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Hubert Schmitz and Rasmus Lema

5.1. Introduction

Three major waves of change have occurred in the global economy in recent decades. First, there was the reduction of barriers to flows of goods, finance, and information. The second involved a shift of economic power from West to East. Third, but only just beginning, is a restructuring towards a greener global economy due to the threat of climate chaos.

China was the main beneficiary of the first wave. Through a process of integration into global value chains, China was able to build up its production capabilities very quickly. This laid the basis for the second wave, the emergence of China as a driver of global change, altering the parameters for competing in the global economy. China has transformed the global map of manufacturing industry. Over a short period it has acquired production capabilities challenging the old industrial powers and forcing them to switch to other stages of the value chain or to other sectors. The green sectors were originally thought be immune from this. During the 2000s Europe expected that its renewable energy industries would retain global pre-eminence and become a bastion of green growth and jobs. Now we know that China is also transforming these green industries.

This chapter examines this challenge from China for Europe's green industry—showing both intense competition and close cooperation. It shows how and why these relationships vary between green sectors and different stages of the value chain. This is the core of the chapter. We then show how the global financial crisis influenced the Chinese challenge for Europe and reflect on how the new division of labour affects the chances of

mitigating climate chaos. The chapter thus traces some of the interconnections between two of the challenges discussed in this book: the economic challenge and climate change.

Concentrating on how China challenges Europe in the global green economy might seem a surprising choice given that China has gained a reputation for damaging its own and the world's environment. Indeed, over more than three decades of resource-intensive growth and reliance on coal-fired power plants, Chinese CO_2-intensity is among the highest in the world (Ecofys, 2014; see also Chapter 1 in this volume). However, having become the world's greatest source of carbon dioxide emissions in the first decade of this millennium, China has now become the world's largest investor in renewable energy and other green sectors (BNEF, 2013). China is thus becoming a major player in the global green economy, with domestic firms rapidly catching up with the world leaders.

The ramifications for European industry vary a great deal, in particular in renewable energy. In hydro-power, China has now become the world's leading exporter of dams for electricity generations. Starting with building up its capabilities by supplying the home market, lead firms such as Sino Hydro have become multinational enterprises. While they operate globally, they mainly compete with European firms in the developing world (Huang and Fang, 2013). In the solar-photovoltaic industry, the local Chinese market only became important more recently. This industry started out as an export-oriented industry and by 'learning from exporting', Chinese producers have moved from supplying components to complete solar panels in a short time-span. By the late 2000s they undercut European (and American) producers, leading to major job losses and prompting a trade war (Fischer, 2012; Luetkenhorst and Pegels, 2014). This painful solar experience has affected not just the European competitors in this sector but the discussion on green growth more generally. As noted by Geels (2013, 83).

> The green growth discourse in Western countries is hindered by cheap Chinese competition, which caused over-capacity, tumbling prices, and bankruptcy or job reductions for many Western wind and solar companies. The industrial shake-out and job losses led politicians to criticize the use of Western government subsidies (for renewable energy) to stimulate Chinese industries.

This chapter sheds light on the assumptions made in the discourse referred to by Geels. It does so by examining the interconnection between China and Europe in the wind power industry. It shows that the changing relationships have to be seen in the context of the global financial crisis. We cannot isolate a 'China effect' because the increasing competitive pressure from China coincides with the global financial crisis.

The European wind power turbine industry was working at full throttle when the financial crisis broke in 2008. Most manufacturers and component

suppliers were working at maximum capacity. Due to long lead-times, the effects of the crisis were initially not felt fully, being mitigated to some extent by financial stimulus packages. But 2008 was nevertheless a turning point where overcapacity caused prices to fall. Starting that year, prices fell by more than 20 per cent over the next three years (Gosens and Lu, 2013, 310). Today, in 2014, the European industry is just beginning to rebound from falling prices, major job losses, and dwindling profits.[1]

It is clear that the global financial crisis and the scaling back of national government support has had an adverse effect on the European wind power industry (Luetkenhorst and Pegels, 2014; Sørensen and Springborg, 2010). It is less clear how the rise of China as a major wind power nation has affected the European wind power industry and what the prospects are for competition versus cooperation between European and Chinese firms. This is the question on which we focus in this chapter.

The chapter is structured as follows. Section 5.2 provides essential background information on China's wind power market and its drivers. Section 5.3 analyses the growing competition among the international wind turbine producers in recent years, highlighting the rapid advance of Chinese firms in the global top ten and the parameters on which they compete with European firms. While the competition between European and Chinese lead firms is strong, there are also many examples of cooperation. In order to explain this, section 5.4 sets out the value chain of wind turbine production and innovation. This provides the analytical basis for unravelling surprising forms of cooperation between Chinese and European firms. This cooperation is driven by the pressure on Chinese firms to catch up and improve the quality of their products and the pressure on European firms to gain access to the large and rapidly expanding Chinese market. Reflecting on these findings, section 5.5 asks wider questions about China's role in Europe's crises, stressing the need to differentiate carefully between and within sectors. Section 5.6 discusses economic and political ways forward and section 5.7 sets out questions for further research.

5.2. China and the Green Economy

The purpose of this section is to provide some background on the build-up of China's green economy. China now boasts the world's largest renewable

[1] Tens of thousands of European jobs were lost in the wind power industry during the economic downturn. Denmark has the highest proportion of wind power jobs in Europe. During 2009 when the crisis gathered speed, the Danish wind power industry lost 4,000 industrial jobs out of a total of approximately 28,000 in just one year. Subcontractors accounted for more than 3,000 of those jobs (Sørensen and Springborg, 2010).

energy system, generating over 1 trillion kWh (in 2013) from water, wind, and sun (Mathews and Tan, 2014). After decades of rapid and 'dirty' economic progress, China has begun to set targets devised to reduce the carbon intensity of growth, in particular by investing in renewables.

The Forces of Change

The rationale for investing in low-carbon restructuring differed from European countries, at least initially. While the first push in Europe three to four decades ago was spurred by a growing environmental movement, China's initial turn to green technologies was mainly rooted in industrial development and energy security interests rather than in environmental considerations (Schmitz, 2015). The main concerns were reducing dependence on imported energy, building competitive industries, and (at the local level) creating jobs and raising public revenue (Dai, 2014).

Recent years, however, have seen a growing dissatisfaction with the environmental degradation and smog in the rapidly growing Chinese urban areas. Chinese policy-makers are struggling with how to combine high economic growth—still demanded by those left behind in the Chinese take-off—with reducing pollution and carbon dioxide emissions, let alone an absolute decline in the use of fossil fuels (cf. Clark and Hornby, 2014). One part of the solution—the consequences of which are now being felt in many parts of the world—is the fostering of the renewable energy industries.

The financial crisis proved to be an important turning point because financial stimuli packages were dedicated to boosting green industries. In 2008 as well as in 2009 the financial stimulus packages in China were more ambitious than any other nation when it comes to investments earmarked for green industries (Morrison and Yoshida, 2009). China allocated 5.3 per cent of GDP to these sectors of the economy through green stimulus packages. Countries in the EU also identified investment in renewable energy as a way to overcome the crisis, create jobs, and develop new growth perspectives, but to a much smaller degree. For example, Germany, a forerunner in greening the economy, allocated roughly 0.5 per cent of GDP through the stimulus package in 2008 (Barbier, 2010). In China the green stimulus strategy proved to be an inflection point in the growth path which became visible over the coming years.

