouse gases during this stage but hoped to obtain technology transfer from developed countries and hoped to receive funding by joining the Clean Development Mechanism (CDM).

China has realised how climate change influences social development and has established stable financial support and kept on increasing input in scientific fields relevant to climate change (China Climate Change Info-Net 2016). It has accelerated the building of talented teams, adjusted and optimised the industrial structure, transformed economic development patterns and publicised scientific knowledge in order to raise public awareness.

On the other hand, China has shown positivity towards bilateral and multilateral international cooperation, such as embarking on dialogue and cooperation with developed countries and giving foreign aid to other developing countries (Yang 2009).

(3) In the most recent ten years, China has fully realised how serious and urgent the climate change issue is. Hence, China has attached great importance to the sustainability of economic development. And China has made noteworthy concessions such as cutting its own carbon intensity and encouraging the use of renewable energy.

Undoubtedly, climate change has become a key topic in the world. Under the framework of sustainable development, China is becoming active in dealing with climate change, trying to advance both mitigation and adaptation through the development of science and technology and making an effort to balance climate change policy with other policies.

This ten-year period is described as the "Post-Kyoto Era". The Bali Roadmap started the two-track negotiation process of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The standpoints of the Chinese government from the COP 14 to 19 can be generalised as: adhering to the CBDR principle; agreeing to a long-term goal of the temperature rising by no more than 2 °C that developed countries should fulfil the obligations of the convention and provide technology, funding and support to developing countries; and although China temporarily refused to promise to reduce the total amount of its emissions, it promised to reduce the emissions growth by reducing its carbon intensity (Wang & Zheng 2009).

Based on the principles of "mutual benefit and win–win results, pragmatism and effectiveness", China undertakes every endeavour to participate and push forward international cooperation, to promote bilateral and multilateral dialogues on climate change in diplomatic activities. Cooperation and dialogue mechanisms have been established between China and the European Union (EU), the USA, the UK, Japan, Australia, Canada and other countries. China has been providing help, within its capabilities, to African states and small island states in the Pacific Ocean to increase their ability to cope with climate change. China welcomes the support and help in the form of new energy and new technology from developed countries.

9.4.3 The Causes of the Evolution of Climate Change Policy in China

China is now adopting a more flexible and cooperative attitude in the international climate negotiations; it is more open to other forms of cooperation and appeals for win–win technology extension systems and mutual beneficial cooperation, instead of receiving assistance unilaterally from developed countries (China News website 2016).

(1) **International Pressure**

As mentioned above, greenhouse gas emissions have grown as a result of rapid economic development and increasing energy consumption. Subsequently, the "environmental threat theory" was introduced. It is believed that the speedy development of a society's economy is accompanied by the consumption of a large amount of resources and energy, which will inevitably bring about serious environmental problems. Some believe that climate change was the result of developing countries like China and India. At the COP 15 in Copenhagen, China was criticised and accused by the west (The Guardian 2009b; Conrad 2012). To a great extent, this is because emissions data lacks transparency. Essentially speaking, the developed countries tried to force China to assume responsibility and obligations in climate negotiations.

(2) **Pursuing the reputation as a responsible great power**

China's international status has changed significantly as its economy has boomed. In order to fight for a peaceful and stable international environment, as well as a friendly public opinion environment, China actively and comprehensively promotes public diplomacy. There are many possible factors influencing the building of China's national image. As far as the current situation is concerned, the factors of the environment and climate are the most prominent.

China has viewed itself as one of the developing countries and has made "uniting and cooperating with other developing countries" a cornerstone of its diplomacy. The issue of climate change provides an excellent opportunity to enhance China's reputation and influence in developing countries. On one hand, China carries out its obligations and safeguards the interests of developing countries. On the other hand, China communicates with developed countries, helping develop itself.

(3) **Proposal of the epistemic community on climate change**

Decision-makers are in great need of consultation and help from scientists since climate matters are so complicated and interdependent. Otherwise, no decision could be made, and actions would be taken without direction and definition. Scientists, not only natural scientists but also social scientists, or anyone who has a contribution in this field could be members of this epistemic community. According to Peter M. Hass, "An 'epistemic community' is a network of knowledge-based experts or groups with an authoritative claim to policy-relevant knowledge within the domain of their expertise. Members hold a common set of causal beliefs and share notions of validity based on internally defined criteria for evaluation, common policy projects and shared normative commitments". Epistemic communities influence state interests in the following ways:

"Elucidating the cause and effect relationships" (Haas 1992, p. 15) and providing advice about the likely results of various courses of actions following a shock or crisis; "shed[ding] light on the nature of the complex interlinkages between issues and on the chain of events that might proceed either from failure to take action or from instituting a particular policy" (Idem., p. 15); "help[ing to] define the self-interests of a state or factions within it" (Idem., p. 15); and helping to formulate policies through framing of alternatives, implications of possible actions, etc. (Haas 1989, 1992).

(4) **The need for the transformation of the economic development pattern**

China emphasises the transformation of the style of economic development. China claims that economics should form a pattern of low input and low consumption, low emissions and high efficiency. Energy saving and emission reductions are the only path towards sustainable development (Xinhua Net 2016). If China aims to take control of the commanding authority and create innovation advantages, focusing on climate change and increasing the economic output in this field are indispensable.

9.5 Conclusion

The understanding of climate change issues in China is an ever-changing process. Compared with other countries' climate policies, it seems that China adopts a tough attitude in international climate negotiations. This allows China to buy time to adjust its domestic development mode and subsequently take a more benign stance in international climate negotiations. China has adopted a carbon trading system from the EU and New Zealand and will soon put it into practice, first in geographically advantageous and economically advanced provinces and municipalities such as Beijing, Shanghai and Guangdong. Also, China is ready to develop technologies to remould traditional energy with the help of other countries.

