

# China, Norway and Offshore Wind Development

*A Win-Win Wind Relationship?*

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## EXECUTIVE SUMMARY

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### Background

The 21<sup>st</sup> Century will see a substantial shift towards cleaner energy sources and renewable energy. In the transition towards a new energy paradigm, offshore wind is emerging as one solution with significant potential to deliver clean and sustainable energy on a large scale.

Europe is currently the driving market for the development and implementation of offshore wind, with a total consented project pipeline of 48GW<sup>1</sup>. The growth in global energy demand, however, is primarily taking place in emerging markets such as China.

China with the world's fastest growing wind industry, an offshore wind pipeline of projects and a political support framework for offshore wind under development is now emerging as the second global hotspot for offshore wind development.

The entry of China into the offshore wind market provides considerable possibilities to scale-up the industry and speed-up commercialization of offshore wind technologies. Scaling-up production of clean offshore wind energy would have a significant effect on reducing the growth rate of greenhouse gas emissions in China and globally.

To unleash China's full potential and speed up the development of offshore wind energy production, bridges must be constructed between stakeholders with the relevant experience and the best available technology (typically in Northern Europe), and policy makers and project developers in China.

This study looks at Norway and China from such a perspective, aiming to outline the emerging offshore wind market in China, assess the strengths and compatibility of the Norwegian offshore industry cluster, and suggest possible ways for future cooperation.

### China

Today China is the world's fastest growing market for renewable energy. The Chinese Government has set a goal to increase the portion of renewable energy in the energy mix, from 10% in 2010 to 15% in 2020. In the same period GDP is expected to double, therefore renewable energy will play a significant role in curbing China's green house gas emissions as energy consumption increases tremendously.

China's annual offshore wind energy generation potential is 11,000TWh<sup>2</sup>, similar to that of the North Sea. There is increased incentive to develop offshore wind as coastal provinces must import up to 25% of their energy from surrounding provinces. Due to nationwide increases in energy consumption China's national goals for wind installation are expected to increase to 100-150GW by 2020. The national targets for offshore wind are expected to be announced in the next national renewable energy plan; news of its release should be available in March or April 2010 at the conclusion of annual governmental meetings.

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1 EWEA. "The European wind industry – key trends and statistics 2009". January 2010.  
note: consented projects - 16GW from report above and 32GW recently announced in the UK.

2 Under publication: CWEA: "An Emerging Offshore Wind Development Hotspot", WWF-Norway 2010.

Considering the national policies, offshore wind energy resources, and market development, Azure estimates that 30GW of offshore wind energy generation capacity is likely to be installed in China during the next decade with an expected market potential valued at 74 billion Euros. If 30GW (within 30m water depths and no account for transmission losses) of wind capacity is installed it could mitigate 1.3 billion tons of CO<sub>2</sub> over the 20 year asset lifetime<sup>3</sup> (- more than forecasted total Norwegian emissions over the same period).

China's offshore industry is now showing signs of considerable development even though policies are still in a formative stage. China's offshore wind long-term cumulative pipeline has already reached 13.7GW, with 514MW to be developed in the next 3-4 years. China's offshore wind industry will likely develop in a similar pattern to the onshore wind industry. The onshore industry started to develop 2 years before the official policies were put into place. Once the national policies were in place, the industry had already reached 100% year-on-year growth.

China's industry will likely be able to export offshore wind turbines to the world within the next 3-4 years as Chinese manufacturers establish their export protocol and offshore wind turbine technology matures. There is a subtle yet important shift in trend as Chinese manufacturers start applying for international certification, positioning to make an entrance into the international market. China's supporting industries for offshore wind include foundations and vessels which have already started to be exported to the European offshore wind market.

China has a unique offshore development area – the Intertidal zone. In this zone turbine foundations are exposed during low tide and submerged in ~5m of water during high tide; methods and equipment used for construction in these areas are different from the European offshore wind industry. China will develop these areas first before moving on to more expensive and higher risk (+30m depths) offshore projects. Other environmental factors unseen in Europe will mean that the offshore industry in China will face new challenges, such as typhoons which are particularly prevalent in the south.