The Significance of China in Renewables

Mathews and Tan (2014) suggest that the year 2013 marked a significant change in the country's energy trajectory because the scales tipped towards electricity generated from renewables compared to coal and nuclear. In 2013, renewables accounted for 60 per cent of *new* electricity generation capacity, of

which 11 GW was solar and 16 GW wind turbines (Clark and Hornby, 2014; GWEC, 2014). This high share of added capacity from renewables in electricity generation is higher in China than in most other countries in the world. Although this is still far from the expansion required to meet targets set by climate scientists, Mathews and Tan (2014) assert that carbon dioxide emissions from the power sector in China can be expected to fall soon.[2]

In 2013 the Chinese wind power market was still growing at an annual rate of more than 20 per cent, and China ranked number one globally in terms of cumulative installed capacity with 91.4 GW, or 29 per cent of global capacity (GWEC, 2014; WWEA, 2014). The number one position was achieved at breakneck speed. In 2005, when the domestic industry took off, China's wind power capacity was 1.25 gigawatt (GW), accounting for only 2 per cent of the world market. Between 2005 and 2013, total installed capacity in China thus increased by more than 70 per cent per year. Approximately five years after the 'take-off' in the home market, the Chinese export of wind power equipment had its own take-off in 2011. From a low average of 18 MW/year during the period 2008–2010, exports rose rapidly to a level of 692 MW installed capacity in 2013. However, only a very small share of these exports went to Europe, whereas the majority of turbines were exported to emerging markets (Lema et al., 2013, 52–4).

This rapid expansion of wind power capacity in China is mainly a result of favourable government policies. These policies have contributed to rapidly growing internal markets for renewable energy. As in Europe, large subsidies are involved, since the cost of generating electricity from wind and sun is still higher in most Chinese locations than that of fossil-fuel-based energy.

China's rise as a wind turbine producer is thus closely related to the size and growth of its wind energy market and the policies that support it. The global demand for wind energy is shifting to the East. European countries and the US have long been the dominant markets in the global wind power sector but by 2010 more than half of newly installed wind power capacity was added outside these traditional markets. China has been the main driver of this development. Within just half a decade or so, China has managed to build the largest market for wind power in the world. This is the home market from which Chinese firms are now taking off and competing internationally.

[2] The current high share of coal in the energy mix, combined with rapid economic growth in heavy industries, has put China in the position of being the biggest CO_2 emitter globally (IEA 2014b). However, a large share of China's emissions is due to exports—approximately 23 per cent of Chinese emissions are due to China's insertion into global value chains catering for the European and North American markets (Watson and Wang, 2007).

5.3. Competition

The world keeps observing China's economic rise with a mixture of admiration and trepidation: admiration because the speed and depth of the country's economic transformation are unprecedented in history; trepidation because China has increased the competitive pressure on industry in many countries and sectors. There is now a substantial literature on the impact of China's industrial transformation in creating both considerable threats but also new opportunities for industry in other countries (Eichengreen, 2006; Kaplinsky and Messner, 2008; Jenkins and Barbosa, 2012; Fujita, 2013). This chapter seeks to show how this balance of threats and opportunities has been unfolding in the European wind turbine industry. This section discusses the increasing competition between Europe and China while section 5.4 examines the opportunities for cooperation.

The Rise of Chinese Lead Firms

The rotating blades of wind turbines have become an iconic symbol of the green economy. Until recently, Europe was the global leader in producing and using such wind turbines. This European leadership rested largely on the green investments of two countries, Denmark and Germany. Most of our discussion of Europe refers to these two countries. Denmark was the pioneer in producing and using wind power, but Germany caught up rapidly. Today, both countries remain global leaders in innovation but China has become number one in the production of wind turbines. China is also catching up in developing new wind power technology (Lewis, 2013). Unpacking and understanding this overall picture is essential for the central argument of this chapter concerning the coexistence of competition and cooperation.

Competition is intense and most visible when we concentrate on the lead firms of the wind power industry. Table 5.1 gives some idea of the competitive pressure on Europe and the speed of China's advance. It shows the top ten turbine manufacturers in the world. While in 2005, seven of the top ten firms were European and none were Chinese, by 2010 there were four Chinese firms in the top ten. By 2013 this number had reduced to three but four of the following five wind turbine manufacturers just below the top were also Chinese (NAW, 2014). Europe remained strong with five in the top ten by 2013 but clearly less strong than in 2005 (Table 5.1). The big loser has been General Electric, whose market share declined from 17.7 per cent in 2005 to less than 5 per cent in 2013.

The lead firms compete head-on, in particular for the major contracts—equipping the new wind farms. The market is differentiated according to different types and sizes of turbines (customized for different wind speeds,

Table 5.1. Top ten global wind turbine manufacturers 2005—2013

2005			2010			2013		
Company	Share	Origin	Company	Share	Origin	Company	Share	Origin
1. Vestas	27.90%	EU	1. Vestas	14.8%	EU	1. Vestas	13.2%	EU
2. General Electric	17.70%	US	2. Sinovel	11.1%	CN	2. Goldwind	10.3%	CN
3. Enercon	13.20%	EU	3. General Electric	9.6%	US	3. Enercon	10.1%	EU
4. Gamesa	12.90%	EU	4. Goldwind	9.5%	CN	4. Siemens	8.0%	EU
5. Suzlon	6.10%	IN	5. Enercon	7.2%	EU	5. Suzlon	6.3%	IN
6. Siemens	5.50%	EU	6. Suzlon	6.9%	IN	6. General Electric	4.9%	US
7. Repower	3.10%	EU	7. Dongfang Electric	6.7%	CN	7. Gamesa	4.6%	EU
8. Nordex	2.60%	EU	8. Gamesa	6.6%	EU	8. United Power	3.9%	CN
9. Ecotécnia	2.10%	EU	9. Siemens WP	5.9%	EU	9. Mingyang	3.7%	CN
10. Mitsubishi	2.00%	JP	10. United power	4.2%	CN	10. Nordex	3.4%	EU
Others	5.00%		Others	17.5%		Others	31.6%	

Note: World market shares
Source: BTM (2006, 2011, 2014)

temperatures, and onshore/offshore installation). Overall, however, Europe has the edge with regard to product differentiation, large-scale and offshore turbines, and reliability, and China with respect to price and medium- and small-scale onshore turbines.

The Sources of Economic Power

In order to understand the competitive dynamics, it helps to observe how China was able to increase its share of the global market. Here one can distinguish four sources of competitiveness which need to be distinguished individually but which also significantly reinforce each other.[3] The first is *the strength of the home market.* The Chinese Government—understandably concerned with energy security—has fostered the production of renewable energy. The Renewable Energy Law of 2005 was the central piece of legislation. Along with other complementary policies, it helped to create a rapidly expanding internal market for wind power. Foreign enterprises were not prevented from competing in this market but Chinese enterprises were favoured, receiving government support through various means, some visible

[3] In this chapter we do not deal with a fifth source coordination power, one which derives from highly modular supply chains in China (Lema et al., 2013).

(e.g. local content requirements in place during 2005–9), others less visible (e.g. bidding for state-funded projects). Since the Chinese market was large and fast-growing, success in this market had a major impact on the global market shares, which are summarized in Table 5.1.

