Catching a Second Wind  
Changing the Logic of International Cooperation in China’s Wind Energy Sector  

Björn Conrad & Mirjam Meissner  

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Executive summary

Challenge

China’s wind energy sector presents a vivid case of the fundamental dilemma of climate technologies. On the one hand, the rapid development and global dissemination of climate technology is highly desirable and necessary as part of an effective strategy to tackle global climate change. On the other hand, these technologies are commercial products, developed and sold by companies on a fiercely competitive market. The logic of climate protection favors the open exchange of technological expertise between corporations. Contrarily, the logic of the market sets narrow boundaries for the sharing of profit-making innovation. Finding ways to reconcile these two aspects will be a decisive challenge faced on the way to solving the global climate crisis.

The case of wind energy in China presents a crucial illustration of the effects of this dilemma. The development of international cooperative structures that are able to provide innovative answers to pressing climate challenges has been hampered by the perception of today’s partners as tomorrow’s competitors in an economic zero-sum game. Chinese players tried to use partnerships as a means to gain a technological edge without an intention to grant their partners a long-term stake in its domestic market. International business actors tried to use partnerships as a means to gain access to China’s domestic wind power market without any real incentive to improve their partners’ long-term technological advancement. Ultimately, neither side got what it wanted. As a result, China’s wind sector stayed below its potential regarding its contribution to global climate protection.

Opportunity

International cooperation could catch a second wind in China’s renewable energy sector. China’s wind market is on the verge of a new development phase heralding a possible shift in the logic of international technology cooperation; the times of China simply “catching up” to foreign technologies are coming to an end. To maintain its growth, China’s wind sector will depend on original technological solutions to manage mounting problems of efficiency, transmission and intermittency. Current technological obstacles threaten the swift expansion of China’s wind power capacity, putting the achievement of China’s ambitious renewable energy targets for the year 2020 at risk. This creates strong political pressure to explore viable solutions such as smart-grid transmission systems and offshore wind power generation. The technological bottleneck of its wind energy sector significantly increases China’s incentives to revisit structures of international cooperation as a means to create urgently needed innovation. This situation in
turn opens new opportunities for foreign political actors, specifically the European Union, to promote the emergence of cooperative structures that can make a tangible contribution to global climate protection.

From the business perspective, the growth of complementary capabilities between Chinese and international wind power companies increases the attractiveness of balanced and mutually beneficial partnerships. Chinese companies can benefit greatly from strategic alliances with international firms in their search for needed technological solutions, while foreign companies can take advantage of the uniquely favorable conditions that China offers for producing cutting-edge innovation in wind power technology. At the core of this mutually beneficial cooperative model lies the creation of shared innovation based on the joint exploration and joint ownership of original technological solutions. Joint development, however, requires a mode of cooperation radically different from the model of international partnerships that have characterized China's wind sector in the past. It calls for deep working relationships and long-term strategic alliances rooted in mutual interests. Looking at the sobering experiences of the past, both sides will have to radically break with the current logic of interaction in order to redefine international partnerships.

**Recommendations**

Seizing the opportunity to change the logic of international cooperation in China’s wind energy sector does not come without risk. Business actors on both sides will be reluctant to enter into comprehensive partnerships fearing that their engagement will follow the familiar unsustainable pattern of cooperation. Foreign companies will be concerned about sharing technological expertise without getting significant market entry in return. At the same time, skepticism about foreign companies’ willingness to share the latest technology and cooperate on an equal footing will result in Chinese companies being reluctant to provide entry points into the domestic market. Newly emerging incentive structures are currently opening a window of opportunity for breaking this vicious cycle, but change will not occur without decisive action. Both sides will have to credibly signal a fundamental change in approach in order to prepare the ground for new models of cooperation. In addition, governmental actors on both sides will have to play an active role in facilitating this development by providing additional incentives and minimizing possible risks for those companies willing to take the cooperative logic to the next level.

Based on the analysis of past mistakes as well as present opportunities, this paper outlines ways in which the emergence of a new model of international cooperation in China’s wind power sector can be facilitated by all parties involved. The recommendations specifically address four groups of actors: China’s political leadership, Chinese companies active in the wind sector, the European Union
(EU) as a political actor\(^1\) and European companies involved in the development, manufacturing and trade of wind energy equipment. The required change in the logic of international technology cooperation can only be achieved if all of these groups alter their current behavior with regards to three interlinked dimensions:

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**European Union**

- **Paradigm shift:** The traditional logic of one-sided development assistance is not suited for bridging the divide between market forces and climate protection with regards to climate technology cooperation. To foster advanced technology cooperation with China, the EU’s political strategy needs to move from a mindset of providing technical assistance to a paradigm of facilitating joint innovation.

- **Strategic investment:** In order to promote and facilitate the infant stage of new technology partnerships, the EU should provide targeted financial incentives in the form of research funds and subsidies tailored to support EU-China Research and Development (R&D) partnerships in strategic technology areas. A clear focus should be on areas where innovation is most needed and most beneficial, for example the development of technologies such as smart grid and offshore. Furthermore, public investments can facilitate the fledgling stage of new cooperative structures, providing incentives for business actors to engage in pilot projects and thereby demonstrating the viability of new forms of cooperation.

- **IPR management:** The focus on the creation of joint innovation with shared intellectual ownership significantly reduces foregone profit that arise through technology transfer between European companies and Chinese partners. However, some transfer of technological expertise will be necessary especially during the initial phase of collaboration. Currently, a fund to compensate

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\(^1\) The agglomerating view on the EU as a political actor is of course somewhat perfunctory. A discussion on the unity of the EU’s and the member states’ approach vis-à-vis China lies, however, beyond the scope of this paper. For the purpose of this analysis, the EU will be assumed to possess a reasonably coherent stance towards China’s wind power sector.
European companies

- **Paradigm shift:** European companies will have to move beyond the narrow perception of Chinese companies as competitors in a zero-sum game and expand their strategic approach to include long-term business partnerships. Strategic alliances are necessary in order to realize the benefits offered by the changing realities of China’s wind market. This is also true with regards to Chinese companies’ drive towards global markets. Chinese wind companies with low production costs will enter the global wind power markets sooner rather than later. While European companies will have to be mindful of their respective competitive advantages, their approach can be supplemented by strategic technology alliances with Chinese partners. Integrating Chinese companies into a network of business partnerships can smoothen the national edge of China’s going global strategy (Zhōuchūqū Zhànlùè) and help European companies manage increased global competition. European companies will have to move beyond the narrow perception of Chinese companies as competitors in a zero-sum game and expand their strategic approach to include long-term business partnerships. Strategic alliances are necessary in order to realize the benefits offered by the changing realities of China’s wind market.

- **Strategic investment:** China offers a “technology laboratory” equipped with strong political backing and public funding, a large pool of well-educated engineering talent, and few geographical or regulatory limitations. European companies should embrace this opportunity by investing in advanced R&D partnerships with Chinese counterparts. Again, the focus should be on clearly defined technology areas where the “China laboratory” will be most complementary to the European capacities and therefore maximize both sides’ innovation capability.
IPR management: Despite the focus on shared innovation and joint ownership, the creation of new forms of EU-China technology cooperation in the wind sector will require some degree of initial technology sharing to put both sides on an equal footing and maximize the overall benefits. In the defined areas, the forgone profits can be kept to a minimum if the Chinese side delivers its part of the bargain (see section on China’s political leadership & Chinese companies). In addition, a limited innovation compensation fund (see section on European Union) could reduce remaining disadvantages. As a matter of principle, European companies will have to start accepting these technology transfers as a worthwhile investment into a partnership with considerable potential for long-term benefits. As described above, public investment from both sides will have a role to play in facilitating the initial phase of trust-building pilot projects.

China’s political leadership

Paradigm shift: An adjustment of the regulatory framework of domestic competition is an essential prerequisite for the emergence of a new cooperation model. Thus far, the rules of competition have effectively shut out international actors from large segments of China’s wind market. But China’s strategy of protecting domestic industry at all costs in order to grow national champions produces diminishing returns. Chinese manufacturers need less protection; they will have to face global competition in the future and can increasingly benefit from advanced technology cooperation with international partners. At the same time, profit-making opportunities in China’s domestic wind market remain the main incentive for international companies to engage in these partnerships. Therefore, China’s leadership will have to make a credible effort to change regulatory practices in order to provide a more level playing field and convince European companies that advanced cooperation with Chinese partners will indeed open improved business opportunities in the Chinese domestic market.

Strategic investment: China’s political leadership has demonstrated its willingness to invest significant amounts of public funding in the development of its wind sector in general, as well as in particularly crucial technologies such as grid and offshore. Mirroring EU financial support for EU-China R&D partnerships in strategic areas, China will have to specifically channel some of these funds into advanced international technology cooperation, simultaneously facilitating the initial phase of development and demonstrating its commitment as a stakeholder.

IPR management: The changing technological needs of Chinese wind sector companies lowers the danger of IPR infringements. Nevertheless, the utilization of sensitive expertise by Chinese partners will remain one of the main inhibitions for European companies to invest in technology partnerships. While legislative
stipulations are in place in China to ensure responsible handling of IPRs, their implementation has been selective and unreliable in the past. To pave the way for balanced technology cooperation, China’s political leadership will have to step up its commitment to uncompromising IPR protection especially with regards to R&D partnerships in the identified technology areas.

**Chinese companies**

- **Paradigm shift:** Chinese companies will also have to move beyond their narrow focus on short-term technology acquisition as the main incentive for international partnerships. The new challenges Chinese wind power companies face will not be solved by quick technology transfers, but by the development of original technology solutions. In this, complementary abilities and capacities of Chinese companies and experienced international partners will prove to be a valuable asset. In addition, long-term strategic alliances with international counterparts can serve to prepare Chinese companies for their gradual entry into global wind energy markets.

- **Strategic investment:** Chinese companies will have to match the investment of EU partners in R&D partnerships in strategic technology areas. In return for realizing the benefits of international partnerships in terms of technological advancement, Chinese companies will have to ensure that the advantages of the “China laboratory” are fully available and accessible to their European counterparts.

- **IPR management:** Chinese companies will have to do their part in bridging the significant trust gap relating to the handling of IPRs. They will have to clearly demonstrate that they have altered their strategic outlook on technology transfer and that they actively promote the security of the sensitive information that is exchanged within the framework of the technology partnership. The structures and legal stipulations governing cooperation will have to strictly address IPR protection issues.