The market dynamics for offshore wind development in China will tie in with the regional offshore wind development. Japan, Korea and Taiwan all have ambitious renewable energy goals and offshore wind is an attractive solution as all three countries have strong infrastructural and geographical barriers for development of onshore wind. China will likely be the production hub serving the regional and global market. Of these countries Japan has the highest potential for deep sea (+50m) offshore development with up to 245GW and has already started conducting research in this area. Korea, while new to the market, has started to move quickly in developing an offshore wind industry and may be the first country in Asia to develop offshore wind projects in deeper waters (+30m).

## **Norway**

With its long coastline Norway has an estimated offshore potential of 14,000TWh up to 300m water depths and 1,000TWh up to 60m water depths<sup>4</sup>. Norway also has a world leading offshore industry cluster, with extensive experience in constructing and servicing offshore installations under rough conditions, as well as linking them to mainland networks. The European Union has set ambitious renewable energy targets for 2020, which should ensure a huge market for Norwegian offshore wind energy. While Norway's obligation under this directive is still being negotiated, energy export might become a more important driver for offshore wind production in Norway than national obligations under the directive.

Large Norwegian companies such as Statoil and Statkraft are involved in offshore wind development in the North Sea, including the Sheringham Shoal project and the recently won

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3 The emission reduction is based on the CO<sub>2</sub> that would be emitted if the wind farms were not installed on their respective grid and the same amount of electricity was produced, following CDM methodology. The technical energy generation potential for each province was supplied by Sun Yat-Sen University. Annual emission reductions are 64 million tons CO<sub>2</sub>e.

4 Enova SF "Potensialstudie av havenergi i Norge" 23 Oct. 2007

license to develop the large scale Dogger Bank (9GW) project. Norwegian companies are also leading in technology development with regards to floating offshore wind installations, drive train innovation, boat design, and certification.

Norway's offshore industry cluster has developed around offshore oil and gas. Surveys show that there is a large interest from companies in this sector to branch out into the offshore wind sector.<sup>5</sup> The Norwegian Government has expressed ambitious plans for Norway to become a key technology and service provider in the field of offshore wind energy, and an infrastructure of research clusters has been established.

While the potential is significant, the transformation of the Norwegian offshore cluster into an offshore wind cluster has so far been limited by several factors;

- Norway has little installed wind power and therefore modest industry experience with wind power.
- Norway has no domestic offshore wind farms, especially preventing small and medium-sized Norwegian offshore companies to gain experience with offshore wind.
- Norway lacks a domestic wind turbine company which could serve as a hub for the industry cluster.
- Norway's offshore cluster suffers from a general shortage of engineers hampering the capacity to follow-up and leverage potential for up-scaling and diversifying.
- Norwegian energy needs are relatively stable and almost exclusively supplied by clean hydropower. There are thus few domestic incentives for development of comparatively expensive offshore wind power.

Norway has also been slow to utilize its potential as a clean technology exporter. A recent world wide country ranking of clean energy technology sales (2008) in absolute and per capita terms, found Norway on the last position (26) listed in both categories.<sup>6</sup>

In order to realize Norway's potential as an international offshore wind energy facilitator and provider, policy frameworks need to be improved and targeted efforts are needed to promote the Norwegian cluster in international markets. Norway is today behind countries like Denmark and Germany, where the companies Vestas and Siemens are leading the efforts. In Norway, the companies Statoil and Statkraft have potential to play a similar role in a global push to position Norway as a key offshore wind energy facilitator and provider.

### **Norway – China: Conclusions**

The offshore wind industry in China is moving at a quick pace, and it will not slow down to wait for partners to collaborate. As the industry is just now at a formative stage, there is still time to engage and participate. By the time governmental regulations are in place in the next few years the industry will likely be in full swing.