The second source of Chinese competitiveness is *producer power*. The large size and rapid growth of the Chinese market enabled Chinese turbine manufacturers to adopt a model of industrial organization geared towards economies of scale. A turbine is a complex product typically consisting of over 10,000 parts. While leading European firms—such as Vestas of Denmark and particularly Enercon of Germany—produced many of these parts in-house (seeking to constantly improve design and quality), their Chinese counterparts relied much more on buying components from suppliers who also supplied other turbine makers and were thus able to achieve economies of scale and reduce costs.

The third source of competitiveness is *financing power*. This is as yet little explored in the literature but is of increasing importance. The essential point is that Chinese firms can offer supplier credit but this is much more difficult for Western firms. This matters greatly for their customers since investment requirements for wind farms are high and time-frames are long. Project finance may become particularly important for competing in export markets. Compared with their Western counterparts, Chinese companies have deep financial pockets. Sinovel, for example, has a US$6.5 billion line of credit from government-owned banks (Zeller and Bradsher, 2010). China Exim Bank has injected capital into Goldwind and Ming Yang to support foreign expansion. Such support opens up the possibility of an export model that has not been directly utilized by European firms—the twinning of wind farm project finance and turbine exports. Many new projects undertaken abroad by Chinese turbine firms have been implemented with tag-along finance. The finance effect is beginning to show. 'Competition from Chinese manufacturers has dragged down prices for wind turbines, while Europe's economic slowdown has tightened credit markets, curbing funds for project development' (BNEF, 2012a).

A potential fourth source of competitiveness is *innovation power*. There is controversy over how real this is. Some argue that the Chinese firms rely largely on technologies licensed from European firms. This view is supported by patent statistics which reveal that China occupied an insignificant position in wind energy patenting well into the first decade of this millennium (McDowall et al., 2013). Others argue that Chinese firms have moved on and started to accumulate significant innovation capabilities. Since the locus of innovation power is essential for the future of Europe's industry, the next section delves deeper into this issue, unpacking the parts of the value chain concerned with innovation. This then enables us to gain new insights into the nature of the relationships between European and Chinese firms.

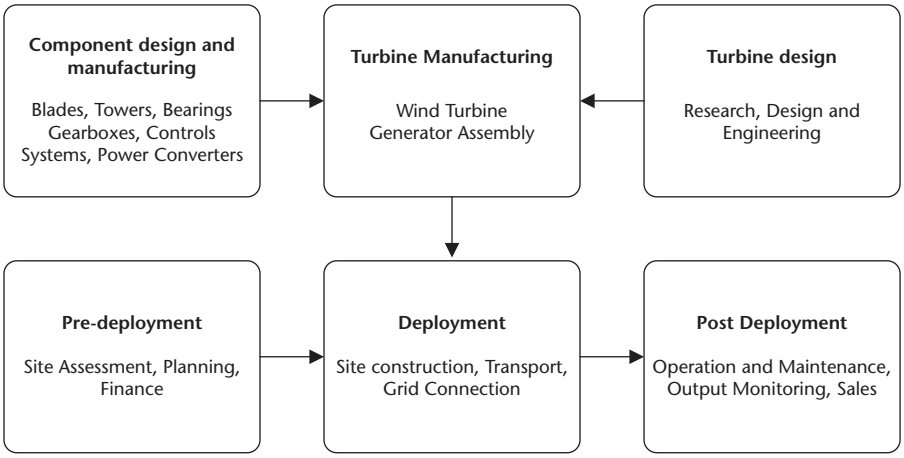

Figure 5.1. The wind power value chain

The head-on competition between Europe and China which we have stressed so far—and which dominates the discourse in the media and business press—occurs between the lead firms in turbine manufacturing. A different picture emerges, however, if we shift our focus to different stages of the value chain, namely turbine design, component design and deployment (Figure 5.1). The next section examines these different parts of the value chain.

5.4. Cooperation

Value chain analysis offers a valuable analytical tool for understanding how the global map of industrial production has changed (Gereffi, 1999). It has proved particularly valuable for understanding the speed with which newcomers come to compete in the global economy (Schmitz, 2006) and how different ways of organizing the global value chain affect the ability to compete (Sturgeon, 2002). The innovation part of the value chain, however, has remained relatively underexplored.

This is beginning to be addressed in new work on the organizational decomposition of the innovation process—ODIP (Schmitz and Strambach, 2009). The essence of value chain analysis, namely slicing the value-adding process into separate activities, was extended to the innovation process. The starting point for this line of investigation was the fundamental change in the way innovation is organized. Innovation activities that used to be carried out in-house are now often transferred to independent suppliers of knowledge-intensive business services (KIBS) or suppliers of key components. This helps with understanding the changing global innovation map. Using such ODIP

analysis, we have shown shifts in innovation power to Brazil and India, as evidenced in the auto and software industries (Lema et al., 2012). Analysing the organizational decomposition of the innovation process is essential for understanding the issue that is central to this chapter—the relationships between European and Chinese firms in the wind power industry.

Cooperation in Licensing and Co-Design Relationships

European wind turbine makers rely more on their internal capabilities than their Chinese counterparts, but even they cannot do everything in-house. As noted earlier, a wind turbine is a very complex product, with some parts requiring highly specialized expertise. A good part of this expertise resides in knowledge-intensive business services. These KIBS firms do not have a manufacturing capacity but instead adopt a business model focused on selling R&D and consultancy services and licences for wind turbine design. To give some examples, Windtec of Austria was among the first to sell licences in the market, becoming a technology supplier to Germany's Fuhrländer and other European firms. Norwin of Denmark focused on turbine design and entered into an agreement with the German firm Preussac, which then manufactured turbines based on the resulting licence agreement. Some of these KIBS emerged out of the earlier consolidation and restructuring of the European wind power industry. For example, Norwin was founded by three engineers from the R&D department of Danwind, a wind turbine firm which went out of business in 1991. Such KIBS play an important role with regard to wind power innovation in Europe. They are also important for the build-up of production and innovation capability in China.

When China entered the wind power industry, it had no turbine technology of its own. It relied almost entirely on licensing technology from Western firms. Such licences were acquired not from the lead firms but from smaller turbine makers and in particular from wind KIBS (Lewis, 2013, pp. 136-37). These KIBS firms have developed a revenue stream based on licence fees from their customers abroad, in particular in China. The Chinese manufacturers used these licences to build up their own production capabilities. All this is relatively well known. What is less well known is that some of the Chinese manufacturers have also now begun to build up their own innovation capabilities. This is being done through various learning channels. One of the most important channels is the relationship with the European KIBS: what was originally a licensing relationship has often become a co-design relationship. Turbines or components are designed jointly between a Chinese manufacturer and a European design house. The Chinese side gains access to top European engineers and the European side gains (indirect) access to the Chinese market.