The current problem is that the Chinese government has already closely related the rapid growth of the economy with the legitimacy of its governance. As the Chinese saying goes, "the flotilla cannot make a swift U-turn". If China's economic growth slows down, not only will it bring about many social problems, but the effective governance of its government will suffer. Thus, only when the EU's "social experiments" of low-carbon transformation genuinely succeed, and China confirms the actual outcome, will the country separate economic growth from GDP, and pursue quality growth rather than speedy growth, thereby finally improving existing policies.

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Chapter 10
Unconventional Sources of Fossil Fuel in the European Union and China: Perspectives on Trade, Climate Change and Energy Security

Rafael Leal-Arcas

10.1 Introduction

This chapter examines the case of unconventional fossil fuels in the European Union (EU) and China.[1] Recent developments in the extraction of energy from unconventional fossil fuels will have consequences for the governance of global energy trade and European energy security. When it comes to trading energy, there is a clear difference between oil and gas, in that oil can be easily transported, whereas gas needs to be liquefied or transported through pipelines and, consequently, the technological and political challenges are higher for gas than they are for oil. The chapter's main argument is that shale gas and shale oil will revolutionise world energy politics and

[1] Unconventional sources of fossil fuel include tight gas, coal bed methane, unconventional oil and shale gas, among others. For the purposes of this chapter, we will focus on shale gas.

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economics. Irrespective of whether environmentally acceptable extraction technologies and political consensus for the extraction of unconventional fossil fuel sources in Europe can be found, the EU will be unable to avoid its impacts on global energy markets and will have to adapt EU internal and external energy policies accordingly. Since the entry into force of the Lisbon Treaty in 2009, the EU's internal and external governance framework has evolved; however, EU energy policy is only partially ready for the unconventional energy revolution. The EU has taken remarkable steps towards addressing its Member States' respective energy security in a more cohesive manner, although issues do exist in terms of the distinct energy interests of EU Member States that undermine cohesive EU action.

The chapter is divided into seven sections. After this introduction, Sect. 10.2 explains the current legal situation of unconventional sources of fossil fuel in the EU. Section 10.3 addresses the ecological viability of natural gas as an energy resource, whereas Sect. 10.4 provides an analysis of the geopolitical impact of unconventional sources of fossil fuel in the EU. Section 10.5 analyses the situation regarding unconventional sources of fossil fuel in China, and Sect. 10.6 proposes the international trading system as a vehicle to both mitigate climate change and enhance energy security. Section 10.7 concludes the chapter and provides some policy recommendations.

10.2 Legal Situation of Unconventional Sources of Fossil Fuel in the European Union[2]

Fracking has raised environmental concerns throughout the world. In fact, the state of New York and the Canadian province of Quebec have imposed a moratorium on fracking as a result of these worries (Cunningham 2014; Reuters 2013). Several cities in the state of Colorado banned fracking in 2013 for at least five years (Coffman 2013). That said, in July 2014, a district court judge in Colorado ruled that the fracking ban imposed by the city of Longmont in Colorado is pre-empted by Colorado state law (Colorado Judicial Department 2014; Kass 2015).[3] A similar situation can be seen in the EU. Although the EU could make use of its own shale gas reserves, there are reasons that make shale gas extraction in the EU rather difficult:

(1) As can be seen in Fig. 10.1, there is no harmonised EU-level legislation regarding its extraction (namely in some EU Member States, it is banned, i.e. in France and Bulgaria; in others, it is allowed, i.e. Belgium and Latvia; and in others, it is allowed upon issuance of a permit, namely the UK, Spain and Portugal) (International Energy Agency 2014); and
(2) public opinion seems to be against the idea in some EU jurisdictions (The Economist 2014).

[2] Parts of this section draw from Leal-Arcas and Schmitz (2014).

[3] As of July 2014, the order was stayed pending an appeal. This means that fracking is suspended. For the full-order granting summary judgement, see Colorado Judicial Department (2014). In September 2015, the Colorado Supreme Court agreed to hear an appeal from the city of Longmont (Kass 2015).

Fig. 10.1 Map of the legal status of shale gas extraction in Europe. *Source* International Energy Agency; KPMG; press reports (International Energy Agency 2014)

While the legal and technical hurdles to unconventional gas extraction can be overcome if there is political will and the economics make sense, the question of whether, in the end, it *should* happen is ultimately linked to its ecological viability.

10.3 Ecological Viability of Natural Gas as an Energy Resource[4]

Natural gas burns in a cleaner manner than coal does. The burning of one million British thermal units (Btu) of coal leads to 228.6 lb of emitted CO_2. The burning of the same amount of natural gas only leads to 117.0 lb of emitted CO_2 (EIA 2015a). Hence, the relation between CO_2 emissions and energy output or heat value is much more favourable for natural gas. One could therefore argue that the increased abundance of exploitable resources of natural gas provides a chance to reduce CO_2 emissions on a global scale. This can already be seen clearly at the regional level with the USA reducing its domestic consumption of coal, particularly for electricity production. Total US coal consumption dropped from 1,120,548 thousand short tons in 2008 to 925,106 short tons in 2013 (EIA 2015b).

Another advantage of electricity production using natural gas is its complementarity with cyclical renewable energy production such as wind and solar. One of the major issues with wind- and solar-based energy production is that there is an abundance of available electricity only when the wind blows or the sun shines in a certain region. However, when the opposite is the case, other electricity production

[4]Parts of this section draw from Leal-Arcas and Schmitz (2014).

sites need to be activated to supplement the sudden reduction in electricity derived from these renewable energy sources. Speaking in relative terms, gas turbines producing electricity can easily be switched on and off at short notice. Energy based on gas could therefore be seen as a supplement supporting the long-term feasibility of renewable energy production, levelling the energy supply during cyclical downturns of energy production from renewable sources. It could be used as a technology bridge until more stable and more efficient renewable energy production is available at market-based costs (Jacoby et al. 2012; Levi 2013; MIT 2012; Boling 2015).[5]

These advantages have to be contrasted, however, with the potential negative effects on the local environment close to the extraction site and the net balance of climate-relevant gas emissions. Anecdotal evidence has shown that so-called fracking technology can have negative impacts on the local environment. The injection of chemicals into the water used to 'frack' shale formations into the ground, the massive quantities of chemically treated water which also have to be disposed of, and the risk of local micro-earthquakes have led to fears in the affected communities resulting in policies ranging from an outright national ban (i.e. France) to local abolition (i.e. some US states and parts of Canada). While some of these issues might be related to inappropriate extraction methodologies that can be rectified (e.g. better monitoring and capturing of the redundant chemically treated water that is used during the fracking process), more research is needed to evaluate these local risks and the impact of appropriate technical regulation to avoid such negative local impacts.