As an emerging offshore wind market China presents huge possibilities for an offshore cluster looking to realize its potential. The size of the Chinese market means that companies who are able to position themselves to play a significant role in this market are likely to become important global players in the industry.

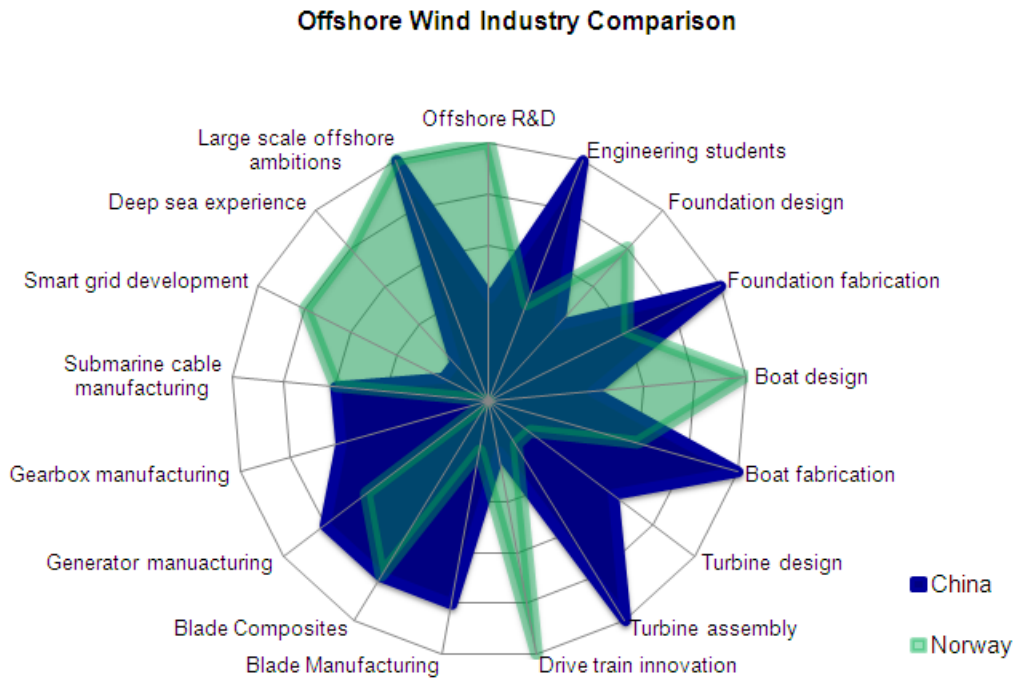
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5 SINTEF: Vindkraft offshore og industrielle muligheter, 2009.

6 Roland Berger Strategy Consultants: "Clean Economy, Living Planet. Building Strong Clean Energy Technology Industries", WWF 2009.

Norwegian and Chinese industry characteristics are complementary in a number of interesting ways (ref. diagram below).

- Areas of Norwegian strengths where there are Chinese needs include: offshore R&D, foundation design, boat design, drive train innovation, grid development and general ocean installation and service experience (especially deep sea).
- Areas of Chinese strengths where there are potential Norwegian needs are: turbine design and assembly, fabrication (of foundations, boats, blades, generators, gearboxes) and a huge pool of engineering students.



Source: Azure International

Norway clearly has a niche with potential to secure a significant role for Norwegian companies in the emerging Chinese offshore wind market. An estimated 74 billion Euros will be invested in developing the market over the next decade, of which 30% may be available to foreign players.<sup>7</sup> Of this Norway could capture an estimated 10%, applying standard offshore project breakdown and accounting for the technical strengths of Norwegian companies, Norway has the potential to secure and estimated 930 million Euros over the next decade.