The underlying shift in technology relationships is captured by Lewis (2013) in her observations on one of the China's lead firms: 'Goldwind, like many other wind companies, began its entry into the wind industry by acquiring a technology licence from a foreign company. At it became more experienced, it sought out a German design firm to work with rather than a manufacturer that could also be a competitor' (2013, 133). This case is not an exception, as shown in Figure 5.2 which depicts the relationships between twenty-six Chinese turbine makers and eighteen (mainly) European KIBS. While not claiming to be comprehensive, the figure indicates that such relationships are now fairly common. Some are mainly about licensing, others about co-design, while some include both. It is not yet clear how durable the arrangements of cooperation in design are, but clearly the inter-firm relationships between China and Europe are changing over time, helping China to break through from production to innovation.[4]

While the globalization of the innovation process has contributed to this process, it was also supported by favourable domestic factors, notably public policies (see section 5.2; Cunningham, 2014), investments in the local innovation systems (Gosens and Lu, 2013), investments in firm-level learning (Qiu and Anadon, 2012) and other factors typically emphasized in the catch-up literature (Lee, 2005; Bell and Figueiredo, 2012).

Cooperation across Value Chain Functions

In addition to the collaborative relationships between European turbine designers and Chinese turbine manufacturers, many other instances of cooperation along the value chain can be observed. For example, European component designers and component manufacturers are working with Chinese firms. While European turbine manufacturers generally face a tough time in China, certain suppliers of key components are working for, rather than competing with, Chinese firms. Control systems software is one of the areas in which European firms have a competitive edge and Chinese firms are seeking to learn from them. For example, the Danish firm Mita-Teknik works with Sinovel on control system software. Sinovel and Mita-Teknik had originally entered into an agreement under which Sinovel purchased controls systems and software from Mita-Teknik, but under a new agreement the two companies will develop the next generation of control systems jointly (Lema, 2012).

European firms are also helping China to develop its offshore wind power base. Siemens was responsible for the Jiangsu Rudong Offshore farms, which

[4] The shift from licensing to co-design has also received increasing attention from Chinese scholars, notably Qiu and Anadon (2012), Ru et al. (2012), Wang et al. (2012), Zhou et al. (2012) and Dai et al. (2014).

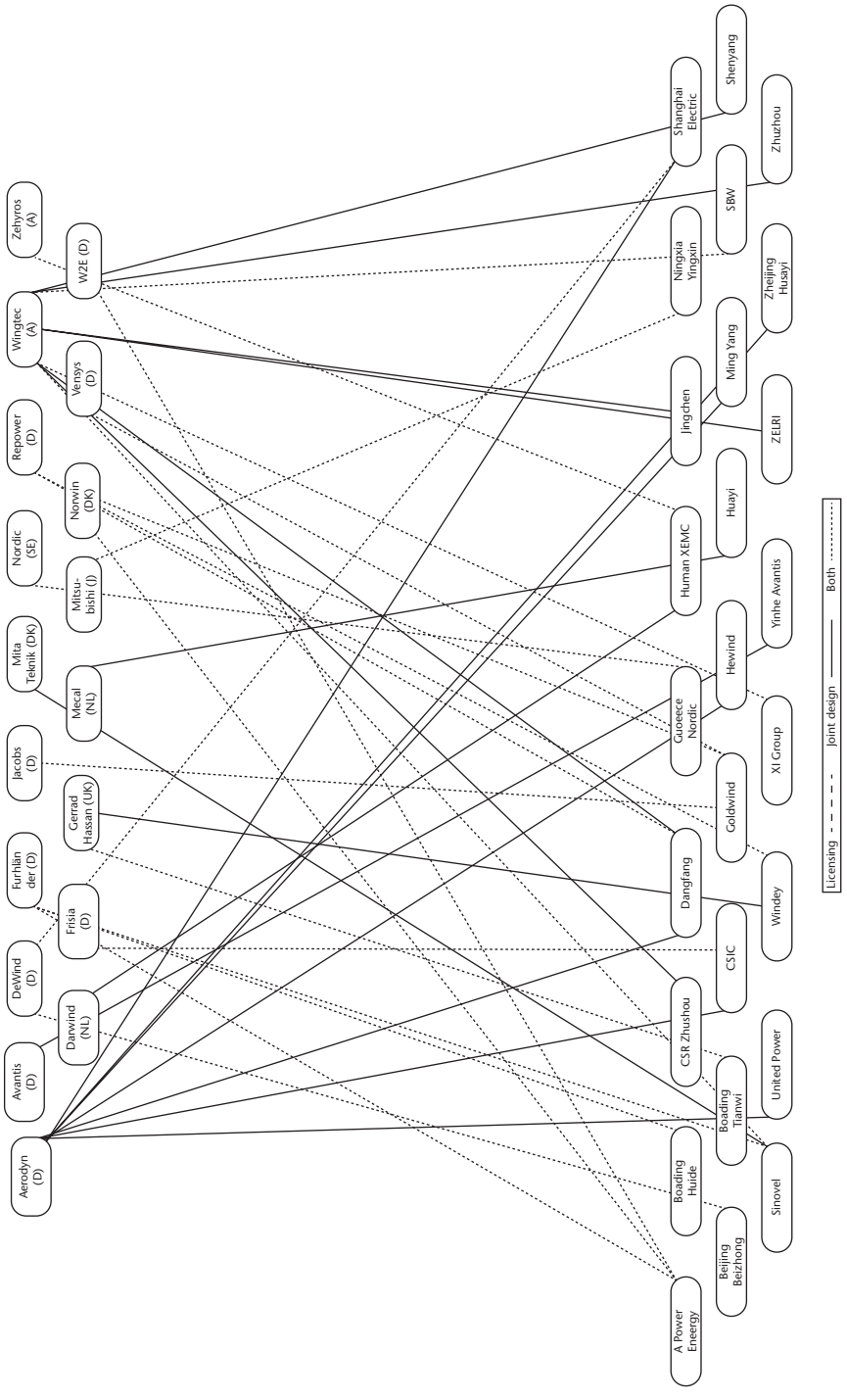

Figure 5.2. Links between European KIBS and Chinese manufacturers

were connected to the grid in May 2012. Besides developing the wind farm, Siemens also entered into a joint venture with Shanghai Electric, which was established to focus on offshore projects. Such projects bring European expertise to the demanding offshore segment of the wind power industry, which is still relatively underdeveloped in China. On the other hand, China has capabilities for producing at low cost. Some European utilities are pondering how to use turbine foundations produced in China to bring down the costs of offshore projects.

The transformation of China–Europe relationships does not stop here. Lead firms from both sides have become global firms rather than remaining purely European or purely Chinese firms. Vestas has established a sizeable R&D laboratory in China and Goldwind has acquired majority control of the German wind turbine maker, Vensys. Titan Wind Energy acquired a tower factory for Vestas of Denmark, thus rescuing jobs that would otherwise have been lost due to the major restructuring process undertaken by Vestas that was triggered by the financial-economic crisis. Merely contrasting European and Chinese industry risks missing out the transformation of relationships between them that is under way.

To sum up, section 5.3 revealed fierce competition between European and Chinese lead firms of the wind power industry. However, this section has shown that this fierce competition coexists with cooperation between Chinese and European firms. The relationships of cooperation become apparent once we closely examine the value chain, in particular the innovation part. Unpacking the innovation process and identifying changes over time are essential for bringing to light the evolving pattern of inter-firm cooperation across the Europe–China divide.

5.5. China's Rise—Europe's Crisis?

The picture which dominates the media is that China's rise has contributed to Europe's crisis. Careful research shows that the China effect varies between countries and sectors (Venables and Yueh, 2006; Jacques, 2012). Nevertheless, competitive pressures have increased for most industrial enterprises, including those operating in the green economy.