Other critics, while admitting that the direct effect of electricity production using gas on the environment and climate change is positive, make the argument that one has to look at the net effect. These authors often refer to the methane emissions which can occur during the extraction phase (Bradbury et al. 2013; Alvarez et al. 2012; Howarth et al. 2011; Makan and Crooks 2013; Schrag 2012; Wigley 2011).[6] Methane is known to be a much more dangerous gas than CO_2 for global warming. Estimates show that the global warming potential of methane is more than 20 times greater than that of CO_2 at 100 years and more than 50 times greater at 20 years of effect in the atmosphere (UNFCCC 2014). Thus, methane has particularly strong short-term effects on global warming. Studies on the effect of methane emissions differ, and currently various research projects are trying to find reliable estimates (EPA 2013).[7] This is complicated by the regulatory environment in the main extraction region, North America, where it is often local- or state-level authorities which stipulate regulations so environmental rules differ on a case-by-case basis. It has also been noted that the practices of local extraction teams in avoiding methane emissions seem to play a relevant role (Brewer 2014). While the latter two arguments could indicate that there is substantial potential for improvement through proper regulation, it is important that the ongoing research be deepened to get a better understanding of the net effects of unconventional gas

[5]Compare with Jacoby et al. (2012), Levi (2013) and MIT (2012). For a focused presentation on exploration and drilling techniques, see Boling (2015).

[6]The issue of methane gas emissions is discussed in Bradbury et al. (2013), Alvarez et al. (2012), Howarth et al. (2011), Makan and Crooks (2013), Schrag (2012) and Wigley (2011).

[7]Compare, for example, with EPA (2013) or Miller et al. (2013).

extraction. Also, if the export potential of liquefied natural gas (LNG) is considered, the effect of transport and energy resources necessary for the cooling process on LNG transporting vessels should be incorporated in the calculations.

In addition to the potential problems cited above, one can also refer to the argument that, even if the use of gas in electricity or heat production could be positive for climate change in its net effects, the energy sources which are replaced will simply be used elsewhere on the planet and the global warming-relevant effect is not necessarily positive (i.e. carbon leakage). One could cite the US increase in coal exports to the rest of the world as an example. US coal exports rose dramatically from 81,519 short tons in 2008 to 117,659 short tons in 2013 (EIA 2015b). While the logic of the carbon leakage argument cannot be denied, the value of the argument is obviously diminished by the fact that, ultimately, this is also true for any other cleaner energy technology, including wind- and solar-based energy production.

Finally, one could also argue that an additional and sudden increase in available fossil energy resources will slow down or dis-incentivise the use of renewable energy sources. The immediate effect of more abundant fossil energy resources could be a price decrease for energy, which will render the still-not-fully competitive renewables even more difficult to finance. It is argued that with a delay of investment in these new technologies, additional fossil fuel energy resources could lead to a slowdown in the technological development of these new technologies and consequently a prolongation of carbon-based energy production.

There are clear environmental risks associated with unconventional gas extraction. Some of these are speculative, such as the crowding-out-effect of renewables or the carbon leakage argument. For other environmental impacts, there is clear anecdotal evidence, such as methane gas emissions in the establishment and operation of wells and the local environmental risks related to the disposal of chemically treated water used in the extraction procedure. For the moment, the literature on unconventional gas extraction is not conclusive on the question of whether the net balance for the environment is positive or negative. In the coming years, it will be important to devote serious efforts to further technical research on the matter.

10.4 Geopolitical Impact of Unconventional Sources of Fossil Fuel on the EU[8]

Irrespective of the final judgment on the ecological viability of unconventional fossil fuel sources, unconventional gas and oil extraction is already happening. Potential access to these vast new fossil energy resources could have a dramatic impact on the EU. The extraction of these unconventional fossil fuels could fundamentally change the EU's position in world energy markets and could also have broader foreign policy and security policy implications.

[8] Parts of this section draw from Leal-Arcas and Schmitz (2014).

Following the discussion above, let us leave aside for a moment the possibility of exploration of unconventional gas and oil in the EU itself and focus on the effects the estimated worldwide resources and their entrance into world energy markets. Starting the analysis from a basic supply and demand framework, and on the assumption that these estimated resources prove to be existent and exploitable, one could assume that additional quantities of worldwide fossil energy resources, paired with an unchanged demand curve (structure), will lead to lower world market prices for these energy sources. In strict economic terms, such a supply shock will generally benefit the market position of the buyer (consumer) and disfavour the seller (producer) of the resources.

Figure 10.2 shows the impact of a supply shock, as would be the case with the additional gas quantities reaching the world energy markets. The aggregate demand structure for energy resources (AD) at a given point in time remains unchanged, while the aggregate supply structure for energy resources shifts from AS to AS', reflecting the additionally extractable energy resources. We see that, as a consequence and under the conditions of liberalised markets, additional output of energy resource production (Y'-Y) leads to generally lower energy resource prices P' compared to P. It can be shown that the area between the two price lines and the demand curve represents the additional consumer rent, which can be interpreted as increased economic welfare of energy consumers.