China’s wind power sector can potentially exemplify the ability of international cooperation to simultaneously achieve climate protection whilst maintaining business interests. As this analysis sets out to illustrate, the incentives of all actor groups are favorable for an adjustment of the fundamental logic of cooperation in China. The chance for a mutually beneficial change of paradigm exists. However, starting from the deeply entrenched precedent of flawed structures and sobering experiences, means that all parties involved will have to undergo major changes in their approaches in order to facilitate the creation of a mature model of cooperation. There can be no illusion that it will be an uphill battle that requires a determined approach. Despite the challenges, the potential benefits, calculated in CO₂ reductions, Euro and Yuan, leave no doubt that cooperation is a worthwhile endeavor.
Introduction

At the beginning of the new millennium, China took the momentous decision to fundamentally restructure its energy production system over the next decades. The political will to expand China's renewable energy sources is powerfully driven by a combination of motives. These range from considerations on energy security and international reputation to concerns about China's own vulnerability to the impacts of climate change as well as the desire to shift China's economic model onto a development path of technological advancement and global competitiveness. The interplay of these interests culminated in the announcement of China's renewable energy law of 2005. The corresponding policy targets stipulated an increase in non-fossil-fuel sources to a level of 15% of China's primary energy consumption by 2020. Furthermore, 3% were to be non-hydro renewable sources. The guideposts for a major energy shift were set.

Wind energy plays a central role in this transition. Due to its price advantages, moderate technological prerequisites and resource abundance, the expansion of installed wind power capacity quickly became the most dynamic aspect of China's renewable energy strategy. Facilitated by extensive government incentives and subsidies as well as corresponding legislative measures, China's production of wind power has witnessed an unprecedented growth during the last decade. Installed capacity has increased from 0.34 GW in 2000 to 25.8 GW in 2009, ranking China second in the world in installed capacity after the United States. China's official estimates for 2020 call for an installed capacity of approximately 150 GW.

During the initial phase of rapid growth, international wind turbine manufacturers dominated China's wind energy market. This picture changed with the emergence of Chinese state-owned enterprises in the turbine sector. Foreign companies expressed concern about the safety of intellectual property rights while the Chinese leadership implemented a strategy of incentives for domestic innovation and protection of rising national champions. The combination of these two factors stifled the emergence of stable cooperative structures between international and Chinese market players. Consequently, the importance of foreign companies in China's wind energy market drastically declined. Favoring low manufacturing costs, market regulations and government subsidies, the rapidly growing Chinese competitors reduced the installed capacity market share of foreign turbine manufacturers to approximately 35% by 2008. By 2009 international companies supplied only 13% of newly installed capacity.

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6 Li et al. (2010)
In hindsight, this first phase of wind energy development marks a lost opportunity to explore sustainable models of collaboration between international and Chinese market players. This could have yielded economic benefits for all sides as well as furthered global efforts to move away from fossil fuels. Instead, the fundamental dilemma of climate technology markets, the dichotomy between a global public interest in international cooperation with extensive sharing and dissemination of climate technologies and the opposing logic of competitive markets to protect domestic industries and safeguard technology expertise and profits, shaped the development of China's wind sector. China's wind energy market could have served as an example for an internationally coordinated effort to facilitate a fundamental energy transition, going far beyond the low-hanging fruits of energy savings and efficiency covered by the Clean Development Mechanism (CDM). But both sides, careful to protect immediate commercial interests, were not prepared to prominently include considerations of advanced climate cooperation in their calculations.

However, international cooperation might catch a second wind. China's wind market is on the verge of a new development phase rendering a shift in the logic of international technology cooperation possible. Wind power expansion in China is approaching a serious bottleneck that cannot be cleared within the current structures of international interactions. The traditional difficulties of wind power, namely storage and transportation, are particularly pronounced in China's wind sector characterized by a strong geographical separation of supply and demand. Given the insufficiency of the power grid and technological barriers to the expansion of offshore wind power, China's wind strategy faces severe technological obstacles that have already begun to impair capacity expansion. In light of the ambitious 15% renewable target against which China’s leadership will be measured in 2020, this bottleneck creates significant political pressure.

The current situation in China’s wind sector opens a new window of opportunity for moving towards a mature model of international cooperation. Faced with mounting technological challenges and increasing time pressure, the benefits of soliciting foreign input are especially high for China’s leadership from now until 2020. However, the flawed cooperative structures of the past, geared toward catching-up with foreign technology by all available means, will no longer yield the results China needs. The challenges China faces today necessitate the development of original technology solutions that are not yet fully developed anywhere in the world. International technology partnerships can play a crucial role in producing the innovation needed to move China's wind development forward. However, creating shared innovation through international collaboration requires mature forms of partnership geared towards utilizing the emerging complementary capabilities of Chinese and international companies. Business as well as political actors on both sides will have to undergo a profound paradigm shift before they will be able to embrace the long-term strategic alliances requisite for joint technology development.
Based on the assessment of past shortcomings, present opportunities and consciousness of political and economic realities, interests and concerns on both sides, this analysis presents recommendations to move towards a mature model of cooperation in China’s wind energy sector. The first part of the study will present the underlying political motives behind China’s broader renewable energy strategy (chapter 1), trace the evolution of China’s wind sector (chapter 2), and identify the dynamics that led to the failed creation of sustainable structures for international cooperation (chapter 3). The second part will focus on the current turning point and the factors that will shape China’s future wind market, describing the opportunities associated with the technological bottleneck (chapter 4), and the potential benefits of international cooperation (chapter 5). Finally, the study will put forward policy recommendations for the European Union, European companies, China’s political leadership and Chinese companies that envision transforming the logic of international technology cooperation in China’s wind sector (chapter 6).
Part 1

1. Context: motives of China’s renewable energy strategy

China’s 2005 “Renewable Energy Law” was a defining milestone of China’s evolving energy strategy. Within a few years, China’s political leadership had turned the expansion of its renewable energy sector into one of the country’s foremost political ambitions. However, the initial task looked daunting. While hydro power was a traditionally significant component of China's energy mix, contributing 6% of total energy consumption in 2006, all other renewable sources excluding nuclear, only accounted for 0.06%. In light of China’s relentlessly increasing energy demand, the target of non-hydro renewable sources reaching 3% of all energy consumption by 2020 represented a dramatic shift in China's long-term energy planning.

Recognizing the underlying interplay of motives that drives China’s broader renewable energy strategy is a fundamental prerequisite for understanding China’s wind power sector. As such, the following section presents a brief overview of the main considerations of China’s renewable energy policy in order of their emergence: energy dependence and supply security; international reputation; climate change vulnerability; and green technology development. With regards to the wind power sector, each motive’s relevance changed with time. Upon chronologically tracing the evolution of China’s wind power sector in Chapter 2, each of these motives will emerge and their influence on the wind sector’s development will be illustrated. During the last decade, China’s political wind energy strategy has been driven by a powerful combination of all four of these motives.

Energy dependence and supply security

Since the onset of economic opening and reform period in the late 1970s, China’s exploding energy demand has been increasingly at odds with its coal-dominated endowment of fossil fuels and its corresponding lack of oil and gas reserves. Especially after China became a net oil importer during the early 1990s, its growing dependence on foreign fuel and related concerns about the security of energy supply rose to the top of the political agenda. Today, China is the world’s largest energy consumer. It is also a net importer of both oil and coal - the latter of which is the country’s most abundant fossil fuel. Despite an annual domestic production of

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8 Ibid.
more than 3 billion tons, official estimates for China’s 2010 net coal imports are as high as 100 million tons.9

Given China’s unflagging economic growth, its appetite for energy resources seems insatiable. China’s energy demand has far outpaced its domestic supply capacities. Its efforts to secure energy supply from abroad, for example in Africa, is a cause of increasing international tension. Consequently, the motivation for diversification of China’s energy mix and expansion of its domestic power generation capacity has never been greater. This situation provides a powerful incentive for the development of alternative energy sources. Wind power represents a largely untapped yet abundant energy resource that is relatively inexpensive to utilize. Consequently, next to hydro and nuclear power, wind energy has become one of the main components of China’s energy diversification strategy and long-term energy supply security.

International reputation

For China, international climate negotiations have turned from a playground into a mine-field. China’s initial participation in the United Nations Framework Convention on Climate Change (UNFCCC) in the early 1990s was driven by the necessity to present itself as a constructive member of the international community, especially in light of international condemnation of the 1989 Tian’anmen crackdown. During the following decade, China’s involvement in the UNFCCC framework was significantly shaped by its desire to be an active stakeholder in the international system and to strengthen its position as an advocate and leading nation among developing countries. China’s main objective in the international climate arena was to cement its role within geopolitical structures and to maintain an international environment that would not disrupt its domestic development path.

At first, mere participation in international negotiations was for the most part sufficient for China to achieve these objectives. However, the dramatic rise in its CO2 emissions made the international climate game more difficult for China. As a result, China faced growing international pressure to take a more active role in global emission reductions. Furthermore, China found itself caught between the contradictory roles of being both an advocate to the developing world and a major climate culprit. Resultantly, climate negotiation has turned into a source of continuous international tension for China. This was clearly illustrated at the 2009 climate negotiations in Copenhagen, where China faced criticism from developed and developing countries alike. In order to minimize these effects, China has begun to more actively seek international acknowledgment for its climate efforts. Dramatically expanding its installed wind power capacity is one

way for China to garner international recognition in the climate change arena and thereby reduce international pressure.

Climate vulnerability

Advances in climate science have heightened the Chinese political leadership’s awareness regarding the threats of global warming to China. Climate impact research consistently singles out China as one of the regions most vulnerable to climate events, specifically flooding and droughts. The risk of such disasters carries implications for China’s long-term economic growth as well as its social and political stability. Published in 2006, China’s first National Assessment Report on Climate Change\(^\text{10}\) provided an extensive overview of the potentially devastating consequences of climate change on China’s agriculture, ecosystems, water resources, coastal zones and social and economic stability\(^\text{11}\). Consequently, the Report brought “public concerns and awareness of climate change to a new height”\(^\text{12}\).

With growing awareness of its climate vulnerability China developed a stake in the reduction of greenhouse gas emissions, changing China’s corresponding objectives on domestic and international levels. This shift resulted in, inter alia, a more ambitious political effort to reduce the carbon intensity of China’s domestic economy. This is most clearly embodied in the 2009 carbon intensity target of a 40-45% reduction on 2005 levels by 2020. The adjustment of China’s energy mix to reduce carbon intensive power generation by coal burning (70% of total energy consumption in 2006), represents the centerpiece of China’s emission mitigation policies. The 2005 “Renewable Energy Law” and subsequent renewable energy targets have to be interpreted in the context of overarching carbon intensity reduction targets. Wind energy was quickly identified as an affordable renewable energy source with significant short-term growth potential, and as one of the most promising instruments for achieving desired emission mitigation effects, adding an additional motive to the set of interests driving China’s wind sector expansion.