The reconfiguration of competition and cooperation has important ramifications both from a European economic crisis perspective and from a sustainability perspective. As shown in this chapter, the assertion that cheap Chinese competition is the root cause of overcapacity, unemployment, and falling share prices in the wind power industry in Europe is an exaggeration. In wind power, the competition from China on European soil is still very limited (Lema et al., 2013, 52–3). The mitigating effects include high-transportation

costs, the inability (of Chinese lead firms) to meet European quality standards, and certain tendencies to favour national firms in major public projects (Lema et al., 2011).[5]

Overcapacity in Europe arose first and foremost from austerity policies which scaled back government support for wind power and led to the cancellation of major projects. For example, Spain completely removed its feed-in tariffs for renewable energy projects in 2012 while many countries reduced their tariffs (REN21, 2012). The offshore sector was also affected. Banks lowered their offshore project funds (Wieczorek et al., 2013, 3015) and governments implemented cancelations and delays. For example, in 2014 Denmark put the 600MW Kriegers Flak, the world's first project to supply three countries (Denmark, Sweden, and Germany), on hold (Jensen 2014).

Figure 5.3 shows how the market contracted in Europe (and continued growing in China) when the global financial crisis hit in 2008. It was this contracting which affected the industry adversely. Wind was not alone; the

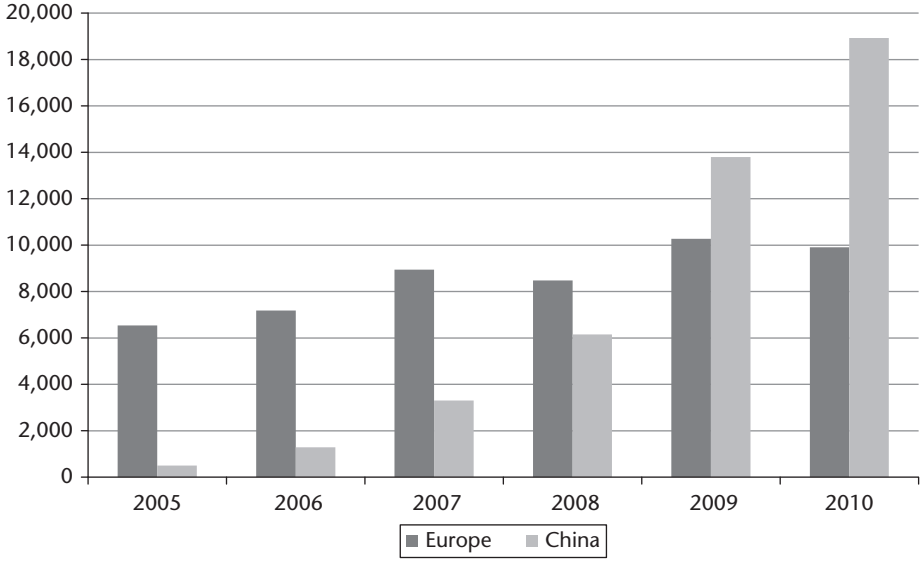

Figure 5.3. Annual wind power installation in EU and China 2005–2010 (MW)

[5] Many countries have implemented formal local content requirements (Kuntze and Moerenhout, 2013). As Fitch-Roy (2013, p. 51) puts it: 'Ministers of trade are adopting a pragmatic attitude to local content rules that reflects the trade-offs faced by an intrinsically political business'. In Europe 'protectionist' tendencies are more hidden within tendering decision-making processes but arguably account for the fact that domestic or nationally incorporated firms dominate the markets in countries such as Denmark, Germany and Spain.

entire renewable energy sector was hit severely. At the time, the consequences were assessed as follows:

> The investment surge of recent years was just starting to ease the supply-chain bottlenecks when the credit crunch arrived and cut demand. The result has been a dramatic and permanent change to the dynamics of the industry. On the supply side prices are falling towards marginal costs, and several players will consolidate. On the demand side renewable energy targets will still drive utilities to build projects, but fewer developers and independent power producers will be involved. (Fritz-Morgenthal et al., 2009, 1)

The picture which thus emerges is that, while China is driving the changes in the wind power industry, it would be misleading to see it as the main cause of the crisis in this industry. China's rise coincided with the global financial-economic crisis, but Chinese competition was not a major cause of job losses and dwindling share prices in Europe. Subsidies for wind energy in Europe accrue almost exclusively to European firms as Chinese firms are yet to make a major foray into the European market. However, the European firms are aware that this might change, since they compete with Chinese firms in third markets and know their cost advantages. They are also forewarned by the rapidly changing fortunes of the European (and American) solar power industries.

Indeed, it is worth reflecting on our findings in a comparative way. The balance between competition and cooperation in Europe–China relationships differs between green industries, notably between wind and solar-photovoltaic industries. A brief comparison helps to see the need for such a differentiated analysis.

As shown in this chapter, China's entry into the wind energy industry is reshaping the relationships between Europe and China in major ways. A big domestic market was critical for building China's production capacity; this in turn put pressure on European incumbents and drove down costs.

China has also caused major disruption and driven down costs in the solar panel industry, but the dynamics were different. Here Chinese firms managed to build up producer power by catering for the European market; initially the domestic market—and reducing green house gas emissions domestically—played less of a role. Figure 5.4 shows how solar-PV production was driven by exports during industry 'take-off'.

Exports enabled China to emerge as the new leader (replacing the EU) in producing solar-PV equipment (Fischer, 2012). However, in contrast to the wind sector, in which Chinese manufacturers still produce predominantly for the Chinese market, the Chinese PV sector has emerged partly on the basis of policy support for solar-energy deployment schemes outside China, mainly in Europe. The development of China's PV sector originated from the production of PV cells and modules. By focusing on these elements, enterprises

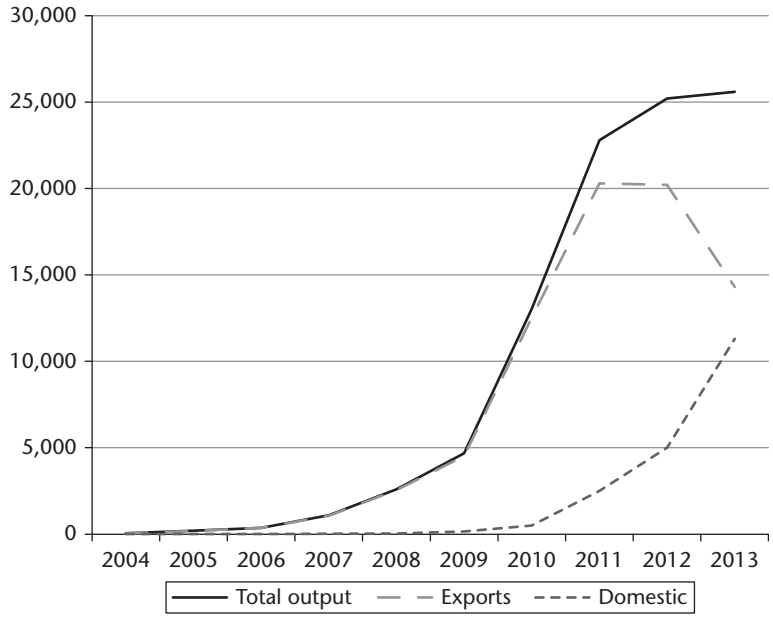

Figure 5.4. Chinese sales of solar-PV cells: exports and domestic market (megawatt)

concentrated on the steps in the PV value chain where they had competitive advantages due to low labour costs, economies of scale, and comparatively weak environmental standards applied to production processes. The development of the Chinese PV sector and exports to Europe have been facilitated by modularization and comparatively low transportation costs.