From a purely economic and energy security perspective, the EU, as a large energy consumer, has therefore principally an interest in widely (and additionally) available energy resources as well as open (and stable) energy markets, which allow these resources to be traded. Unfortunately, the world energy market is not as simple as the graph above suggests. This is because such a simplistic model of a world energy market does not account for transaction costs, such as transportation costs (gas can only be transported in liquefied form overseas and has to be cooled to −161 °C (California Energy Commission 2015) throughout its journey to the pipeline network of the consumer), network externalities (pipelines and gas terminals are very costly

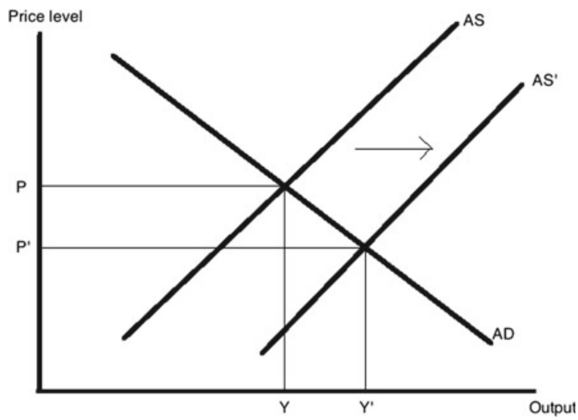

Fig. 10.2 Supply shock resulting from additional energy resources output

to build and maintain, and imply high sunk costs), political risk and risk aversion (Western Europe opted for stable energy supply from Russia through long-term fixed contracts) (Neuhoff and von Hirschhausen 2013) and export restrictions on gas and oil. As a consequence of these factors, and focusing on gas, one could broadly speak of three separate energy markets that exist with interlinkages (mainly through LNG spot markets), but which are de facto still operating relatively distinctly from each other: Europe, Asia and North America.

While the European energy market is historically dominated by massive oil and gas inflows from Russia under long-term supply contracts linked to the oil price, the Asian energy market, with its dominant consumers, namely China and India, and its absence of a dominant supplier (Russia is only beginning to pivot towards Asia), is somewhat more diversified. Local gas prices in Asia are therefore potentially more volatile and partially more oriented towards spot markets. Generally, the Asian gas market price has been higher than in Europe, which is related to Asia's geographically less favourable position, but could also indicate higher risk aversion or more insecure buyer–seller relationships. The third big energy market, North America, mainly links US and Canadian suppliers and consumers. If the current trend of exploitation of unconventional gas and oil resources continues, we will start seeing a local market situation in North America of relatively stable energy demand (EIA 2015c), paired with abundantly available local energy resources.

In addition, the USA and Canada are not the only places where large basins of shale gas and potentially also shale oil are estimated to exist, leading to a large additional gas and oil occurrence topping up the worldwide estimations of conventional gas and oil resources (EIA 2013a).

10.5 Unconventional Sources of Fossil Fuel in China[9]

Having surpassed the EU and the USA in 2010, China is currently the largest energy consumer in the world (EIA 2014). Its economic model is still mainly based on manufacturing and is highly energy dependent. At the moment, a large amount of highly polluting domestic coal paired with gas and oil imports are the energy base for the Chinese economy (EIA 2014). During the last decade, China has begun to strategically invest, both politically and economically, in regions supplying its resource-hungry economy, such as Africa and Latin America (Zweig and Bi 2005). From a European perspective, these investments have sometimes been considered as undercutting the EU's intention of conditioning its development aid and investment to political conditions, which China did not feel it had to replicate. But China is also investing in the shale gas industry in the USA (Dezember and Areddy 2012). While this could be interpreted as a strategy to acquire knowledge on shale gas production methods (China is estimated to have the world's largest shale gas reserves) (EIA

[9] Parts of this section draw from Leal-Arcas and Schmitz (2014).

2013a),[10] it could, on the other hand, also signify a long-term Chinese interest in more abundant and accessible worldwide gas supplies.

China is principally starting from a similar position to that of the EU. It has relatively large domestic shale gas resources which, for different reasons from those of the EU (a large part of the Chinese shale gas lies in the water-poor Western part of the country; technology constraints) (EIA 2013c), are not easily accessible, but, at the same time, it also has a strong interest in a stable and low-price supply of natural gas as well as in diversifying its gas sources. However, in stark contrast to the case of the EU, its energy consumption is expected to rise dramatically and China will consequently have to look for a continuously increasing supply of energy resources. The natural strategy of China might therefore not differ so much from the strategy the EU has been following in the past: establishing a long-term buyer–seller relationship with Russia (Financial Times 2014),[11] while using the current low spot market prices to control prices. It is clear that, as a net consumer, it would principally benefit from more available energy resources that could cause downward price pressure and diversify its supply.

While China could, in a similar fashion as potentially the EU, aim at trying to tap into the future worldwide shale gas supply, its geographical and political position in the world might render this endeavour less fruitful. On the one hand, its domestic gas and oil industry so far lacks the technology to exploit shale gas basins abroad in places such as South America or South Africa, not to speak of the political and

[10] As of 2013, the estimated technically recoverable shale gas of China was 1115 trillion cubic feet. See EIA (2013a).

[11] Russia and China signed in May 2014 the biggest natural gas deal in history: a $400 billion agreement for 30 years of gas supply. See Financial Times (2014). This new deal raises the following questions: Are we witnessing the unfolding of a new great game in Central Asia between Russia and China? If so, to what extent does this rivalry between them pose a threat to the fragile geopolitical equilibrium and energy security in the region? An ever-growing rivalry between China and Russia over energy resources in Central Asia has been unfolding since the demise of the USSR. The Sino-Russian rapprochement and their new 'strategic partnership' aim, among other things, at preventing the West (primarily the USA) from further meddling in Central Asia. Both Russia and the Central Asian republics are seeking to diversify their energy exports, hence China represents an ideal partner for them and vice versa. Soon after the collapse of the USSR, China immediately recognised the newborn Central Asian states and established diplomatic relations with them. In 1993, China's domestic consumption of oil surpassed its domestic production and, therefore, it became of paramount importance for them to start importing energy from abroad. At the same time, the Central Asian republics' economies lay in tatters and they were desperate for liquidity, which their former master, Russia, could not always guarantee them as its economy was also in a dire state. Thus, the Central Asian States started looking for alternative export routes. However, since all their existing export routes and pipelines belonged to Russia, they had to find new customers somewhere else. Hence, energy-thirsty China represented an ideal partner. In the 1990s, China began importing significant amounts of oil from the Middle East (still in 2009, 47% of its total oil imports originated from there) via shipping routes passing through the Strait of Malacca, on which China is still nowadays dependent for over 75% of its total crude imports. However, there is increasing concern in China regarding the country's overwhelming reliance on the Strait of Malacca because of its vulnerability to terrorism and piracy. Thus, Beijing started looking for alternatives to diminish its reliance of the Strait of Malacca and diversify its imports from other sources, such as neighbouring Russia and Central Asia.