Green technology development

In recent years, the development of advanced green technologies has become a priority of China’s political strategy as articulated in the canon of official development plans and guidance documents. This prioritization reflects the

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10 Commissioned by the Ministry of Science and Technology, the China Meteorological Administration, and the Chinese Academy of Sciences


“recognition that by investing in a green economy and green growth underpinned by emerging green technologies, China has an opportunity to leapfrog over decades of traditional development based on high-polluting fuels”. The development model China has been following since the beginning of the opening and reform era, based on low-key manufacturing and export of resource and labor intensive goods, is unsuitable to secure China's continued economic growth. The mid-term viability of China's growth path depends on its leadership's ability to move the economy up the value chain into the next stage of economic development. Accordingly, the “change of China's economic development pattern” has been highlighted as one of the main themes of the upcoming 12th Five-Year-Plan.

One crucial component of the necessary economic transformation is the ability to produce technologically advanced and internationally competitive goods for export to global growth markets. Instead of focusing on traditional technologies and trying to catch-up to the developed world's decade-long head-start, China's leadership has embraced green innovation as a means to leapfrog traditional development and quickly compete on global markets. In China's policy planning, the “green economic revolution” has already begun and, in contrast to the industrial revolution of the 19th century, China plans to be ahead of the curve this time.

Alternative energy technology, specifically wind energy, represents a core building-block of this advancement strategy and has been continuously highlighted as one of seven strategic industries, earmarked to produce technology innovation. The direct link between wind technology development and the overarching motive of economic transformation not only provides powerful interest in the expansion of China's wind sector, but also shapes development in a specific way. Accordingly, the role of wind technology as a crucial component of China's overall development strategy will be of particular importance throughout this analysis.

The combination of these four motives that reflect some of the China's most fundamental contemporary challenges, provides a powerful incentive for the rapid expansion of China's installed wind power capacity. However, this study will also illustrate that the underlying motives shape, and at times limit, the way in which this expansion is carried out. Any attempt to build lasting and mutually beneficial structures of international cooperation in China's wind sector will have to recognize these underlying factors in order to utilize the resulting dynamic and simultaneously manage the corresponding limitations.

14 “转变经济发展方式” - see for example: Website of the Central People's Government of the PRC (16 October 2010): “十二五期间加快转变经济发展方式的重要着力点” (The 12th Five Year Plan accelerates the change of important aspects of the economic development pattern), http://www.gov.cn/jrzg/2010-10/16/content_1723905.htm
2. Evolution: policy measures and market development

In 1986, the Danish wind turbine manufacturer Vestas imported three 55kW wind turbines to China, equipping China’s first wind farm in Shandong province. Initiated by the provincial government and the Ministry of Aeronautics Industry but paid for by foreign grants, this pilot project marked the modest beginnings of China’s on-grid wind power sector. During its infancy, the development of wind energy in China was entirely based on foreign technology imports from donor countries. On the Chinese side, none of the motives outlined above had translated into a significant political dynamic towards non-hydro renewable energy development. Thus, due to a lack of corresponding interests, no political efforts were made to develop domestic on-grid wind technology or manufacturing capabilities. This picture only gradually started to change a decade later.


In 1995, China’s government issued the “New and Renewable Energy Development Plan 1996-2010”. This document mandated the first expansion of installed wind power capacity in China, setting a target of 300-400MW by the year 2000. While the motives of energy security and protection of China’s international reputation despite growing CO₂ emissions played a role in these initial steps to accelerate renewable energy development, the articulated political objective of wind power expansion was the electrification of remote rural areas. During this primary phase of China’s wind sector development, the relatively limited strategic importance attached to the wind power industry opened an opportunity for foreign companies to attain a dominant role in the Chinese market.

Due to the lack of technological expertise and manufacturing capabilities on the Chinese side, the mandated expansion of installed wind capacity remained highly dependent on foreign imports of wind power equipment. Accordingly, China’s government decided to promote necessary imports through the exemption of grid-connected wind turbines from customs duty. However, China’s political leadership had already initiated multiple incomplete attempts to facilitate the creation of domestic production capacity. As early as 1997, the State Development and Planning Commission introduced the “Riding the Wind Program”. This program aimed to establish joint ventures between Chinese and foreign wind...
energy companies in order to introduce and adapt foreign technology as well as to achieve a local production rate of 60% by 2000. While the objective of localizing manufacturing remained a main political concern in China’s wind power strategy, the initial attempts to create joint ventures were unsuccessful. Undermined by the countervailing system of import subsidies that provided international companies with a more attractive way to supply the Chinese market, the “Riding the Wind Program” resulted in only two joint ventures, one with the German wind turbine manufacturer NORDEX and the other with MADE (Spain).17 Neither joint venture was able to establish a lasting market presence.

In order to achieve the target of 300-400MW installed capacity, Beijing implemented the “Shuangjia” project from 1996 to 1998, which channeled preferential loans through the State Economic and Trade Commission (SETC) into four wind farms in Xinjiang, Inner Mongolia, Zhejiang and Hebei. In combination with the initial 1995 Chinese power purchase agreement for wind power, the “Shuangjia” project resulted in a short-term boom of wind power installation between 1996 and 1997 with annual growth rates of over 100%. In 2000, the installed wind power capacity reached 344MW. The short-term surge thus secured the achievement of the 300-400MW target under the “New and Renewable Energy Development Plan 1996-2010”.

![Figure 1: Cumulative and annual installed capacity of wind power 1995-2006 (Li et al. 2007)](image)

17 MADE was bought by the Spanish manufacturer Gamesa in 2003.
Typical for early wind sector development in China, the “Shuangjia” project was an ad hoc, top-down policy measure that was primarily geared towards and ultimately succeeded in meeting short-term political targets, but did not contribute to the sustainable development of a domestic wind energy sector. Overall, contradictory policy measures and insecure investment incentives kept domestic manufacturing capabilities low and prevented a more rapid expansion of China’s wind energy sector in this first phase of development. This changed when the motives described in Chapter I began to exert a more direct influence on China’s wind energy strategy.

Phase 2: growing strategic importance of renewable energy (2000-2006)

The new century brought a number of decisive changes for China’s wind energy sector. Two of the motives described above, namely energy supply security and the desire to use wind technology as a building-block for broader economic transformation, started to shape China’s wind energy policy more directly as is evident in the adoption of two important policy plans: the “New and Renewable Energy Industry Development Plan 2000-2015” and the “10th Five Year Plan or the Development of New and Renewable Energy”, released in 2000 and 2001 respectively.

The two plans marked a turning point in the development of China’s wind power sector. The newly emerging political framework put an explicit focus on renewable sources as a means to improve energy security and limit China’s dependence on foreign energy resources. Even more momentous was the emerging motive of strengthening domestic capacities for green technology development. The creation of a domestic wind power manufacturing industry quickly became the top priority within this changing political framework, reflecting the recognition that advances in green technologies offered a promising way to drive the desired changes in China’s economic growth pattern. The “New and Renewable Energy Industry Development Plan” made the explicit request that the “[...] majority of electronic components for [grid-connected] wind power systems should be nationally manufactured and technical standards as well as operation quality should meet the standard of comparable international products [...]”. While the political plans did not neglect the importance of international cooperation and technical assistance, the main objective was to actively support and protect a national industry with domestic manufacturing capabilities and a high localization rate of production processes. China was determined to use its competitive advantage of low production costs to make wind energy affordable in a country reliant on cheap energy sources.

Simultaneously, the first attempts to develop home-grown technology innovations were initiated. On-grid wind projects were included in the national technology programs that provide significant public funding for R&D efforts of national importance.\(^\text{19}\) The “New and Renewable Energy Industry Development Plan 2000-2015” articulated the target of “establishing famous trademarks with own intellectual property rights and strengthening wind technology R&D”.\(^\text{20}\)

While environmental issues were not yet of primary concern for political leaders, the “10th Five Year Plan for the Development of New and Renewable Energy” already illustrated the emergence of an environmental agenda by including sustainability as an aspect of China’s energy policy. The increasing awareness of environmental issues as a threat to social and political stability, especially the changing perceptions of climate change, gradually began to be reflected in the political framework for renewable energy development.

The 2002 power sector reform generally reiterated the increasing political emphasis on China’s wind energy development whilst particularly focusing on the promotion of Chinese technological capacities. In the course of the reform, the rigid framework of the highly monopolized power sector was broken up. Prior to that, the State Power Corporation (SPC) controlled 46% of China’s power generation and 90% of China’s grid facilities, as well as serving as the umbrella organization for all provincial power companies. With the aim to establish a competitive electricity market and to separate plant and grid, the SPC was now split into 6 power generation companies\(^\text{21}\) and 2 grid companies with several regional subsidiaries.\(^\text{22}\) Until today, these companies are ultimately controlled by the state, but also have significant influence on the political decision-making process on their part.\(^\text{23}\)

\(^{19}\) MOST et al. (2002): p.49


\(^{21}\) China Huaneng Group, China Datong Generation Group, China Huadian Group, China National Power Group, China Power Investment Group, and North China Power Group

\(^{22}\) State Grid Corporation of China and China Southern Power Grid Corporation

\(^{23}\) Downs (2008)
As part of this 2002 energy sector reform, a new pricing model for the wind power sector was introduced. Aimed at lowering production prices and promoting more efficient local production and innovation processes, the new policy was organized in a bidding format led by the National Development and Reform Commission (NDRC). Initially, the consortium offering the lowest price per kilowatt hour of power produced at the tendered wind farm won the concession. However, in order to win concessions the mostly state-owned companies offered extremely low and clearly loss-making prices for wind electricity that did not reflect real production costs. Consequently, many of the wind projects awarded through the bidding process were either not built at all or lacked the installed wind capacity to reach originally planned output levels. Consequently, adjustments were made during an evaluation phase from 2005 to 2007. Since 2007, the concession went to the bidder with the price closest to the average of all bids put forward after exclusion of the respective lowest and highest bid. Through this system, the NDRC hoped to award concessions to realistic and deliverable bids.

Despite the changes, bids of international firms remained 50-70% higher than the prices of Chinese competitors, leaving the former no chance of winning concessions under the bidding system. In line with the political objective to strengthen the national wind industry and to localize manufacturing, the 2002 pricing mechanism represents an insurmountable entrance barrier for international wind companies vying for a share of the Chinese market. This effect was further strengthened by the additional criterion for participation in the bidding process that stipulates a local manufacturing requirement of 50% from 2002-2004 and 70% from 2004-2009. This requirement practically forces interested foreign firms to produce locally in China. The extraordinary high growth rates of installed wind power capacity in China demonstrate the enormous impact of the new political framework. An average growth rate of 68.7% between 2003 and 2006 led to an installed capacity...
of 2.6GW in 2006 (see figure 1). At the same time, foreign wind turbine manufacturers rapidly lost ground. Foreign market share in newly installed capacity dropped from 75% to 13% between 2004 and 2009 with Joint Ventures playing a negligible role. Chinese wind power companies, backed by political interests and government regulations, were obviously taking their home turf by storm.