In China, government support for these activities was driven by local economic considerations and was similar to support given by local government to other export-oriented industries (Iizuka, 2014). Support schemes for the use and deployment of PV energy technology in China evolved in the context of the global financial crisis when export-oriented producers of PV cells and modules faced falling external orders, particularly in Germany. Hence, when the central government started to support PV energy use within China in 2009, the Chinese PV industry was already a highly capable producer and a fierce competitor in global markets. Figure 5.4 shows how domestic sales were increased dramatically when exports began to stagnate in 2011 and then fell from 2012—thus compensating for decreasing external demand and ensuring overall growth in output.

This was almost the complete opposite to the route taken in the wind turbine industry where the local Chinese market was the mainstay for domestic firms and where exporting came later. The patterns of competition and collaboration therefore differed in important ways both during and after the financial crisis.

In summary, the two green sectors are now highly globalized and Europe's leadership is challenged in both. However, keeping in mind our focus on competition and cooperation with China, the value chains lens shows that the challenges take different forms in the two sectors. Hence there is also a need for differentiated responses when it comes to finding ways forward.

5.6. Ways Forward

There is no shortage of contentious accounts of EU–China relationships in renewable energy. China is portrayed as causing the problems for the green industry and the climate. This chapter highlights the need to go beyond media headlines and simplistic rhetoric. Cutting through the complexities is essential for understanding the rapidly changing world.

Currently, we observe that competition between the lead firms of the wind and solar PV industries is increasing rapidly, not least as a result of China's increasing production and innovation power. From a green transformation perspective, this development is to be welcomed as it drives down the price of renewable-energy technology, supporting the reduction of greenhouse gases. Policy-makers in China and Europe, of course, are concerned not only about the global gains, but also the distribution of those gains among nations.

In a rapidly globalizing renewable-energy sector, however, it is becoming increasingly difficult to define the 'national content' of a wind turbine or a solar-PV panel. Production and innovation in both sectors are increasingly globalized. This can be turned to mutual advantage. For example, the Chinese system of renewable-energy production is entering a new stage where it is increasingly important to improve the quality and reliability of technology. Hence, Chinese lead firms should seek to collaborate with European companies at various stages of the value chain to develop this expertise. In turn, Europe, in its current stage of getting back on its feet after a prolonged financial and economic crisis, is in need of more affordable renewable-energy technology. European lead firms, under pressure to reduce costs, may be able to cooperate with Chinese firms and access capabilities and resources for scaling up.

The solar-PV industry manufacturing industry was severely affected by Chinese competition and 'rescue missions' seeking to breathe life into European solar-PV manufacturing are probably futile. Rather, policy-makers should seek to support those elements of the value chain that are globally immobile. Distinguishing between the manufacturing chain and the deployment chain is critical. While it is true that European lead firms of the production value chain are losing market shares due to increased competition from Chinese lead firms, European installation, operation, and maintenance

companies in the downstream segment of the value chain are likely to benefit from the expansion of the market as a result of falling prices for solar-PV equipment. Policies designed to support the solar deployment chain while drawing on Chinese manufacturing capabilities may contribute to job creation as well as green transformation.

In wind energy, policy-makers may seek to support collaborative relationships that benefit European industry, Chinese industry, and the global climate. Chinese involvement in select value chain steps, such as manufacturing of foundations for offshore deployment or the provision of bearings, may help to lower costs significantly. More ambitiously, cross-continental consortia may be formed between actors such as banks/institutional investors, utilities, manufacturers, and operators for projects in Europe, China, and the rest of the world. Pushing down costs and pushing up scales requires experimenting with different approaches.

The China effect has certainly been painful for German and other affected producers in the solar-PV industry. The question is whether a similar process may occur in wind power. From a European perspective, the gloomy observer might suggest that, while the many relationships between European design houses and Chinese wind power producers may create or preserve jobs and profits in Europe, the industry needs to be viewed from a dynamic perspective. These design houses and their engagement in co-design relations may be undermining the competitiveness of European producers in the long run, with the consequence that the wind industry in Europe will follow a similar pattern to the solar-PV industry. We do not think this likely. Due to the markedly different technological characteristics of solar-PV and wind energy and the associated differences in industrial organization, there will be a less dramatic China effect in the manufacturing part of the wind power value chain. It is more likely that regional production networks will be strengthened. As with the automotive industry, 'regional' European, Asian, and American networks are likely to coexist in which different lead firms dominate and compete globally while producing and sourcing mainly locally.

Value chain analysis can be a powerful tool for designing intelligent policies for the support of European renewable energy sectors that are faced with global competition in different ways. The multiple challenges confronting Europe today (climate change, reduced public finances, and competitive pressures from Asia) call for highly selective and directed strategies to support markets and new collaborative business models.

Developing and implementing such selective green industrial policy is not easy. The technological, economic, and political uncertainties are considerable (Schmitz et al., 2015). In order to succeed, green industrial policy needs to focus on specific subsectors and adopt specific instruments aimed at developing and deploying specific technologies. Predicting which technology to

support for how long means making choices about allocating policy rents on the basis of highly incomplete information. The uncertainties are exacerbated by the long time-horizons needed for new energy systems to become viable. Yet mitigating climate change requires action now. Climate and earth scientists warn that delaying action means incurring rising costs and potentially irreversible damage.

This combination of uncertainties makes green industrial policy particularly challenging. Elsewhere we have argued that the way forward lies in lies in putting politics centre stage and taking four critical steps. The first is to recognize that no single actor has the resources necessary to bring about the green transformation. The second is to recognize that, within government, civil society, and business, there are actors seeking to block or slow down the green transformation. Third, attention needs to focus on supportive alliances across these categories. Fourth, including actors with different motives helps one to understand and accelerate the green transformation process (Schmitz, 2015).

The last point is particularly critical for the concerns of this book. There is a range of actors who can support climate-relevant policies (e.g. by investing, providing expertise, or lobbying) but their motive need not be mitigating climate change; the main motive might be to secure energy, to build competitive green industries, or to foster green jobs—with climate change mitigation at best a 'co-benefit' (Dubash et al., 2013). Acting upon this can be a 'game changer' and provide the basis for building transformative alliances. The problem for European countries is that China's rise makes it more difficult to build such alliances. Mobilizing political support for green policies in Germany, Denmark, or other European countries is much harder if many of the resulting jobs are created in China. So the question at the core of this chapter—competition or cooperation between Europe and China—has ramifications for the political dynamics behind green industrial policies.

5.7. Questions for Future Research

The insights provided in this chapter contribute to understanding a number of questions which are not the core focus here but are nevertheless critical for Europe and the rest of the world. We set out five questions that can provide a starting point for future research.

First, the chapter indicates that business relations between Europe and China are characterized by cooperative competition in important areas of the value chain. The changes over time have implications for jobs, taxes, and long-run competitiveness. The changes have often been painful for European lead firms and their workers. For example, while collaborative relationships between KIBS providers in Europe and turbine manufacturers in China

are mutually beneficial to the parties involved, such relationships may be against the interest of European industry as a whole because they may undermine long-run competiveness, jobs, and taxable income. Future research needs to map out more precisely the strategic implications and the distribution of costs and benefits emerging out of those changing relationships.