technical feasibility of exploiting the potential shale gas resources in Russian Siberia. On the other hand, China's political clout in getting a foot in the door of the currently most promising and politically stable potential gas market, namely the USA, is rather limited. For political and economic reasons, if the USA were to massively open its gas resources to other energy consumers, a choice between establishing a long-term buyer–seller relationship with the EU or China could most likely lead to the EU getting the larger share of the deal, as it is clear that the discussion in the USA on whether to ease its export restrictions is not only limited to industrial policy arguments, but also to its geopolitical dimension (Cunningham 2013).

Based on the above, a nearly energy-independent USA with its lessened interest in securing the global shipping routes of oil and LNG from the Persian Gulf, as well as a potentially more diversified sourcing of energy resources throughout the world, will also lead to greater Chinese awareness of its dependence on secure transport and production environments. Whether the Chinese strategy will predominantly be one of trying to monopolise its sourcing relationships with privileged partners or whether it will arrive at the conclusion that it has a joint interest with Europe and the USA in stabilising certain regions such as the Middle East or the shipping routes of energy resources, remains to be seen. The participation of its navy in the anti-piracy activities off the Somali coast could be interpreted as a promising sign, while its common front with Russia when it comes to regime-change and institution-building in unstable regions of the world shows diverging evidence.

10.6 How Can the Trading System Help Mitigate Climate Change and Enhance Energy Security?

Climate change is one of the biggest challenges humanity faces today. This chapter proposes making an impact on this major agenda by using trade law to help decarbonise the economy. Trade law has been a very powerful instrument for change, as illustrated in these three examples:

1. Poverty reduction: thanks to trade agreements, around 1 billion people have escaped poverty in the last 20 years (The Economist 2013);
2. Access to medicines: thanks to trade agreements, more people have access to medicines (World Health Organization 2006);
3. The protection of human rights: 75% of countries use trade agreements to protect human rights (Aaronson 2011).

So why not use trade law as a novel tool for mitigating climate change? Today, 80% of the global energy supply comes from fossil fuels (World Energy Council 2013). Fossil fuels contribute to climate change and are finite, which leads to energy insecurity. Renewable energy can help here in that it is cleaner than fossil fuels. It also helps achieve energy independence and therefore enhances energy security (Leal-Arcas and Minas 2014). Trade law could be used as a vehicle to achieve this goal.

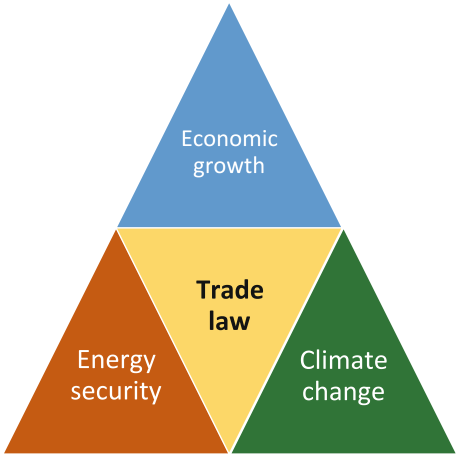

Fig. 10.3 Triple benefit of trade

We stand to achieve considerable gains when trade law becomes a tool for change. This chapter's hypothesis is that trade law can be a tool to help mitigate climate change and enhance energy security (Leal-Arcas 2015). And it is well known that, thanks to trade, countries grow economically. Hence, the triple benefit of trade (see Fig. 10.3). What is needed is to fill the theoretical and empirical gap on how trade law can help mitigate climate change. As a result of this knowledge gap, we have missed crucial opportunities for cooperation between trade and climate change. An example of this was the concluding of two major agreements in the 1990s; one on climate change—the United Nations Framework Convention on Climate Change—and one on international trade—the World Trade Organization (WTO) Agreement. The WTO Agreement only briefly mentions in its preamble the importance of 'sustainable development' in the context of international trade. I argue this was a missed opportunity for trade law to play a bigger role in mitigating climate change. In 2015, a new global climate agreement came into existence—the Paris Agreement on Climate Change—which does not even mention the term 'trade'. These are examples of missed opportunities for cooperation between the trade and climate regimes.

The vision of this work is that trade law can be used as a vehicle not only for climate action and energy security (Leal-Arcas et al. 2015), but for many of the sustainable development goals. Currently, the governance of trade and renewable energy is fragmented, involving many different institutions and legal instruments. There is insufficient research on how trade and renewable energy regimes can cooperate.

This work suggests that greater cooperation will lead to climate change mitigation and energy security. In this sense, identifying the gaps and opportunities for cooperation between these two regimes is crucial to create the basis for a new normative framework on how the trading system can help mitigate climate change and enhance energy security. How can the trading system help? There are very few trade agreements with sustainable development chapters. Moreover, there is a lack of scholarship that can inform practice. This chapter's hypothesis is that trade agreements can become a vehicle to address common concerns. The concept of using the trading system to mitigate climate change and enhance energy security will transform our understanding of trade in the context of environmental protection. It will shift the current paradigm from trade as a major cause of environmental harm to trade as a tool for environmental protection.