**Figure 3: Comparison of Newly Installed Capacity Market Share between Domestic and Foreign Companies in the Chinese Wind Power Market (Li et al. 2010: p.37)**

**Phase 3: from local manufacturing to the “China laboratory” (since 2006)**

In 2005, the State Council issued the “Renewable Energy Law” representing a comprehensive legal framework for the further development of China’s renewable energy industry and marking the beginning of the current phase of wind energy development in China. Besides the “Renewable Energy Law”, two important political plans underline the growing importance of renewable energy for the government’s political strategy since 2006: the “11th Five Year Plan for New and Renewable Energy Development” and the “Medium- and Long-term Renewable Energy Development Plan”, both implemented by the NDRC.

Within the adjusted legislative and political framework, considerations on China’s climate vulnerability were articulated more prominently. The replacement of fossil energy sources was explicitly defined as an objective of renewable energy expansion constituting a significant political step. China, which had internationally fallen into disrepute as one of the world’s biggest CO2 emitters, officially announced the pursuit of carbon-reduced development. Wind energy expansion is given a major role in China’s plans to achieve these ambitions. Besides large-scale on-grid wind turbines, the development of off-shore wind parks and corresponding technologies is now, for the first time, explicitly included as part of the political
strategy. In addition, wind power science and technology (S&T) development plays a dominant role. The two mentioned policy plans for renewable development explicitly identify intensified S&T improvement as the main factor for successful wind power expansion and call for Chinese domestic innovation to strengthen the country’s competitiveness in this field, officially marked as a key priority within the “Medium- and Long-term S&T Development Plan”. Following the motive of green technology development, wind technology was declared one of the strategic technologies in China’s overall economic transformation strategy.

By now, the powerful combination of political motives driving China's climate policy agenda was in full swing. The corresponding push for renewable energy development was substantiated in form of ambitious quantifiable targets. The Renewable Energy Law requires that “the energy authorities of the State Council set medium- and long-term overall targets for the development and utilization of renewable energy at the national level, which will be implemented and released to the public after being approved by the State Council”\(^24\). In 2007, the NDRC defined a 10% renewable energy target by the end of 2010 and a long-term target of 15% in 2020. At that time, the contribution of wind energy was estimated to be 5GW in 2010 and 30GW in 2020.\(^25\) However, since the overall renewable targets are courageously defined as a percentage of overall energy consumption, China’s exploding energy demand dramatically increased the dimensions of required renewable energy expansion and with it the necessary amount of additional wind power capacity. By now, government officials estimate that the wind power capacity could reach 150GW by 2020.\(^26\) This is necessary to sufficiently contribute to the increasing renewable energy target tied to massively growing energy consumption. At the end of 2009, the official consumption rate of renewable energy was 9.9%. But in light of a continuous rise of energy demand and increasing difficulties to keep the rate of renewable expansion, the 15% target by 2020 constitutes an even greater challenge than originally expected.\(^27\) Both the ambitions and instruments of China’s wind power development had to be adapted accordingly.

The political necessity to sustain very high growth rates for China’s newly installed wind power capacity started to alter the approach towards the role of foreign wind power equipment manufacturers. During the previous phase of wind sector development, the protection of the domestic industry from outside competition was of overriding importance. However, with growing political pressure for swift capacity expansion, the potentially positive growth effect deriving from foreign companies’

\(^{24}\) "国务院能源主管部门根据全国能源需求与可再生能源资源实际状况，制定全国可再生能源开发利用中长期总量目标，报国务院批准后执行，并予公布”， Renewable Energy Law: §2.2

\(^{25}\) Medium- and Long-term Renewable Energy Development Plan: §4.3

\(^{26}\) Li et al. (2010): 77

engagement in China’s wind market became more pertinent. Consequently, in June 2006, the Ministry of Finance released the “Provisional Administrative Measures on the Renewable Energy Development Fund”, providing financial aid and loans with discounted interest rates to domestic as well as foreign-owned enterprises in the renewable sector. The inclusion of foreign-owned enterprises in this policy mechanism can be interpreted as an attempt to at least partially revive the role of foreign players as catalysts for swift capacity expansion, mirroring the situation at the beginning of China’s wind sector development. The abolition of the local manufacturing requirement for participation in wind power tenders in November 2009 underlined this trend. The gradual softening of market entry barriers for foreign firms also reflects the growing maturity of China’s wind turbine manufacturing industry and a decreasing need to protect the domestic companies from foreign imports of technology and equipment.

On the other hand, China’s political leadership was not prepared to completely abandon preferential treatment of its domestic wind power industry. Since 2008 the “Special Fund for the Industrialization of Wind Power Manufacturing Sector in China” has exclusively supported Chinese-owned companies. Funding is available for R&D of large-scale (1.5MW and above) wind turbines which feature Chinese patents, are certified by the China General Certification Center and consist of Chinese made blades, gearboxes and generators. Aiming towards home-grown innovation, the “Special Fund” is a measure to accelerate technological innovation and to strengthen the global competitiveness of Chinese-owned wind companies. Domestic wind energy companies also continued to be favored by the amendment of China’s taxation system in 2008. In the “China Corporate Income Law”, the wind industry is explicitly categorized as an encouraged industry. Domestic wind power companies therefore benefit from tax reductions as well as VAT and import tax rebate on imported wind turbine components. Expenses for R&D that are eligible for “super deduction” are permitted a tax deduction of up to 150% of related expenses. In 2007 import promotion measures for the wind turbines described above were limited to wind turbines with a capacity of more than 2.5MW by the first amendment of the Renewable Energy Law. Since April 2010, only imports of wind turbines over 3MW capacity are exempted from import taxes.29

In order to promote overall wind capacity growth, the wind energy pricing system was once again adjusted in favor of wind power producers in 2009. A “Circular on the Establishment of Feed-in Tariffs for On-grid Wind Power Projects” by the NDRC officially proclaimed the introduction of a feed-in tariff for wind power in August 2009. The regulation defines four price-regions with different wind power tariffs corresponding to regional wind power potential, the lowest being 0.51RMB (Inner Mongolia, Xinjiang et al.) and the highest being 0.61RMB per kWh.

Additionally, the latest amendment of the Renewable Energy Law now mandates a state-guaranteed purchase of all renewable energy generated electricity. The new feed-in tariffs mark a gradual shift towards a more competition-based approach to wind power development. While the former concession model cemented the dominance of large state-owned enterprises (SOEs) in China’s wind power sector, the feed-in tariffs and purchasing guarantees also allow private-owned companies to compete for market shares.

Figure 4: Regional divisions for feed-in tariff in China (Li et al. 2010: p.47)

3. Impediments: unsustainable models of cooperation

The evolution of China’s wind energy market is neither a success story for foreign business interests nor for efforts to establish mutually beneficial structures of cooperation between Chinese and international players. Initially, the dynamic development of China’s wind sector seemed to offer ample incentives for both sides, favoring significant involvement of foreign companies. However, the sharp drop in foreign companies’ market share after 2000 and the insignificance of international joint ventures due to further development of China’s wind market painted a very different picture. Evidently, the incentives for the establishment of sustainable collaborative structures were superseded by interfering considerations that effectively prevented the creation of a mutually beneficial model of international cooperation. The potential deal, offering quick technological advancement in return for market access, did not materialize.
Market access
The Chinese government’s attempts to balance the protection of its domestic industry from foreign competition against the positive effects of foreign companies’ involvement have shaped the regulatory framework of China’s wind power market. During the infant stage of China’s wind sector development, when wind power had not been elevated to an issue of high political priority, international engagement represented a cost and time effective way of expanding installed capacity and introducing new wind power technologies in China. With the growing importance of wind energy as a strategic technology of China’s long-term economic planning, the objective of fostering domestic innovation capacity and technological independence moved to the center of its strategy. As a result, the corresponding regulations, from high local content rates to the different pricing models as delineated above, created a highly uneven competitive environment. This effectively excluded foreign-owned companies from direct market participation. The protective market structures represent one of the central impediments to the emergence of collaborative structures in China’s wind energy sector.

After 2000, the tightly regulated avenues for international entry into China’s wind sector were effectively limited to technology licensing and joint ventures. The latter was utterly unsuccessful, primarily due to foreign companies’ reluctance to engage in the comprehensive sharing of intellectual property with Chinese partners. Yet the former became the most common model of international cooperation in China’s wind energy sector. Under licensing agreements, Chinese manufacturers produce wind power equipment with a foreign company’s technological design and pay royalties to the license giver. However, foreign companies only license older designs to Chinese manufacturers, whilst withholding the distribution of cutting-edge technology. The contribution of licensing agreements to the advancement and dissemination of effective climate technologies and the corresponding positive effects for global climate protection are accordingly limited. In addition, given the technological advancement of Chinese wind power equipment companies, the returns for China’s business actors from licensing agreements are quickly diminishing, making this only remaining form of international cooperation on China’s wind market increasingly obsolete.

Intellectual property rights
The vast potential for profit-making ensures the continuous attractiveness of China’s wind market for foreign companies despite setbacks and disappointments. As Lie Huihan of Suzlon Energy (China) put it: “Whatever the circumstances are, not being here is just not an option.” Yet the necessity to protect their innovative edge puts limits on international companies’ willingness to engage in comprehensive partnerships with Chinese counterparts. Especially in a relatively
young business sector like wind energy, where international competition is shaped by rapid technology improvements and large competitive advantages through innovation, cutting-edge technology represents the basis for success. Therefore, concerns about IPR infringements (see box 1) have significant influence on international companies’ business decisions when it comes to entry into the Chinese wind market. Foreign firms cautiously avoid introducing sensible and up-to-date technology to China and have been reluctant to locate R&D activities in China. More recently, concerns about safeguarding technological advantages have been intensified by the prospects of Chinese manufacturers starting to export to markets outside China, making them global competitors. In light of these concerns, joint R&D projects between foreign and Chinese wind firms are exceedingly rare thus far. Given the Chinese side’s strong focus on technology advancement as the primary benefit of international cooperation, this dynamic significantly limits the scope of workable international collaboration in China’s wind sector.