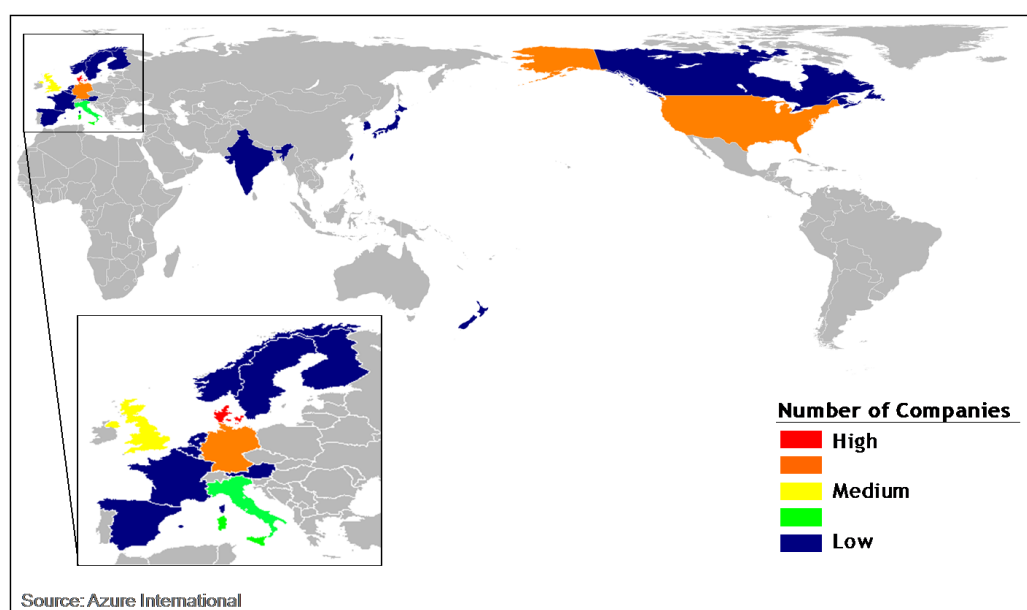
<b>Table 9: Estimated Norwegian Economic Potential in China's Offshore Wind Market 2010-2020</b>		Market potential (Euros)
Foreign market		22 billion
10% of Foreign market		2 billion
Norwegian potential based on industry strengths		930 million
Foundations		580 million
Electrical infrastructure		130 million
Electrical installation		220 million

Source: Azure International

<sup>7</sup> Azure Research Team – estimated portion of the market occupied by foreign competitors based on dynamics of the onshore wind industry

Norway is presently behind countries like Denmark and Germany in developing relationships and cooperation with wind energy stakeholders in China, see number of companies in the figure below. Still, Norway's main strengths are different from these countries whose main ambition is to develop and sell turbines. This still leaves an opportunity for Norway if a concerted effort were made, actively supported by the Norwegian government, and led by Norwegian companies with financial muscle and a willingness to engage long-term. (Note that Scottish offshore companies, which have similar strengths as the Norwegian offshore cluster, are already engaging the emerging Chinese offshore wind market actively.)

### Competing wind industry clusters in China's market



The fact that Norway has a limited number of domestic turbine manufacturers (Scanwind now owned by GE and Sway AS piloting the development of a 10MW turbine supported by Enova) advantageously positions Norway as a strategic partner with China in offshore wind technical development. Some of the big Norwegian companies with international ambitions could invite a Chinese turbine producer to set up a joint company in Norway, focusing on large scale deployment of offshore wind turbines for the European and global market.

### Recommendations

To realize the potential for offshore wind engagement in China, the Norwegian Government, offshore wind cluster, and key companies must develop a shared vision about how to strategically approach China and the broader Asian market, using the strengths of the cluster to build on existing relationships.

In order to become a key player in China's large scale offshore development, by leveraging both Norway's innovation and China's ability to quickly mobilize and bring products to full scale production in a short period of time, Norway will want to position as a "cluster" that clearly has:

- Experience with large scale offshore wind development
- Innovative designs necessary for the development of the offshore wind industry
- Complementary offshore and marine industrial resources and capacities
- Opportunities for Chinese offshore wind companies to establish in Norway as a gateway to the European market

The Norwegian Government should implement renewable energy policies to help support the development of offshore wind domestically in order for it to be an attractive base for international companies and developers, and to systematically promote clean tech export.