10.7 Conclusions and Recommendations

On the basis of the analysis above, the EU will have to adapt to the likely changes in energy politics and economics that derive from the unconventional gas and oil revolution. In our view, the environmental risks that clearly exist should not lead to a complete discarding of the new extraction technology. On the contrary, the energy revolution will take place with or without the EU. It is therefore in the interest of the EU to not only benefit from enhanced energy security through the exploration of new and relatively clean fossil energy resources, in particular gas, but, moreover, to be able to influence the discussion about which technologies and regulatory environments shall be applied for the exploration of these newly accessible resources. In combination with solar energy and wind energy, energy production from gas could become a powerful complementary technology towards the long-term goal of sustainable energy production.

In our view, the EU should therefore not stand aside, but should try to shape the global environment in which this possible energy revolution will take place. Embracing any new technology is not without risk. However, letting others develop (or not develop) the right technologies or the necessary international policy frameworks should not be an option for such a highly energy-dependent global actor as the EU. In its reaction to the foreseeable shale gas development and taking into account the internal and external policy framework of the EU, we think the EU should therefore consider the following two areas of political action:

1. Carefully study and explore its shale gas reserves, where necessary with test drilling and, if the appropriate technology for protecting the local environment can be found, with commercially viable extraction;
2. Work towards a truly global energy market by developing an international framework for energy trade based on open markets and consequently adapt its gas supply infrastructure to benefit from the possibility of diversifying its gas imports.

To implement the first policy recommendation, two basic components are necessary. On the one hand, we need to learn more about the best technologies for extraction and its environmental impact. For obvious reasons, energy companies are not the most reliable source of information for this research. More independent technical research, where necessary publicly funded, should be conducted to come to a better conclusion about the environmental impact of shale gas extraction, both with regard to the local environmental impact as well as to the net climate balance.

On the other hand, and under the condition that technical research has reasonably concluded that the unconventional gas extraction is environmentally viable and that the net climate impact of shifting from coal to natural gas is indeed positive, taking into account both the methane gas emissions and the eventual transport and liquefying of natural gas, the EU should consider regulating the sector horizontally at the supranational level. A European-wide regulation would avoid a regulatory fragmentation and possible regulatory arbitrage of extraction companies seeking to explore the resources where the environmental standards and regulatory overview are lowest. Developing and setting technical standards could also lead to pressure on the extraction industry and exploration in other places throughout the world to use the safest available technology.

To implement the second policy recommendation, the EU can build on its past efforts codified in the Energy Charter Treaty (ECT). The ECT is an international agreement which aims to provide a 'multilateral framework for energy cooperation' based on the principles of 'open, competitive markets and sustainable development' (Energy Charter Secretariat 2004; Leal-Arcas and Wilmarth 2015). By binding governments to commitments that guarantee open markets, non-discrimination and access for foreign investment (McGowan 2008), the ECT (Energy Charter Secretariat 2004) aims to strengthen the global rule of law on energy issues and thereby reduce the risks associated with energy-related investments and trade (Article 14 of the ECT). The ECT itself rests on five primary areas: investment protection (Part III of the ECT), trade (Part II of the ECT), transit (Article 7 of the ECT), environmental protection (Article 19 of the ECT) and dispute settlement (Part V of the ECT), while there are optional protocols on various topics, including energy efficiency and the environment (Protocol on Energy Efficiency and Related Environmental Aspects or PEEREA, 1994) (Energy Charter Secretariat 2004).

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Organising Institutions

The UACES Collaborative Research Network on EU-China Relations

UACES is the University Association for Contemporary European Studies. It is a membership organization for academics, students, and practitioners who are interested in all aspects of Europe and the European Union. The UACES Collaborative Research Network (CRN) on EU-China Relations was initiated by Prof. Dr. SHEN Wei, Director of the Confucius Institute, and Jean Monnet Professor of International Business, Lancaster University & ESSCA School of Management, Prof. Dr. MEN Jing, InBev-Baillet Latour Chair of EU-China Relations at the College of Europe in Bruges, and Dr. Frauke Austermann, Head of Campus, International School of Management, Cologne and Research Associate at the ESSCA EU*Asia Institute, and an alumna of the Graduate School of Global Politics at Free University Berlin. The UACES EU-China CRN aims at promoting discussion, exchange of ideas, and high-quality research on the current state of EU-China relations, in an inclusive environment. More information can be found on http://www.uaces.org/china/.

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Konrad-Adenauer-Stiftung (KAS)—Regional Project Energy Security and Climate Change Asia-Pacific (RECAP), Hong Kong SAR, PR China

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Workshop Programme

Programme

5th Workshop on EU-Asia Relations in Global Politics

'EU-Asian Energy Politics in the 21st Century'

The Hong Kong Polytechnic University

Hong Kong SAR, PR China

10–12 March 2016

Hosting Institutions:

EU-China Collaborative Research Network:

P. Hefele et al. (eds.), *Climate and Energy Protection in the EU and China*,
https://doi.org/10.1007/978-3-319-99837-4

Welcome Day—Thu, 10 March 2016—Li Ka Shing Tower—Senate Room 16th Fl.

13.30–14.00. Welcome Words

Prof. C.S. **Agnes Cheng**. Chair Professor and Head, School of Accounting and Finance, The Hong Kong Polytechnic University and Director, Center for Economic Sustainability and Entrepreneurial Finance, The Hong Kong Polytechnic University

Mrs. **Evelyn Gaiser**. Head of Section for India, Central Asia, RECAP and Climate- and Energy-Related Topics, Team Asia and the Pacific, Konrad-Adenauer-Stiftung, Berlin

14.00–14.30. Opening Speeches

Andrew Fung. Executive Director and Head of Global Banking and Markets of Hang Seng Bank

14.30–15.00. Tea Break

15.00–16.00. Keynote Address and Introductory Plenary—EU-Asian Energy and Climate Politics

Host: Dr. **Peter Hefele**. Director of the Regional Project "Energy Security and Climate Change" at Konrad-Adenauer-Stiftung, Hong Kong

H.E. **Nikolaus Graf Lambsdorff**. Consul General of the Federal Republic of Germany to Hong Kong SAR and Macau SAR

Prof. Dr. **Klaus Segbers**. Director of the German Chinese Graduate School of Global Politics at Freie Universität Berlin.