### BOX 1 | UNDESIRABLE IPR TRANSFER IN CHINA

<table>
<thead>
<tr>
<th>1. Forced cooperation:</th>
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<tr>
<td>Undesired transfer of intellectual property in China often occurs through business cooperation forced by the Chinese market’s regulatory stipulations. In several industrial sectors, most prominently the automobile industry, market entry for foreign firms is only possible through a joint venture with a Chinese company that includes sharing technological information. In China’s wind sector, joint ventures are not mandatory, and wholly foreign-owned enterprises (WFOE) are admitted to compete on the Chinese market. Foreign wind power equipment companies, driven by concerns about forced technology transfers, almost exclusively choose this option. However, other regulatory stipulations such as public procurement procedures practically exclude WFOEs from large segments of the Chinese wind power sector, heavily constricting international players.</td>
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<th>2. IPR infringements:</th>
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<tr>
<td>Technology theft is another concern to foreign wind equipment producers active in China. However, the ease of copying of product designs that characterizes IPR infringements of textiles and other consumer goods does not equally apply to complex industrial products like wind turbines. IPR infringement in the wind power industry requires comprehensive industrial espionage. Thus far, no official charges of industrial espionage in the Chinese wind power equipment industry have been put forward by foreign firms. One mechanism potentially increasing foreign companies’ vulnerability to industrial espionage is the local content requirements that force foreign firms to produce locally in China. However, these requirements have been lifted in the wind power sector in 2009.</td>
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The occurrence of undesired technology transfers from foreign to Chinese actors in the wind power equipment sector appears limited. However, the preventive behavior of foreign companies (such as choosing WFOE models over joint ventures and producing only outdated technology locally) hampers the emergence of cooperative business models.
Technology transfer

The approach to international cooperation by Chinese wind power equipment companies has been narrowly focused on the acquisition of advanced technology. Therein, China's business actors have been as thoroughly disappointed as foreign companies with regards to gaining sustained access to China's domestic wind power market. Due to the IPR concerns described above, international companies have been avoiding the setup of joint ventures with Chinese partners and the few attempts at joint ventures between Chinese and foreign wind turbine manufacturers have been unsuccessful. Even the original advantages of joint ventures formed under the “Riding the Wind Program” were not enough to bring about effective partnerships. The inability to establish a sustained market presence pointed to the ultimately disappointing yield of such partnerships for both sides.

In absence of alternatives, licensing agreements became the only viable and legal way for Chinese firms to attain technology from foreign companies. In the earlier stages of their development, Chinese companies such as Sinovel and Goldwind based their success on a combination of licensed foreign technology and an ability to produce at low manufacturing costs. However, foreign companies have been extremely careful not to provide cutting-edge technology to Chinese counterparts, protecting their innovation advantage at all times. Furthermore, China's capabilities in onshore wind technology are rapidly catching up with those in Europe -- capabilities supported by public investments in technology development and R&D. This trend renders traditional licensing agreements increasingly obsolete as a form of international cooperation in China's wind sector.

China's disappointment with the quality of transferred technology is one of the central reasons for its lack of enthusiasm in facilitating international cooperation. China's disdains also reflected in lackluster wind-related efforts under the Kyoto Protocol's Clean Development Mechanism (CDM). While over 250 CDM wind energy projects have been conducted in China between 2006 and 2010\(^{31}\), these projects failed to meet Chinese stakeholders' expectations regarding the introduction of advanced technologies to the Chinese market. As Gao Guangsheng, director general of climate change at Beijing's National Development and Reform Commission explained, “CDM was making only a small difference to the attractiveness of wind power in China”\(^{32}\). The perceived low transfer rate of high-end technology through the CDM framework added to China's tendency towards innovative self-reliance. Chinese officials are now expecting to fund 90% of the necessary investment to allow self-achievement of renewable energy targets.

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\(^{31}\) UNFCCC: CDM Project Database. cdm.unfccc.int.

Public facilitation

From an economic perspective, the failure to create sustainable models of international cooperation in China’s wind sector might follow rational business choices. However, this perspective does not reflect the global threat of climate change, which is inseparably connected to the failure or success of renewable energy utilization. From a climate protection perspective, the expansion of China’s installed wind energy and corresponding reductions in CO₂ emissions carry benefits which are not internalized in wind companies’ business calculations. Governmental actors already attempt to address the gap between corporate and public interests through government-to-government cooperation schemes within the wind power sector. The primary focus of these initiatives lies in the field of research collaboration, which, as this study will show, is a promising and sensible approach. However, existing initiatives will have to sharpen their profile and target strategic areas of technology development in order to make a difference.

A number of renewable energy initiatives either exist or are in planning. One example is the EU-China Institute for Clean and Renewable Energy (ICARE). These projects emphasize the promotion of scientific exchange, fundamental research and university based training courses. However, as the scientific knowledge base and quality of engineering personnel in China’s wind sector has rapidly improved in recent years, collaboration that concentrates on one-sided knowledge transfer, teaching and training will not reflect the needs of China’s advancing wind sector much longer. In addition, given China’s willingness to inject significant public funds into energy related education, international financing in this sector will gradually lose its attractiveness. In the future, government level cooperation will have to go beyond teaching programs and funding schemes in order to offer tangible benefits for China’s wind power expansion and increase the chances of balanced partnerships.

33 Delman/Chen 2008: p.95
Part 2

4. Limits & opportunities: the bottleneck of China’s wind strategy

Despite extensive political efforts to support the rapid development of wind energy in China, the real test of strategy still lies ahead. China’s wind power development has reached a bottleneck that challenges the viability of past achievements. Often located in remote areas and unsteady in its availability, the harnessing of wind power resources faces two fundamental technological obstacles: transmission and intermittency (see Box II). These obstacles, which prevent attaining a high proportion of wind power in the overall energy mix, are particularly pronounced in China. In 2008, only 8.7 GW of China’s 12.2 GW installed wind power capacity were connected to the power grid, leaving 30% of installed capacity lying idle. 34

At the beginning of 2010, 40% of China’s wind turbine manufacturing capacity was left unused due to a slump in wind farm construction caused by technical constraints of the power grid. 35 The ultimate success of China’s wind power strategy will be determined by its ability to tackle these technological obstacles and to clear the bottleneck as fast as possible.


China’s wind power bottleneck

In China’s current wind infrastructure, long-distance transmission is an acute problem. China’s on-shore wind potential is heavily concentrated in its northern regions, specifically in the Autonomous Region of Inner Mongolia, parts of Xinjiang, as well as in the provinces of Jilin, Heilongjiang and Gansu (see figure 5). These locations are far from the industrial and commercial centers along China’s eastern coast and feature a very limited local energy demand. Wind energy produced in these areas requires long distance transmission in order to be utilized. The president of the China Wind Energy Association He Dexin acknowledges, “the problem is that the regions where wind resources are the most abundant tend to have the weakest grid infrastructure development.”

The transmission problem in China is not limited to wind power. As wind power still constitutes only a small portion of China’s overall energy mix, efforts to drastically improve transmission capability are primarily driven by considerations on other energy resources. Importantly, approximately 80% of China’s coal reserves are located in northern and western regions. This results in expensive transportation of coal to power generation facilities nearer to China’s industrial and commercial centers.

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centers. In addition, about 80% of non-transportable hydro power is generated in western regions. Accordingly, China’s incentives to create adequate long distance transmission infrastructure are extraordinarily high and are not exclusively dependent on wind sector development. Nevertheless, transmission capability is an essential prerequisite for the desired wind power expansion in China.

Figure 5: Geographic distribution of China’s wind power potential (McElroy et al. 2009: p.1378)

The second difficult complication inherent in wind power is its intermittency (see Box 2). In China’s case, the rapid expansion of installed wind power did not allow sufficient time to develop the technology and experience needed for installing a highly complex power transmission system. Such a system requires constant monitoring, storage capacities and supply- as well as demand-side management. All of these features are necessary to accommodate the utilization of a high share of energy from intermittent sources. Given the current low proportion of wind energy in China’s energy mix, the inadequacy of transmission infrastructure is the more acute problem. If, however, China’s wind energy expansion is continued as planned, intermittency will quickly become a major obstacle to the development. Such a future challenge may prove much more difficult to tackle than transmission issues.

China’s political leadership is aware of the looming slowdown in wind power expansion and the problems this will pose for the achievement of its 2020 renewable energy goals. As the following sections will describe, the two most promising solutions to the technological obstacles of transmission and intermittency are advanced power grid technologies, or so-called smart grid solutions, as well as the expansion of China’s offshore wind power capacity. Clearly, China has recognized the importance of rapid advancement in grid and offshore infrastructure by significantly investing public funds in both areas. The initial phases of development in both fields can be implemented on the basis of capacities and technologies already available in China. However, in the near future, the adjustments necessary
to reach the desired level of wind power integration will require technological advancement and experience that Chinese companies may not be able to provide quickly without outside assistance.

In order to fulfill the government’s targets, the players in China’s wind sector will have to learn fast. Cooperation with foreign companies represents one attractive way of doing so. Even though smart-grid and offshore wind are new technologies everywhere in the world, European companies have gathered valuable experience and expertise in these areas, potentially complementing the current efforts on the Chinese side. This knowledge, if utilized efficiently, could play an essential role in expediting the development of China’s wind sector while providing benefits for all parties involved. The failed deal between China’s decision-makers and foreign companies (see Chapter 3) could be renewed under changed circumstances. With China chasing its 2020 renewable energy target, the time pressure on the country’s leadership will lead to an increased willingness to provide regulatory adjustments that make collaboration more attractive to foreign companies. In addition, the forward-looking dynamic and extensive political and financial backing enjoyed by China’s wind market create opportunities for international companies to improve their own innovation capacity through partnerships with Chinese companies. To seize this short window of opportunity will still be an exceedingly difficult task, but the circumstances are unusually favorable.

Possible solution 1: grid technology

Installation of a power grid capable of transmitting electricity over long distances while managing an increasing proportion of intermittent power sources is the greatest future challenge for China’s wind strategy. So called “smart grid technology” uses superconductive transmission lines and incorporates a two-way digital communication system to monitor and control all stages of the power system (production, transmission, distribution and consumption) in order to ensure grid stability even when using fluctuating power sources. While it remains in the R&D and political consideration (especially in the EU and USA) phases, implementation of smart grid technology is limited to a small number of practical examples: the ENEL smart grid in Italy and city pilot projects in Austin (USA) and Mannheim (Germany). A full-fledged, comprehensive smart grid system does not exist thus far.
China’s government is nonetheless determined to install an extensive ultra high voltage (UHV) smart grid system by 2020. This project will proceed in three phases: planning and standard development until 2011, installation of UHV transmission lines and digital monitoring units until 2015, and the creation of a full-fledged, demand-side managing power distribution system until 2020.37 Driven not only by its wind energy strategy but also by the necessity to transmit energy from other sources like coal and hydro-power over long distances, China’s leadership is prepared to invest considerable efforts and funds into this extremely ambitious endeavor. $134 billion of public funding have already been earmarked for smart grid development.38 Responsible for the implementation of these plans are China’s two state owned grid providers, the State Grid Corporation (SGC) operating in all of northern China including the areas with significant wind power generation capacity, and China Southern Power Grid operating in the five southern Provinces.