- The Norwegian Government should ensure that at least some offshore wind farms are constructed in Norway and establish an offshore infrastructure for research and testing of offshore clean energy technologies.
- The Norwegian Government should start publishing data for Norwegian clean tech export to monitor this trend and design policies that systematically position Norway as a global clean technology provider.

Norwegian companies should tap into the offshore wind industry in China, which has similar potential to the North Sea.

- Strategically position to engage in the offshore wind industry in China and the deep sea offshore wind industry in broader East Asia, through presence at relevant forums and exhibitions, developing relationships and (pilot) projects. .
- Norwegian companies with relevant existing contacts should actively develop these with a focus on strategic offshore wind cooperation. This especially applies to Statoil which has a long relationship with CNOOC (China National Offshore Oil Exploration) which is developing a 3GW offshore wind pipeline.
- Leverage China's strong onshore wind and offshore supply chain to meet the needs of large scale growth in the North Sea and the broader Asian market.
- Continue to develop relationships with Korea and Japan through deep sea offshore wind training and position to be prepared for these markets when their development accelerates.

The Norwegian Government should continue to support and encourage a Sino-Norwegian bilateral educational exchange and research and development.

- Norwegian institutions should systematically cooperate with Chinese partners to design undergraduate training programs in relevant fields for Chinese students in China and foster participation in exchange programs with Norwegian institutions. Provide advanced research program scholarships for technical Chinese graduates in Norway in line with industry needs.
- Encourage Chinese technical students to continue working in Norwegian companies after graduation. Provide guidance and support at university level for finding a job in Norway.
- Establish research collaboration for offshore wind development with Chinese research institutions.

The Norwegian Government and the regional clusters should further investigate the potential for strategic bilateral relationships with a Chinese province constituting a core area for offshore wind industry development, for instance Shandong.

- Prepare a trade mission to explore relationship potentials, and market the Norwegian offshore wind industry strengths and potential collaborations with China.
- Support domestic Norwegian offshore wind development to encourage investment from China.

# TABLE OF CONTENTS

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EXECUTIVE SUMMARY.....	i
TABLE OF CONTENTS.....	vii
List of Figures and Tables .....	ix
Introduction.....	1
1. Emerging Offshore Wind Market in China .....	2
1.1 Potential of offshore wind in China .....	2
1.1.1 <i>Offshore wind: meeting energy demand in coastal provinces</i> .....	3
1.2 Policy Environment.....	4
1.2.1 <i>Renewable Energy Law and its administrative provisions</i> .....	5
1.2.2 <i>Renewable Energy Law amendment</i> .....	5
1.2.3 <i>11th 5 year plan – most recent offshore industry targets</i> .....	6
1.2.4 <i>Offshore wind power development and construction meeting – key goals and players for developing a national plan</i> .....	7
1.3 Development of offshore wind: parallels with onshore wind .....	8
1.3.1 <i>China meets and exceeds its goals ahead of schedule</i> .....	8
1.3.2 <i>Project performance and feed-in tariffs</i> .....	8
1.3.3 <i>CDM status</i> .....	9
1.4 Current offshore wind pipeline in China (2009) .....	10
1.5 Offshore demonstration projects – Bohai and Donghai.....	11
1.5.1 <i>Bohai project – first offshore project</i> .....	11
1.5.2 <i>Donghai project – official demonstration project</i> .....	12
1.5.3 <i>Intertidal projects – under construction</i> .....	12
2. Industry Developments and Trends .....	14
2.1 Development of Chinese offshore wind turbines for the world .....	14
2.2 Technology transfer modes influencing turbine exportability .....	15
2.3 Industry shift towards international certification .....	16
2.4 Localization.....	16
2.5 Developments in supporting industries for offshore wind.....	17
2.5.1 <i>Foundation design</i> .....	17
2.5.2 <i>Boats</i> .....	18
2.5.3 <i>Grid and transmission</i> .....	18
2.6 Keeping up with China’s pace .....	19
2.7 Competing international wind clusters in China’s market.....	21
3. Offshore wind potential – regional perspective.....	23
3.1 Overview and comparison of wind market development in Asia .....	23
3.1.1 <i>Japan’s Wind Market</i> .....	25
3.1.2 <i>Korea’s Wind Market</i> .....	26
3.1.3 <i>Taiwan’s Wind Market</i> .....	27
3.2 Typhoon Risk .....	28
3.3 Deep sea potential in Asia.....	29