Dr. **Frauke Austermann**. Head of Cologne Campus at International School of Management.

16.00–16.30. Tea Break

16.30–17.30. Presentations of Thematic Sessions of the Workshop

Dr. **Thomas Sattich**. Associate Researcher at the Institute for European Studies, Adjunct Professor Vesalius College Brussels

Mr. **Andrew Leung**. Chairman of Andrew Leung International Consultants Limited and Visiting Professor with the London Metropolitan University Business School

Dr. **David C. Broadstock**. Associate Professor, Research Institute of Economics and Management Southwestern University of Finance and Economics, Chengdu, China

Prof. Dr. **Michael Palocz-Andresen**. Professor for Sustainable Mobility at the Institute for Sustainable and Environmental Chemistry, Leuphana University Lüneburg and School for Environmental Engineering at Shanghai Jiao Tong University

18.00–20.00. Welcome Dinner—Choi Fook Royal Banquet 彩福皇宴

858, 8/F, Fortune Metropolis, 6–10 Metropolis Drive, Hung Hom—紅磡都會道 6–10 號置富都會 8 樓 858 號舖.

Parallel Thematic Sessions—Fri, 11 March 2016—Li Ka Shing Tower—14th Fl.
08.30–10.00. Theme 1. The Geopolitics of Energy in Europe and Asia

Session 1A (Room 14.1)	**Session 1B (Room 14.2)**
Chaired by: Prof. Dr. **Klaus Segbers**, Director of the German Chinese Graduate School of Global Politics at Freie Universität Berlin 1.1: Dr. **Artur Lakatos**, Postdoctoral Researcher with the Bolyai Fellowship of the Hungarian Academy of Sciences. *Pipelines for Energy, Possibilities for countries of East-Central Europe. Why most of the pipeline projects failed?* 1.2: Ms. **Saskia Jürgens**, Associate, Department of International Political Economy of East Asia, Ruhr- University Bochum. *Changing Patterns in Sino-Russian Energy Relations and their Implications for European Energy Security* 1.3: Dr. **Wang Xiaoguang**, Assistant Professor; Dr. **Liu Qian**, Assistant Professor, The Academy of Chinese Energy Strategy, China University of Petroleum, Beijing. *The "Democratic Deficit" and the Sino-Russo Energy Cooperation* 1.4: Dr. **Sonny Lo Shiu Hing**, Professor; Dr. **Dennis Hui Lai Hang**, Lecturer, Department of Social Sciences, The Hong Kong Institute of Education. *Chinese Energy Diplomacy with the Central Asian States*	Chaired by: Dr. **Thomas Sattich**, Associate Researcher at the Institute for European Studies, Adjunct Professor Vesalius College Brussels 1.5: Dr. **Ivaylo Gatev**, Assistant Professor in European Politics and Regional Integration, School of International Studies, University of Nottingham Ningbo China. *Chinese and European Approaches to Energy Cooperation in Central Eurasia* 1.6: Ms. **Preksha Shree Chhetri**, Research Scholar, Centre for European Studies, School of International Relations, Jawaharlal Nehru University, New Delhi. *One Belt One Road project as an answer to Eurasia's energy crisis: Some Explorations* 1.7: Mr. **Wang Ran**, M.A. Candidate, Middle East Institute, Shanghai International Studies University. *Study on the New Oil Policy of Saudi Arabia in the New Period* 1.8: Mr. **Anastas Vangeli**, Doctoral Researcher at the Polish Academy of Sciences and Claussen-Simon Ph.D. Fellow at the ZEIT-Stiftung Ebelin und Gerd Bucerius. *The politics of energy and climate change cooperation in the 16+1 framework*

10.00–10.30. Tea Break

10.30–12.00. Theme 2. Macro-Economics and Micro-Business of Changing Energy Markets

Session 2A (Room 14.1)	Session 2B (Room 14.2)
Chaired by: Dr. **David C. Broadstock**, Associate Professor, Research Institute of Economics and Management Southwestern University of Finance and Economics, Chengdu 2.1: Dr. **Thomas Sattich**, Associate Researcher at the Institute for European Studies, Adjunct Professor Vesalius College Brussels; Dr. **Duncan Freeman**, Research Fellow, Brussels Institute of Contemporary China Studies, Vrije Universiteit Brussel. *The EU and China: Energy Policy Interactions and Interdependence. Geo-economic interactions between policy and the energy sectors of Europe and China* 2.2: Mr. **Przemyslaw Ozierski**, Ph.D. Candidate, Russian Presidential Academy of National Economy and Public Administration, Moscow and External Expert, The National Institute for Strategic Studies of the Kyrgyz Republic, Bishkek. *China-Central Asia Neighborhood Complex Interdependence. New Energy Architecture and the Silk Road Economic Belt sustainability* 2.3: Mr. **Fang Meng**, Ph.D. Candidate in Law, Chinese University of Hong Kong. *The Rise of Trade Remedies on Renewable Energy Sector and the Need of Bilateral Agreement between the EU and China*	Chaired by: Dr. **Frauke Austermann**, Head of Cologne Campus at International School of Management 2.4: Dr. **Aude Pommeret**, Assistant Professor; Dr. **Tunç Durmaz**, The School of Energy and Environment, City University of Hong Kong; **Dr. Prudence Dato**, IREGE, Université de Savoie. *Renewables, storage and smart meters* 2.5: Mr. **Andrew LEUNG**, Chairman of Andrew Leung International Consultants Limited & Visiting Professor with the London Metropolitan University Business School. *China's energy dynamics and global implications in the 21st century* 2.6: Mr. **Stratos Pourzitakis**, Ph.D. Candidate and Teaching Assistant, Department of Government and International Studies, Hong Kong Baptist University. *Securing energy insecurity? China's and EU's Quest for Energy in the Caspian Sea Region* 2.7: Dr. **Cheng Chunhua**, Assistant Professor, Institute of Global Ethnology and Anthropology Minzu University of China. *The prospect for cooperation in the framework of The Belt and Road Initiative between China and transiting Energy Charter*

12.00–13.30. Networking Lunch—Staff Restaurant 南北小廚

4/F, Communal Building, The Hong Kong Polytechnic University.