With the purpose of addressing intermittency, SGC’s first smart grid compatible transformer station went on-grid in 2007 in the city of Wuxi, near Shanghai. Currently, SGC has installed close to 100 such stations across the country. The installation of another 1000 transformer stations is planned by the end of 2011. Simultaneously, SGC is investing heavily in research on transmission technology by running the world’s largest transmission research facility in

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**BOX 3 | STATE GRID’S SHOWCASE UHV PROJECTS**

<table>
<thead>
<tr>
<th>(1) UHV alternate current demonstration line</th>
<th>(2) UHV direct current demonstration line</th>
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<tbody>
<tr>
<td>Operational: January 2009</td>
<td>Operational: July 2010</td>
</tr>
<tr>
<td>Length: ca. 640 km</td>
<td>Length: ca. 2000 km</td>
</tr>
<tr>
<td>Voltage: 1000kV</td>
<td>Voltage: 800kV</td>
</tr>
<tr>
<td>Route: Shanxi (coal power plants) to Hubei</td>
<td>Route: Sichuan (hydro power plants) to Shanghai</td>
</tr>
<tr>
<td>Investment: RMB 5.9 billion</td>
<td>Investment: RMB 23 billion</td>
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Beijing. Two major UHV demonstration projects implemented by SGC raised worldwide attention (see Box 3). More UHV lines are currently in planning, following SGC’s plan to build 17,600 km of UHV lines by 2012 and to create a full-fledged national UHV grid spanning 90,000 km and transmitting 2 GW by 2020. To realize these ambitions, SGC announced an investment of RMB100 billion for the next three to four years.

While SGC frequently points out that the research and development as well as design and construction of the Shanxi-Hubei UHV AC line was “totally developed in China” with most experts agreeing that China “has the know-how to build long-distance high-voltage transmission systems,” there remain technological obstacles in this first phase of China’s smart grid development. Major technical problems plagued construction of the UHV AC demonstration line and raised doubts about its actual maximum capacity as well as its transmission stability. Furthermore, the construction of the UHV DC line between Sichuan and Shanghai depended heavily on foreign assistance, primarily provided by Siemens and ABB Power Systems. The technological obstacles become even more pronounced when looking at the third phase of China’s planned smart grid development which features advanced demand control technologies. International experts widely agree with Tristan Edmundson of clean-tech intelligence firm Mint Research who says, “China has the technology to build a first-stage grid [transmission system], but to reach the kind of efficiencies [it needs, the technology is not available in China].” Beyond relatively basic UHV transmission, the overall development of a cutting-edge power distribution system in China is still in an early stage and “grid enterprises have relatively limited experience of absorbing wind power.” This fact is reflected in a noticeable increase of international activity within China’s grid sector during the last two years. From the perspective of China’s grid companies, cooperation with international partners on grid technology carries enormous potential not only for cutting costs but also, and more importantly, reducing the time taken to reach the necessary grid integration of wind power.
sources: “They need the grid efficient now. [...] And Chinese companies are not going to be able to evolve in the time frame we are talking about.”

For foreign companies, the incentives are equally apparent. With an estimated public investment of about $10 billion annually, China’s smart grid development represents an extraordinary business opportunity. In addition, the prospect to utilize the vast capacities of the “China laboratory” to improve their own technology development and innovation capability (see chapter 5) represents a highly attractive opportunity for foreign players. The maturing of China’s wind power sector can be of great benefit to international companies as well. Therefore, it is not surprising that international players are starting major attempts to be part of this development. General Electric is building a smart grid technology demonstration center in partnership with the city of Yangzhou and is exploring possibilities for a joint venture with Yangzhou Beichen Electric Equipment Co.. Siemens has made a deal with the Hong Kong based smart-meter producer Wasion Group to conduct joint feasibility studies for smart grid pilot projects. IBM opened its Energy and Utilities Solutions Laboratory in Beijing and is planning pilot projects with SGC, expecting $400 million of revenue from Chinese smart grid development until 2014. From smart meter makers like Itron and Echelon to system solution providers like Cisco or HP, virtually all major international players in transmission technology are vying for China’s future market. The rapid spread of early cooperation attempts is a clear sign of the benefits that increased international involvement offers to both sides. However, the rules governing international involvement and determining the success of building sustainable partnerships are yet to be decided.

Possible solution 2: offshore wind farms

An adequate transmission system is vital in order to utilize large amounts of wind power. In China, however, a complementary option is available to mitigate the problem of long-distance transmission as well as intermittency: offshore wind farms. On sea wind power density is on average not only higher than on land, but the flow of wind is also more continuous making it less intermittent than its onshore equivalent. At the same time, since China’s industrial, commercial and residential centers are located along the coast, the distance between power generation and consumption would be considerably reduced by offshore wind farms. In addition, natural conditions favor the prospects of offshore wind power development in China. Along its 18,000 km of coast, China’s offshore wind potential amounts to an estimated 750GW, more than three times its on-shore potential, according to the China Meteorological Administration (CMA).47 Or, as Barbara Finamore

of the Natural Resources Defense Council claims, “China has the largest wind resources in the world, and three-quarters of them are offshore.” Unsurprisingly, China’s wind energy planners have been paying close attention to the prospects of offshore wind development. Shi Lishan, deputy director of the new energy department under the National Energy Administration, recently announced that “construction of offshore wind projects will be one focus of China’s wind power industry in the future.” The development is already underway. In time to draw global attention by providing power to the 2010 Shanghai EXPO, China’s first offshore wind farm and the first major offshore facility outside Europe, the 102 Megawatt $337 million Donghai Bridge Wind Farm, went on-grid in July 2010. The 34 turbines at Donghai Bridge are manufactured by China’s largest turbine manufacturer Sinovel using a joint design developed with American Superconductor. This revolutionary wind development marks the beginning of a massive expansion of China’s offshore wind sector. In May 2010, the first public tender for concession to build offshore wind farms was issued. It comprised four projects along the coast of Jiangsu province: two 300MW wind farms near the cities of Binhai and Sheyang and two 200MW projects near Dongtai and Dafeng located in the near-coast, inter-tidal zone.

Bidding closed on 10 September 2010 with China’s five largest power SOEs participating. As expected, state-owned companies entered extremely low bids between RMB 0.6 and 0.7 per kWh. In comparison, the on-grid price for the wind farm at Donghai Bridge is RMB 0.98 per kWh. The prices for onshore wind power, which should be considerably lower than offshore prices, range between RMB 0.51 and 0.61. Consequently, the offshore wind developers of these four projects are expected to consciously enter into a loss-making endeavor. Under these circumstances, private companies had, as usual, no chance to compete. However, the bidding procedure reflected some adjustments from the earliest onshore tenders that produced extremely low bids with correspondingly low quality of implementation (see Chapter 2). According to unnamed government sources, price “would account for only 60% of all criteria used to decide the winners. The other 40% will be based on whether bids are technologically robust and have reasonable operational management plans in place.” In terms of pricing, the evaluation procedure first eliminates the highest and lowest bidders and afterward determines the average price. The target price is 10% lower than the average price and bids are ranked according to how close they are to the target price.
The results of the first off-shore wind power tender, announced by China's National Development and Reform Commission on 8 October 2010, are summarized in Box 4.  

According to the National Energy Administration, the recent tender of relatively modest size was launched to “accumulate technology and management expertise for larger-scale offshore wind power projects in the future”53. Although no official targets have been announced for offshore wind capacity thus far, installed offshore capacity could reach around 30 GW by 2020 according to Wang Minhao, vice president of the Hydro-power Planning Research Institute.54

As is the case with grid technology, China's offshore wind development is still in its early stages. A rapid expansion is desired, but the technological expertise and experience to implement large scale offshore wind farms along the environmentally difficult Chinese coastline is limited. Installation poses a particularly difficult challenge due to “muddy seafloors and shifting sandbars”55 of the tidal flats along China's coast where most offshore wind farms will be located. Furthermore, harsh environmental conditions including frequent typhoons add to the problems of maintenance and grid connection. Some of these technological challenges

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53 Ibid.


go beyond China’s, or in some aspects every countries’, experience in offshore wind power generation. Even though offshore conditions in China are somewhat different from those in the EU, the two decades of experience and technological development of offshore solutions behind European wind firms are of great interest from a Chinese perspective. As in the case of smart grid development, the interests on the side of foreign companies are equally pronounced. As the president of Vestas China, Jens Tommerup, proclaims: “China has substantial wind resources, so we see great opportunities in China to develop offshore wind energy and to move the sector forward.” 56 Vestas’ offshore president Anders Søe-Jensen confirms the company’s plans to target China’s potential offshore wind market. “Having installed around half the world’s offshore wind turbines Vestas is one of the most experienced players in this field and we are happy to share our experience with the Chinese offshore wind industry.” 57 Moreover, Vestas’ international competitors are not remaining on the sidelines. Suzlon subsidiary REpower recently announced plans to introduce a 6.1MW offshore wind turbine to the Chinese market. 58 However, given previous sobering experiences of foreign companies in China’s onshore wind market, many questions remain about what role international players will ultimately have in China’s offshore wind expansion.

5. Benefits: why move towards a new model of cooperation?

In October 2010 Vestas, the world’s largest wind turbine manufacturer, opened the first foreign wind energy R&D center in China. Vestas’ President, Finn Strom Madsen, stated the aim to “maximize the talent and experience we have in China, incubate innovative solutions with local engineering talents, and build stronger connections between the Chinese and global wind energy industries.” 59 Vestas’ interest in improving its own technological innovation capacity by tapping into the innovative dynamic and talent pool of China’s wind sector resonates with the stated objectives of China’s political leadership. As Cao Jianlin, Vice Minister of the Ministry of Science and Technology, said during the opening ceremony of the R&D center: “China welcomes talents, entrepreneurs and multinational corporations


from all over the world to continue to develop partnerships in the pursuit of win-win outcomes.”60 Vestas, seeking to complement its own innovation strategy, offers what China needs: a drive for innovation on the basis of world leading technology combined with high-end technological working conditions for well-educated local engineers. From the Chinese perspective, according to Vice Minister Cao, “this brings along many opportunities [...] in China’s transformation from ‘Made in China’ to ‘Invented in China.’”61

In light of foreign companies’ experiences on the unequal playing field of China’s state-lead market, Cao’s statement may sound more threatening than encouraging. However, in combination with Vestas’ bold investment decision, the statement can also be read as a harbinger of a fundamental shift in the logic of international technology cooperation in China. China’s wind energy market is on the verge of a new development phase in which the various forms of technology transfer will no longer yield the results China seeks. The technological solutions China requires to move its wind development forward are not fully developed anywhere in the world. The times of simply “catching up” with foreign technologies are coming to an end. In the future, China will be reliant on original innovation. While it might decide to create these innovations domestically, utilizing international cooperation represents an attractive alternative that appeals to the interests of all parties involved. As such, the current developments in China’s wind energy market create incentive structures that favor change to the logic of technological cooperation in China.