Second, there is worldwide concern that China's economic rise has triggered a global 'race to the bottom'. While the mobilization of China's industrial reserve army has exerted a downward pressure on wages and prices in many industries, its firms are not stopping at competing by price cutting but are also now competing by innovating (Altenburg et al., 2008). The wind power industry analysed in this chapter shows that the country is undergoing this transformation in record time. New research is needed that gives specific attention to the time-scale over which China is catching up in this technological area. The need to pay greater attention to the time-scales of building up innovation capability has been set out in detail by Bell (2006). This chapter suggests that such research focus on the combination of internal and external capabilities. Collaboration with external KIBS has provided a relatively fast route to catching up, but exactly how fast has it been and how deep do the Chinese innovation capabilities go?

Third, there is worldwide concern that China's rapid growth is polluting the planet and harming the climate. While China has indeed contributed more than any other nation to the recent increases in carbon dioxide emissions, it has also become the number one investor in renewable energy (BNEF, 2013). This chapter suggests that these investments are being used productively to establish competitive green industries. Mathews (2012) even suggests that China may be on its way to developing a 'green model of industrial capitalism'. Examining the reality of this proposition requires research which compares the growth rates of investment in low versus high carbon industries and which compares the strength of alliances supporting low versus high carbon industries. Such studies need to take into account the insight that 'green alliances' are not necessarily driven by environmental concerns but also by concerns with energy security and competitiveness in green industries.

Fourth, it is clear that global benefits are emerging because China's entry into the wind power industry is lowering the costs of renewable energy technology. Whether the lower equipment costs will speed up the deployment of wind turbines in Europe and other parts of the world is, however, not yet clear. Other considerations influence the deployment of wind technology, in particular reliability and energy output. Life-time costs and actual electricity generation capacity are more important than upfront costs and nominal capacity. This depends on the demand preferences of different markets. The big unknown is the preference in new markets. A recent report suggests that future growth in the wind power industry will be driven more by new

markets such as South Africa, Chile, or Russia (MAKE, 2013). How effective will Chinese firms be in bringing down the cost of energy and opening up new markets?

Fifth, China is building up its own innovation capabilities. The question is whether innovations coming out of China will differ substantially from innovations coming out of Europe and, if so, how and why. Are different specializations emerging that may give rise to a new division of labour? It would be particularly interesting to examine whether solutions from China are more affordable and appropriate for the poorer parts of the world, enabling a closer alignment of environmental and development objectives. Examining whether this is occurring entails looking beyond core technologies and examining the relevance of European versus Chinese business models for poorer parts of the world.

References

Altenburg, T., Schmitz, H., and Stamm, A. (2008). 'Breakthrough? China's and India's Transition from Production to Innovation', *World Development,* 36(2): 325–34.

Barbier, E. B. (2010). 'How is the Global Green New Deal Going?', *Nature,* 464: 832–3.

Bell, M. (2006). 'Time and Technological Learning in Industrialising Countries: How Long Does it Take? How Fast is it Moving (If at All)?', *International Journal of Technology Management,* 36(1–3): 25–39.

Bell, M., and Figueiredo, P. N. (2012). 'Innovation Capability Building and Learning Mechanisms in Latecomer Firms: Recent Empirical Contributions and Implications for Research', *Canadian Journal of Development Studies,* 33(1): 14–40.

BNEF (2012). *Global Trends in New Energy Investment 2012*, Frankfurt: Frankfurt School of Finance and Management.

BNEF (2013). *Global Trends in New Energy Investment 2013,* Frankfurt: Frankfurt School of Finance and Management.

BTM (2006). *World Market Update 2005,* Ringkøbing: BTM Consult.

BTM (2008). *World Market Update 2007,* Ringkøbing: BTM Consult.

CCB International (2011). *Alternative Energy: China Wind Power*, Hong Kong: China Construction Bank Corporation.

Clark, P., and Hornby, L. (2014). 'A Shift in the Wind (Chinese Pollution)', *Financial Times,* 28 Apr., <www.ft.com/cms/s/0/9ea031fe-cc5c-11e3-9b5f-00144feabdc0.html#axzz3WzYAPgkK>.

Cunningham, E. A. (2014). 'Green Innovation in China: China's Wind Power Industry and the Global Transition to a Low-Carbon Economy', *Review of Policy Research,* 31(2): 150–2.

Dai, Y. (2014). *Who Drives Climate Policies in China?*, mimeo, Beijing: School of Public Policy and Management, Tsinghua University.

Dai, Y., Zhou, Y., Xia, D, Ding, M., Xue, L (2014). *Innovation Paths in the Chinese Wind Power Industry*, DIE Discussion Paper, Bonn: German Development Institute, forthcoming.

Dubash, N. K., Raghunandan, D., Sant, G., and Sreenivas, A. (2013). 'Indian Climate Change Policy: Exploring a Co-Benefits Based Approach', *Economic and Political Weekly*, 48(22): 47–61.

Earth Policy Institute (2014). *Data Highlights: China's Solar Panel Production to Double by 2017*, Data Highlight, 47, Washington, DC: Earth Policy Institute.

Ecofys (2014). 'International Comparison of Fossil Power Efficiency and CO_2 Intensity', Update, Sept. 2014, Utrecht.

Eichengreen, B. (2006). 'China, Asia and the World Economy: The Implications of an Emerging Asian Core and Periphery', *China and World Economy,* 14(3): 1–18.

EWEA (2014). *Wind in Power: 2013 European Statistics*, Brussels: European Wind Energy Association.

Fischer, D. (2012). 'Challenges of Low Carbon Technology Diffusion: Insights from Shifts in China's Photovoltaic Industry Development', *Innovation and Development,* 2 (1): 131–46.

Fitch-Roy, O. (2013). 'Local-Content Rules have their Role in an Imperfect Market', *Recharge,* 4(13): 51

Fujita, M. (2013). *Does China's Economic Rise Help or Hinder the Development of its Neighbours?*, Evidence Report 45, Brighton: IDS.

Geels, F. (2013). 'The Impact of the Financial-Economic Crisis on Sustainability Transitions: Financial Investment, Governance and Public Discourse', *Environmental Innovation and Societal Transition*, 6: 67–95.

Gereffi, G. (1999). 'International Trade and Industrial Upgrading in the Apparel Commodity Chain', *Journal of International Economics,* 48(1): 37–70.

Gosens, J., and Lu, Y. L. (2013). 'From Lagging to Leading? Technological Innovation Systems in Emerging Economies and the Case of Chinese Wind Power', *Energy Policy,* 60: 234–50.

GWEC (2014). 'Global Statistics', Global Wind Energy Council, www.gwec.net (20140429).

Huang, B., and Fang, D. (2013). 'Internationalization of Chinese State-Owned Construction Enterprises: A Case Study of Sinohydro', *Journal of Engineering Management,* 3: 111–16

IEA (2012). *National Survey Report of PV Power Applications in China*, ed. Xu, Honghua, et al. Paris: International Energy Agency Photovoltaic Power Systems Programme

IEA (2013). 'Energy Statistics', <http://www.iea.org/statistics>.