13.30–15.00. Theme 3. The Role of Regional and Municipal Actors in Energy and Climate Change Policy

Session 3A (Room 14.1)	Session 3B (Room 14.2)
Chaired by: Mr. **Maximilian Rech**, Programme Director & Assistant Professor for International Affairs at ESSCA School of Management, Shanghai	Chaired by: Mr. **Anastas Vangeli**, Doctoral Researcher at the Polish Academy of Sciences and Claussen-Simon Ph.D. Fellow

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3.1: Dr. **David C. Broadstock**, Associate Professor, Research Institute of Economics and Management Southwestern University of Finance and Economics, Chengdu (China). *Oil spillovers & the asymmetric reaction of China to international oil price dynamics* 3.2: Dr. **LI Yijing**, Lecturer, China Executive Leadership Academy Pudong (CELAP), Shanghai. *The development of China's climate change policies and actions* 3.3: Dr. **Ali Cheshmehzangi**, Assistant Professor; Mr. **Ayotunde Dawodu**, Ph.D. Candidate, Department of Architecture & Built Environment, The University of Nottingham Ningbo, China; Dr. **Chris Butters**, Faculty of Engineering, The University of Warwick (UK). *Housing Energy Efficiency for Whom? The Roles of Actors, Profitability and Appropriate Scales* 3.4: Ms. **Chan Sau Kan**, Ph.D. Candidate, Graduate School of Global Politics, Free University of Berlin. *A Dynamic Alliance—Local Enterprises in interaction with local and national governments as the driver of renewable energy innovation and development in China*	at the ZEIT-Stiftung Ebelin und Gerd Bucerius 3.5: Ms. **Helen Tung**, Ph.D. Candidate, University of Greenwich (UK), Lawyer and Mediator in Australia 3.6: Dr. **Shao Jingjing**, Postdoctoral Research Associate; Dr. **Odette Paramor**, School of Geographical Sciences, Faculty of Science and Engineering, The University of Nottingham Ningbo, China. *The Resilience of Coastal Energy Infrastructure to Climate Change* 3.7: Mr. **Brian C. Ventura**, Ph.D. Candidate, University of the Philippines Visiyas / Northern Illinois University. *Energy Security and the Rise of China*

15.00-15.30. Tea Break

15.30–17.00. Theme 4. Innovation and Reciprocal Investment in EU-Asian Energy Sectors

Session 4A (Room 14.1)	Session 4B (Room 14.2)
Chaired by: Prof. Dr. **Michael Palocz-Andresen**, Professor for Sustainable Mobility at the Institute for Sustainable and Environmental Chemistry, Leuphana University Lüneburg and School for Environmental Engineering at Shanghai Jiao Tong University 4.1: Ms. **Guan Jian**, Director of Administration Office, M.A. Candidate, School of Foreign Languages, Sun Yat-sen University, Guangzhou, China. *China's Policies toward Climate Change.* 4.2: Ms. **Jovana Kondic**, Inventor, Novi Sad, Serbia; Dr. **Nikola Zivlak**, Lecturer, Center of International Programs, Donghua	Chaired by: Prof. Dr. **Steffi Weil**, Academic Director, Antwerp Management School, Belgium 4.6: Mr. **Yan Shaohua**, Ph.D. Candidate of European Studies, The University of Hong Kong, Dr. **Rafael LEAL-Acras**, Professor at Queen Mary University of London. *From Energy Politics to Energy Governance: the EU and China as Partners in Global Energy Governance* 4.7: Dr. **Zhang Xingxing**, Assistant Professor (Lecturer) in Building Services, Engineering / Building Physics; **Shen Jingchun**; **YANG Tong**; **Tang Llewellyn**, Department of Architecture and Built

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University, Shanghai. *Highly Efficient Thermo-Insulating Panel Made of Ecological Recyclable Materials as a Solution for Energy Loss* 4.3: Mr. **Leung Kin Pong**, Research Associate of European Union Academic Programme, Hong Kong. *Chinese investment in the EU energy sector.* 4.4: Mr. **Richard Q. Turcsányi**, Ph.D. Candidate, Faculty of Social Studies at Masaryk University. *Responses to Chinese Investments in the Central Europe's Energy Sector* 4.5: Dr. **Wang Weidong**, Post-Doctoral Researcher, Early Warning Management of Industry Risk, College of Public Administration, Zhejiang University, Hangzhou, China. *"One Belt One Road": The New Power of China-EU Cooperation*	Environment, University of Nottingham, Ningbo, China. *Case study of the effectiveness of business strategies for a representative Chinese solar photovoltaic (PV) manufacturer and its potential role in future energy industry* 4.8: Dr. **Yu Xiaojing**, Researcher, Institute of National Economy, Shanghai Academy of Social Sciences (SASS). *Study on the Effects of Renewable Energy Policies in China* 4.9: Mr. **Zhou Lei**, Co-founder of Independent Think Tank, Oriental Danology Institute (ODI). *Energy saving strategy through creative water initiatives*

17.00–17.30. UACES CRN on EU-China Relations—Best Paper Award

Mr. **Maximilian Rech**. Programme Director and Assistant Professor for International Affairs at ESSCA School of Management, Shanghai.

18.30–20.30. Farewell Dinner – Staff Club (5/F, Communal Building, Hong Kong Polytechnic University)

Dr. **Peter HEFELE**. Director of the Regional Project "Energy Security and Climate Change" at Konrad-Adenauer-Stiftung, Hong Kong

OPTIONAL CITY TOUR—SAT, 12 MARCH 2016—HONG KONG

10.00–12.30. City Tour & Visit of Hong Kong Electric Operational Headquarters

13.00–14.00. Farewell Lunch