The following overview of potential benefits deriving from a new model of international cooperation will focus on four groups of actors:62 the European Union (EU) as a political actor; European companies involved in the development, manufacturing and trade of wind energy equipment; China’s political leadership; and Chinese companies active in the wind sector.

**European Union**

1. **Reducing global emissions:** For the European Union, fair economic competition and the interests of industrial players cannot be the sole reference point for action. In light of the larger implications of climate change as one of the dominant challenges of our time, an exclusive logic of market competition will not serve global public interest. In addition to economic considerations, the EU has a vital interest in China achieving its renewable energy ambitions, expanding its wind

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60 Ibid.
61 Ibid.
62 The agglomerating view on the EU as a political actor is of course somewhat perfunctory. A discussion on the unity of the EU’s and the member states’ approach vis-à-vis China lies, however, beyond the scope of this paper. For the purpose of this analysis, the EU will be assumed to possess a reasonably coherent stance towards China’s wind power sector.
power capacity and advancing its green technology capabilities. Finding workable solutions to turn China’s climate related goals into reality promises benefits that go far beyond profit margins and market leadership. Wind energy can become a crucial building-block of a comprehensive energy transition in China, moving the entire international community closer to an effective answer to the global climate challenge. The joint development of innovations that address the fundamental technological challenges of renewable energy utilization will not only help to increase China’s emission reductions, but will also add greatly to the efforts to bring about a global transition towards low-carbon energy production. The EU, as a self-proclaimed champion of global climate protection, bears the responsibility of actively seizing any opportunity to facilitate the emergence of mature models of cooperation in China’s wind power sector. Previous models of international cooperation, shaped primarily by the logic of economic competition, fell short of their potential to provide a significant contribution to China’s energy transition. A stable model of joint technology development represents a more promising approach that could unleash the potential for innovation and problem-solving that lies within China’s wind sector.

**European companies**

1. **Re-opening China’s wind equipment market:** Market entry into the Chinese wind power sector remains the main interest of European companies when considering potential partnerships with Chinese counterparts. Even though international companies’ hopes of gaining access to China’s domestic market through cooperation have been disappointed in the past, the soaring Chinese wind power sector remains too economically attractive to ignore. If changing the incentive structure opens new opportunities for increasing European companies’ market shares, business actors will certainly consider their options despite past failures. In light of prior experiences, considerable doubts exist as to whether China’s political leadership is ultimately prepared to change the regulatory framework, create a more equal playing field and grant international players a more significant role in its wind energy sector in return for advanced R&D partnerships. This willingness will ultimately depend on the Chinese leadership’s assessment of the advantages of joint technology development. This assessment will, among other factors, be influenced by the extent to which foreign companies are prepared and able to assist China in clearing the technological bottleneck that hampers China’s wind power expansion. European companies, as much as European governmental actors, will have to make a strong case to this effect.

2. **Using the “China laboratory”:** As the opening of Vestas’ R&D center signifies, the incentives for international companies have expanded well beyond the uncertain prospects of market shares and profits. Peggy Liu, founder and chairwoman of the Joint US-China Collaboration on Clean Energy, believes China’s rapidly developing wind sector has more to offer since it “is going from manufacturing
hub to the clean-tech laboratory of the world”. Using this laboratory promises great advantages for European companies. With strong political backing, ample public funding, and a large and highly educated pool of engineering talent, China provides a unique testing field for the development of new technologies. Opportunities for experimentation in on- and offshore wind power, as well as power grid design, are relatively unconstrained politically and geographically. The room for technology demonstration, often requiring major construction effort, is more open in China than in most industrialized countries, where strict regulations, budgetary restraints and politically contested frameworks complicate procedures. European companies increasingly see the opportunities for technology development in China. However, for international firms, the “China laboratory” can only be accessed when accompanied by a Chinese partner.

3. Managing China’s international market entry: European companies have a strategic interest in playing a role in China’s strategy to go global, managing the inevitable global market entry of China's wind equipment manufacturers through international partnerships. China’s wind sector players are likely to increase their involvement in international markets sooner rather than later. Building stable partnerships with Chinese companies can serve as an instrument for mitigating the confrontational implications of this development and provide a way for international players to gain a certain degree of influence over an inevitable development. The impact of increased competition might be more manageable for foreign firms that are already in strategic alliances with Chinese companies. reduce the fiercely national edge of Chinese companies’ international ambitions.

China’s political leadership

1. Clearing the bottleneck: The actions of China’s political leadership regarding wind power development are determined by a set of motives including economic transformation driven by the advancement of high-end green technologies, energy supply security, climate sustainability and international reputation. The combination of these motives translated into ambitious political targets for the mid-term expansion of China’s renewable energy sector generally and in relation to wind power. Meeting these targets turns out to be an unexpectedly difficult challenge that requires significant technological advancements, particularly regarding the adjustment of China’s power grid. The achievement of targets by 2020 will put significant pressure on China’s leadership, and force an increased acceptance of available outside assistance. In the longer term, the benefits of international cooperation will potentially decrease due to China’s growing ability to clear technological bottlenecks without outside help, creating a situation highly reminiscent of the first phases of China’s wind sector expansion as described in chapter 2. Consequently, the short window of opportunity for establishing stable structures of cooperation is now.
China's political leadership's buy-in regarding the advantages of joint technology development for clearing the bottleneck is crucial since balanced structures of cooperation require a significant willingness of China's political actors to create fairer market conditions on its domestic markets and allow for a more significant role of international companies in its wind sector. China's leadership will have to be convinced of the added value of cooperation that goes beyond technology transfer in order to implement corresponding measures, for example in public procurement rules or joint venture stipulations.

Chinese companies

1. **Clearing the bottleneck**: Almost exclusively organized as state-owned and -controlled entities, the underlying goal of SOEs in China's wind sector is to clear the technological bottleneck in order to fulfill their politically set targets. Especially in the energy sector, performance of Chinese SOEs and their management personnel is measured against these political targets. For wind park developers, turbine manufacturers and grid corporations alike, this creates strong incentives to quickly present effective solutions to current challenges. The ambitious renewable targets to be reached by 2020 add considerable time pressure to these efforts. Developing workable solutions in cooperation with experienced international players is likely to decrease the costs and time needed to put measures in place. Technological advancement thus remains the central objective of international cooperation from the perspective of Chinese companies. However, the method of acquiring technology is fundamentally different from previous phases of China's wind market development. Instead of taking over existing technologies from foreign firms, new technologies will need to be created. In doing so, the abilities and capacities of international and Chinese companies will complement each other, which could prove to be an invaluable asset.

2. **Facilitating international market entry**: In addition, strategic alliances with international partners characterized by close working relations can serve as an instrument to prepare Chinese companies for their gradual entry into global wind energy markets. China's has only recently embarked upon wind turbine exports with Chinese companies exporting a mere 20 wind turbines in 2009 to India, the US, Thailand and Great Britain with an overall capacity of approximately 28MW.63 But as Robert Todd, director of the Renewable Energy, Resources and Energy Group at HSBC, states, “[Chinese manufacturers] have already established international sales teams and are actively bidding for contracts overseas. The process is underway.”64 While Chinese companies are approaching

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a globally competitive technological level in the traditional onshore sector, they are still lacking experience and knowledge of how to act successfully within an international market environment. Here, Chinese companies are unprotected by the public procurement advantages and favorable regulations they enjoy in their domestic market. However, strong alliances with leading international players can facilitate Chinese companies’ entry on the global stage. Ultimately, China’s move to global wind energy markets will happen with or without embedment in international networks of cooperation. As such, partnerships that influence this process also lie within European companies’ interests.

6. Vision: how to move towards a new model of cooperation?

In order to redefine international partnerships in China’s wind power sector and to create a more mature model of cooperation, both sides will have to radically break with the current logic of interaction. Thus far, the genesis of long-term cooperative structures has been thoroughly undermined by a perception of today’s partners as tomorrow’s competitors in an economic zero-sum game. Chinese players have single-mindedly tried to use partnerships as a means of gaining a technological and competitive edge without any intention of granting their partners a long-term stake in China’s domestic market. International players have single-mindedly tried to use partnerships as a means of gaining access to China’s growing domestic wind market without any intention of improving their partners’ long-term technological advancement. Ultimately, neither side has been willing to provide what the other side desired. As long as this narrow focus persists, cooperation will not advance to a mutually beneficial stage.

The maturing character of China’s wind sector changes these incentive structures. Achievement of each side’s objectives becomes increasingly reliant on comprehensive partnerships and the full cooperation of the respective partner. This situation opens an opportunity to broaden the narrow focus and move towards the joint exploration and, most importantly, joint ownership of technological solutions. At the core of this cooperative model lies the creation of shared innovation. Joint development of shared innovations, however, requires a mode of cooperation radically different from previous international partnerships. It calls for deep working relationships and long-term strategic alliances rooted in mutual interests. All parties involved will have to make specific contributions to build this sort of partnership.

However, the type of engagement necessary to seize the emerging opportunity for changing the logic of international cooperation does not come without risk. Especially on the side of European companies, realizing the benefits outlined in Chapter 5 requires a leap of faith that is not for the fainthearted. Even though the changing incentive structures theoretically create a stable basis for mutually
beneficial cooperation, the possibility looms large that a renewed engagement in China’s wind energy sector will follow the exact pattern of the past. European companies could invest in comprehensive partnerships and share their technological expertise without reciprocally gaining significant market entry or access to the advantages of the “China laboratory.” If alliances again prove to be unstable over time, they would indeed strengthen their future competitors on global markets without gaining an appropriate benefit in return. The bruising experience of the first phase of China’s wind sector development, when foreign companies were allowed to play a role while their input was useful for the development of a domestic industry before being effectively shut-out once Chinese companies were ready to manage on their own, will make European companies extremely reluctant to initiate a renewed attempt of engagement.