IEA (2014a). *Snapshot of Global PV 1992–2013*, Paris: International Energy Agency Photovoltaic Power Systems Programme.

IEA (2014b). *World Energy Investment Outlook*, Paris: International Energy Agency.

Iizuka, Michiko (2014). *Diverse and Uneven Pathways towards Transition to Low Carbon Development: The Case of Diffusion of Solar PV Technology in China*, MERIT Working Papers, 002, Maastricht: United Nations University—Maastricht Economic and Social Research Institute on Innovation and Technology (MERIT).

Jacques, M. (2012). *When China Rules the World,* 2nd edn, London: Penguin.

Jenkins, R., and Barbosa, A. d. F. (2012). 'Fear for Manufacturing? China and the Future of Industry in Brazil and Latin America', *China Quarterly,* 209: 59–81.

Jensen, Karin (2014). 'Danes Bump Kriegers Flak to 2022', *Recharge News*, <http://www.rechargenews.com/wind/article1366276.ece>.

Junfeng, L. (2012). *China Wind Energy Outlook 2012*, Beijing: Chinese Wind Energy Association.

Kaplinsky, R., and Messner, D. (2008). 'The Impact of Asian Drivers on the Developing World', *World Development,* 36(2): 197–209.

Kuntze, J. C., and Moerenhout, T. (2013). *Local Content Requirements and the Renewable Energy Industry: A Good Match?*, Geneva: International Centre for Trade and Sustainable Development.

Lee, K. (2005). 'Catch-up: Barriers and Opportunities', *Asian Journal of Technology Innovation,* 13(2): 97–131.

Lema, R. (2012). 'The Decomposition of Innovation and China's Catch-up in Wind Power Technology', paper presented at the 10th Globelics Annual Conference, Hangzhou, China, Novr.

Lema, R., Berger, A., Schmitz, H. and Song, H. (2011). 'Competition and Cooperation between Europe and China in the Wind Power Sector', *IDS Working Papers*, 2011: 1–45.

Lema, R., Berger, A., and Schmitz, H. (2013). 'China's Impact on the Global Wind Power Industry', *Journal of Current Chinese Affairs,* 1/2013: 37–69.

Lema, R., Quadros, R., and Schmitz, H. (2012). *Shifts in Innovation Power to Brazil and India: Insights from the Auto and Software Industries*, Research Report, 73, Brighton: Institute of Development Studies.

Lewis, J. I. (2013). *Green Innovation in China: China's Wind Power Industry and the Global Transition to a Low Carbon Economy*, New York: Columbia University Press.

Luetkenhorst, W., and Pegels, A. (2014). *Stable Policies—Turbulent Markets, Germany's Green Industrial Policies: The Costs and Benefits of Promoting Solar PV and Wind Energy*, Research Report, Geneva: International Institute for Sustainable Development.

McDowall, W., Ekins, P., Radosevic, S., and Zhang, L.-Y. (2013). 'The Development of Wind Power in China, Europe and the USA: How have Policies and Innovation System Activities Co-evolved?', *Technology Analysis and Strategic Management,* 25(2): 163–85.

MAKE (2013). *Europe, Middle East and Africa (EMEA)*, Regional Report, MAKE Consult, Aug. Cited in 'De næste store vind-markeder boomer' (The next big wind markets are booming), Børsen, 20 Aug. 2013.

Mathews, J. (2012). 'Green China – Part I: Why Go Green?', *The Globalist,* 22 Nov.

Mathews, T., and Tan, H. (2014). 'China's Continuing Renewable Energy Revolution: Global Implications', *Asia-Pacific Journal,* 24 Mar.

Morrison, G., and Yoshida, P. (2009). 'China, United States, Korea Take Lead in Clean Energy and Low-Carbon Initiatives', *Research Technology Management,* 52(6): 2–4.

NAW (2014). 'Top 15 Wind Turbine Suppliers of 2013 Revealed', *North American Windpower*, <www.nawindpower.com> (20140311).

Qiu, Y. M., and Anadon, L. D. (2012). 'The Price of Wind Power in China during its Expansion: Technology Adoption, Learning-by-Doing, Economies of Scale, and Manufacturing Localization', *Energy Economics,* 34(3): 772–85.

REN21 (2012). *Renewables 2012: Global Status Report*. Paris: Renewable Energy Policy Network for the 21st Century, <http://ren21.net/Portals/0/documents/activities/gsr/GSR2012_low%20res_FINAL.pdf>.

Ru, P., Zhi, Q., Zhang, F., Zhong, X. T., Li, J. Q., and Su, J. (2012). 'Behind the Development of Technology: The Transition of Innovation Modes in China's Wind Turbine Manufacturing Industry', *Energy Policy,* 43: 58–69.

Schmitz, H. (2006). 'Learning and Earning in Global Garment and Footwear Chains', *European Journal of Development Research,* 18(4): 546–71.

Schmitz, H. (2015). 'Green Transformation: Is there a Fast Track?', in I. Scoones, M. Leach, and P. Newell (eds), *The Politics of Green Transformations,* London: Earthscan Routledge.

Schmitz, H., and Strambach, S. (2009). 'The Organisational Decomposition of Innovation and Global Distribution of Innovative Activities: Insights and Research Agenda', *International Journal of Technological Learning, Innovation and Development,* 2(4): 231–49.

Schmitz, H., Johnson, O., and Altenburg, T. (2015). 'Rent Management: The Heart of Green Industrial Policy', *New Political Economy,* forthcoming.

Sørensen, B. H., and Springborg, S. (2010). 'Sidste udkald for dansk vindindustri' (Last call for the Danish Wind Industry), *Berlingske Business*, <www.business.dk/energi-miljoe/sidste-udkald-dansk-vindindustri>.

Sturgeon, T. (2002). 'Modular Production Networks: A New American Model of Industrial Organization', *Industrial and Corporate Change,* 11(3): 451–96.

Venables, A. J., and Yueh, L. (2006). *The China Effect*, Centre Piece 208, Centre for Economic Performance, London School of Economics and Political Science, <http://cep.lse.ac.uk/pubs/download/CP208.pdf>.

Wang, Z. Y., Qin, H. Y., and Lewis, J. I. (2012). 'China's Wind Power Industry: Policy Support, Technological Achievements, and Emerging Challenges', *Energy Policy,* 51: 80–8.

Watson, J., and Wang, T. (2007). *Who Owns China's Carbon Emissions?*, Tyndall Centre Briefing Note 23, Norwich: Tyndall Centre.

Wieczorek, A. J., Negro, S. O., Harmsen, R., Heimeriks, G. J., Luo, L., and Hekkert, M. P. (2013). 'A Review of the European Offshore Wind Innovation System', *Renewable and Sustainable Energy Reviews*, 26: 294–306.

WWEA (2014). 'Statistics of Wind Power Development in China 2013', *WWEA Quarterly Bulletin,* 1 Mar.: 22–33.

Zeller, T., and Bradsher, K. (2010). 'Wind Power for Boston, Made in China', *New York Times*, 16 Dec.: B4.

Zhou, Y. C., Zhang, B., Zou, J., Bi, J., and Wang, K. (2012). 'Joint R&D in Low-Carbon Technology Development in China: A Case Study of the Wind-Turbine Manufacturing Industry', *Energy Policy,* 46: 100–8.