4.	The Norwegian offshore cluster and the potential in China .....	30
4.1	Norway's emerging offshore wind cluster .....	30
4.2	Engaging in China's offshore wind industry.....	31
4.2.1	<i>Applying Norwegian technology in China's market</i> .....	33
4.2.2	<i>Strengthening educational and research platforms - together</i> .....	34
4.3	Building on existing Sino-Norwegian relationships .....	35
4.4	Strategies for engaging with China.....	36
4.4.1	<i>Potential bilateral strategic relationships</i> .....	36
5.	Recommendations .....	39
6.	Supplementary Section: Company Entrance Strategies - Issues of IPR .....	41
6.1	Entrance strategy – choosing your company structure in China.....	41
6.2	IPR Enforcement .....	42
6.2.1	<i>Legal protection</i> .....	42
6.3	Legal framework .....	43
6.4	Contract law .....	44
6.5	Payment security .....	45
6.6	Understanding the cultural nuances of business in China .....	46
6.6.1	<i>Intercultural issues</i> .....	46
6.6.2	<i>Lack of governmental regulations</i> .....	46
6.7	Robust strategies and mitigating risk .....	47
	Abbreviations and Acronyms .....	48
	List of Appendixes .....	49
	Appendix A – Chinese National Governmental Agencies.....	50
	Appendix B – Offshore Developer Profiles – Top 5.....	51
	Appendix C –Offshore Turbine Manufacturers – Top 5 .....	54
	Appendix D – Typhoon Paths in China .....	57
	Sources .....	58

## List of Figures and Tables

---

Figure 1: China's offshore wind map .....	2
Figure 2: Energy generation and consumption in coastal provinces in 2007 .....	3
Figure 3: China's offshore wind development timeline .....	5
Figure 4 China's onshore annual turbine installations .....	8
Figure 5: China's offshore wind development pipeline .....	10
Figure 6: Bohai turbine installation .....	11
Figure 7: Donghai project – China's first offshore demonstration project.....	12
Figure 8: Offshore water depth depiction. Source: World Bank .....	12
Figure 9: Longyuan Group erects first turbines in Intertidal zone at Rudong Intertidal project	13
Figure 10: Map of Chinese wind turbine exports .....	14
Figure 11: Chinese established turbine manufacturer technology transfer mode .....	15
Figure 12: Shanghai Zhenhua Heavy Industry monopile transportation .....	17
Figure 13: CNOOC floating crane .....	18
Figure 14: Turbine prototype development in the Chinese wind market .....	20
Figure 15: Number of international companies engaged in China's wind market.....	21
Figure 16: Asian wind market annual installations .....	23
Figure 17: Broader Asian Qualitative Comparison .....	23
Figure 18: Japan's offshore wind map (at 60m hub heights).....	25
Figure 19: South Korea's national wind map (80m hub height) .....	26
Figure 20: Maximum wind speed of 1/50-year influence of tropical cyclones .....	28
Figure 21: Broader Asia deep sea locations.....	29
Figure 22: Norway and China offshore wind industry qualitative comparison.....	32
Table 1: China's National Goals for Installed Wind Capacity.....	6
Table 2: Offshore Feed-in Tariff .....	9
Table 3: Top Offshore Wind Farm Developers.....	11
Table 4: Offshore Turbine Design Development Pipeline .....	15
Table 5: Chinese Turbine GL Certification .....	16
Table 6: Deep Sea Offshore Wind Industry Overview (East Asia and Norway) .....	24
Table 7: Taiwan - Wind Fixed Feed-in Tariff.....	27
Table 8: Deep Sea Potential - Floating Turbine .....	29
Table 9: Estimated Norwegian Potential in China's Offshore Wind Market 2010-2020 .....	32
Table 10: Norwegian Companies in China Suitable for Wind Industry Development.....	35