However, as this study has set out to illustrate, circumstances and incentive structures are fundamentally different at this stage of China’s wind sector development. The window of opportunity does exist, but to seize it will require decisive action from all parties involved. Business actors on both sides will have to credibly signal a fundamental change in approach to prepare the ground for new models of cooperation. Governmental actors on both sides will have to play an active role in facilitating this development by increasing incentives and minimizing risks for those companies willing to take the cooperative logic to the next level. The required change of the logic of international technology cooperation can only be achieved if all groups significantly alter their current behavior with regards to three dimensions:

- **Paradigm shift that reflects the changing realities of China’s wind energy market**
- **Targeted public and private investment in strategically chosen technology areas**
- **Improved management of intellectual property rights (IPR) and profits from innovation**
European Union

1. **Paradigm shift:** The traditional logic of one-sided development assistance is not suited to bridging the divide between market forces and climate protection. To foster advanced technology cooperation with China, the EU’s political strategy needs to move from a mindset of providing technical assistance to a paradigm of facilitating joint innovation. In addition, a crucial task of EU is to facilitate a corresponding paradigm shift for China's political leadership. The EU will have to make a strong case for new forms of technological cooperation while at the same time insist on breaking with the cooperative models of the past. The rules that will ultimately govern these partnerships will be decided on the political level. Inter-government negotiations will have to ensure that these rules are based on an altered understanding of the objectives and mechanisms of collaboration. The significant benefits for the Chinese political leadership that derive from the creation of stable R&D networks give the EU a powerful lever when negotiating a new framework for cooperation.

2. **Strategic investment:** In order to promote and facilitate the infant stage of new technology partnerships, the EU should provide targeted financial incentives in the form of research funds and subsidies tailored to support EU-China R&D partnerships in strategic technology areas. A clear focus should be on areas where innovation is most needed and most beneficial, for example the development of technologies such as smart grid and offshore. Public investments can facilitate the fledgling stage of new cooperative structures and provide incentives for business actors to engage in pilot projects, thereby demonstrating the viability of new forms of cooperation. In this way, public investments can serve to bridge the trust gap between European and Chinese business actors and provide the necessary starting point for renewed cooperation. Subsidizing joint R&D efforts in the wind power sector should not be understood as a handout to China, but a start-up aid leading into a positive private sector dynamic.

3. **IPR management:** The focus on the creation of joint innovation with shared intellectual ownership decreases the profits European companies forfeit by cooperating with Chinese partners. However, some transfer of technological expertise will be necessary especially during the initial phase of collaboration. A fund to compensate companies for forgone innovation profits caused by the transfer of climate technologies does not seem to be a politically viable option on a global scale at the moment. However, the EU should consider a limited bilateral EU-China compensation mechanism that specifically aims at strategic areas of joint technology development. Regarding the areas in question, the technology gap is small and forgone profits accordingly low. Therefore, the fund would not serve as an instrument for major financial redistribution, rather as a case-by-case mechanism to minimize risks and increase incentives for those companies willing to try new forms of collaboration. An IPR compensation fund can facilitate the initial phase of advanced technology cooperation.
European companies

1. **Paradigm shift:** European companies will have to move beyond the narrow perception of Chinese companies as competitors in a zero-sum game and expand their strategic approach to include long-term business partnerships. Strategic alliances are necessary in order to realize the benefits that the changing realities of China's wind market offer. Defying the difficulties of the past, the example of the new Vestas R&D center provides a first impression of how international companies can contribute to changing the logic of cooperation in China's wind power sector. The hotbed for new forms of cooperation will be joint technology R&D that is directly geared towards the challenges China is currently facing, most importantly addressing offshore wind power as well as smart grid development. European companies' innovative capacities in conjunction with informed Chinese experts can become a winning combination for closing the gap between R&D and product maturity. International partnerships aimed at creating shared innovation, will have to be long-term endeavors that identify and utilize the respective strengths of both sides. This is also true with regards to Chinese companies’ drive towards global markets. Chinese wind companies with low production costs will enter the global wind power markets sooner rather than later. While European companies will have to be mindful of competitive advantages, their approach can be supplemented by strategic technology alliances with Chinese partners. Integrating Chinese companies into a network of business partnerships can smooth the national edge of China’s going global strategy and help European companies to manage increased global competition.

2. **Strategic investment:** China offers a “technology laboratory” equipped with strong political backing and public funding, a large pool of well-educated engineering talent, and few geographical or regulatory limitations. European companies should embrace this opportunity by investing in advanced R&D partnerships with Chinese counterparts. Again, the focus should be on clearly defined technology areas where the “China laboratory” will be most complementary to the European capacities and therefore maximize both sides' innovation capability. To some extent, companies will be able to draw on experiences from the limited number of past joint design projects in wind turbine manufacturing that demonstrated the possibility of profitable joint R&D. One example is the engagement of the German wind turbine developer Aerodyn Energy Systems in joint design endeavors with a number of smaller Chinese companies such as Mingyang Electric Group and the Shanghai Electronic Wind Power Equipment Corporation.

3. **IPR management:** Despite the focus on shared innovation and joint ownership, the creation of new forms of EU-China technology cooperation in the wind sector will require some degree of initial technology sharing to put both sides
on an equal footing and maximize the overall benefits of the cooperation. In the defined areas, the forgone profits can be kept to a minimum if the Chinese side delivers its part of the bargain. In addition, a limited innovation compensation fund could reduce remaining disadvantages. As a matter of principle, European companies will have to start understanding these technology transfers as worthwhile investments in a partnership with considerable potential for long-term benefits. As described above, public investment from both sides will have to play a role in facilitating the initial phase of pilot projects.

China’s political leadership

1. **Paradigm shift:** An adjustment of the regulatory framework of domestic competition is an essential prerequisite for the emergence of a new cooperation model. Thus far, the rules of competition have blocked international actors from large segments of China’s wind market. However, China’s strategy of protecting domestic industry at all costs in order to grow national champions produces diminished returns. Chinese manufacturers need less protection; they will have to face global competition in the future and can increasingly benefit from advanced technology cooperation with international partners. At the same time, profit-making opportunities in China’s domestic wind market remain the main incentive for international companies to engage in these partnerships. Therefore, China’s leadership will have to make a credible effort to change regulatory practices in order to provide a more level playing field. If China’s political leadership accepts this fundamental shift of approach, it will play an essential role in facilitating the emergence of mature forms of cooperation. Extensive political control over virtually all relevant players in China’s wind market means these SOEs respond to political considerations. Therefore, firm political support from the Chinese government is a prerequisite sine qua non for a successful redefinition of technology partnerships.

2. **Strategic investment:** China’s political leadership has demonstrated its willingness to invest significant amounts of public funding in the development of its wind sector as well as particularly crucial technologies such as grid and offshore. Mirroring EU financial support for EU-China R&D partnerships in strategic areas, China will have to specifically channel some of these funds into advanced international technology cooperation, facilitating their initial phase of development whilst simultaneously demonstrating commitment as a stakeholder. If China’s leadership can be convinced to put the creation of international R&D cooperation ahead of an exclusively benefit part of their economically driven wind energy agenda, the emerging new incentive structures that can potentially lead to sustainable cooperation will be immensely strengthened.
3. **IPR management**: The changing technological needs of Chinese wind sector companies lower the danger of IPR infringements. Nevertheless, the utilization of sensitive expertise by Chinese partners will remain one of the main inhibitions for European companies to invest into technology partnerships. While legislative stipulations to ensure responsible handling of IPRs are in place in China, implementation has been selective and unreliable in the past. To pave the way for balanced technology cooperation, China's political leadership will have to step up its commitment to uncompromising IPR protection especially with regards to R&D partnerships in the identified technology areas.

**Chinese companies**

1. **Paradigm shift**: Chinese companies will also have to move beyond their narrow focus on short-term technology acquisition as the main incentive for international partnerships. The new challenges that Chinese wind power companies are facing will not be solved by quick technology transfers, but by the development of original technology solutions. In this, the complementary way in which abilities and capacities of Chinese companies interact with experienced international partners will prove to be a valuable asset. In addition, long-term strategic alliances with international counterparts can serve to prepare Chinese companies for their gradual entry into global wind energy markets.

2. **Strategic investment**: Chinese companies will have to match the investment of EU counterparts in R&D partnerships in strategic technology areas. In return for realizing the benefits of international partnerships in terms of technological advancement, Chinese companies will have to ensure that their own beneficial capacities such as the “China laboratory”, are fully available and accessible to their European counterparts. One prerequisite for success will be the effective integration of China's academic sector. In China's wind power sector, theoretical knowledge carrying practical implications is primarily agglomerated in academic institutions. Successful R&D networks will therefore have to include research units at the relevant Chinese universities. To facilitate cross-sectoral integration, international networks should be embedded into the local clustering approach that created large industrial complexes. These are hubs of different branches of wind power industries as well as smart-grid development projects in close geographic proximity, for example the Wind Power Technology Park in the city of Wuxi or the planned Smart Grid Valley as part of the S&T development zone of Yangzhou City. The latter already has signed agreements with international companies such as Siemens and GE. These local hubs should be used to reach maximum integration of international partners in the existing R&D structures, strategically capitalizing on spill-over effects and opportunities for network expansion.
3. **IPR management**: Cooperation based on the common objective to develop new technological solutions and hold joint ownership of these innovations will considerably lower the risks and tensions associated with possible infringement of intellectual property rights and forced technology transfers. Nevertheless, in light of past experiences, concerns about the responsible handling of sensitive information by the Chinese partners will represent a major concern for international companies entering into R&D cooperation. Chinese companies will have to do their part in bridging the significant trust gap relating to the handling of IPRs. They will have to demonstrate that they have altered their strategic outlook on technology transfer and actively promote the security of sensitive information necessary for exchange within the framework of the technology partnership. The structures and legal stipulations governing cooperation will have to prominently address IPR protection issues. Within the framework of advanced wind technology partnerships, it is in the interests of both the Chinese political leadership and economic actors to provide IPR protection for the respective international players. There are signs that IPR protection in China can be efficient if strongly applied, especially in the R&D sector. According to recent studies, companies with R&D units in China increasingly do not consider IPR infringements a major problem if employment contracts include appropriate provisions.65

China’s wind power sector can potentially exemplify the ability of international cooperation to simultaneously achieve climate protection whilst maintaining business interests. As this analysis sets out to illustrate, the incentives of all actor groups are favorable for an adjustment of the fundamental logic of cooperation in China. The chance for a mutually beneficial change of paradigm exists. However, starting from the deeply entrenched precedent of flawed structures and sobering experiences, means that all parties involved will have to undergo major changes in their approaches in order to facilitate the creation of a mature model of cooperation. There can be no illusion that it will be an uphill battle that requires a determined approach. Despite the challenges, the potential benefits, calculated in CO2 reductions, Euro and Yuan, leave no doubt that cooperation is a worthwhile endeavor.

65 Delman/Chen 2008: p.106


Ministry of Science and Technology (MOST) et al. (2002): Evaluation of policies designed to promote the commercialization of wind power technology in China.