## Introduction

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The 21st Century will require a substantial paradigm shift in order to address climate challenges posed by the long-term use of coal and fossil fuels. The implications of continuing to follow this path have far reaching global effects. It requires a unified global effort to minimize the risk of irreversible damage to our planet and our livelihoods, by striving to keep the average global temperature increase below 2°C.

As China becomes one of the largest emitters of green-house gases, it will have a challenging and critical role to play as its economy continues to grow at a staggering rate. Norway, one of the world's leading producers of oil and natural gas will also have a significant role in re-examining its development strategy in order to promote the export of renewable energy. In this transition towards a new energy paradigm, offshore wind is emerging as one solution with significant potential to deliver clean and sustainable energy on a large scale.

Europe is currently the driving market for the development and implementation of offshore wind. The proposed goal of 40GW by 2020 should be achievable as there are already 16GW<sup>8</sup> of consented projects in the pipeline along with another 32GW recently approved in the UK. The development of an industry of this scale will require a new supply chain on a scale that will match the North Sea oil and gas endeavors. The growth in global energy demand, however, is primarily taking place in emerging markets such as China.

Even with the financial crisis in 2009, China remained the world's fastest growing wind industry with 100% year-on-year growth and moved into 3<sup>rd</sup> place globally for total installed wind capacity. The offshore wind industry is poised and ready to take off with pilot projects already under construction, a 13.7GW project pipeline, and political support framework for offshore wind under development. China is now emerging as the second global hotspot for offshore wind development.

The entry of China into the offshore wind market provides huge possibilities to scale-up the industry and speed up commercialization of offshore wind technologies due to the magnitude of China's wind industry. China has 90 wind turbine manufacturers several of which already have offshore wind turbine prototypes manufactured, some of which have already started manufacturing and exporting equipment to Europe's offshore wind industry.

To enable China's full potential speed up the development of offshore wind energy production, bridges need to be made between stakeholders with the relevant experience and the best available technology (typically in Northern Europe), and policy makers and project developers in China.

This study looks at Norway and China from such a perspective aiming to outline the emerging offshore wind market in China, assess the strengths and compatibility of the Norwegian offshore industry cluster, and suggest possible ways forward.

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<sup>8</sup> European Wind Energy Association. "Oceans of Opportunity – Harnessing Europe's largest domestic energy resource." September 2009.

# 1. Emerging Offshore Wind Market in China

## 1.1 Potential of offshore wind in China

China's long coast has a substantial opportunity for offshore wind development. China Wind Energy Association in collaboration with Sun Yat-Sen University based in Guangzhou, which has more than 10 years of wind resource analysis experience, calculated the total technical wind resource potential along China's coast with wind speeds above 7m/s to be 11,000TWh<sup>9</sup>. The analysis was restricted to 100km from the coast at a hub height of 100m applying a 3MW wind turbine power curve to China's coastal wind resources. Compared to studies in Europe<sup>10</sup> the offshore wind generation potential in China is approximately 80% of the North Sea's potential.<sup>11</sup>

The study further classifies the wind resource by water depth in China's predominant coastal provinces: Fujian, Guangzhou, Jiangsu, Hainan, Shandong and Zhejiang. In these provinces the greatest offshore wind energy generation potential (43%) is in water depths below 30m. In consideration of China's deep sea potential, 34% of the wind generation potential is beyond 50m water depths.

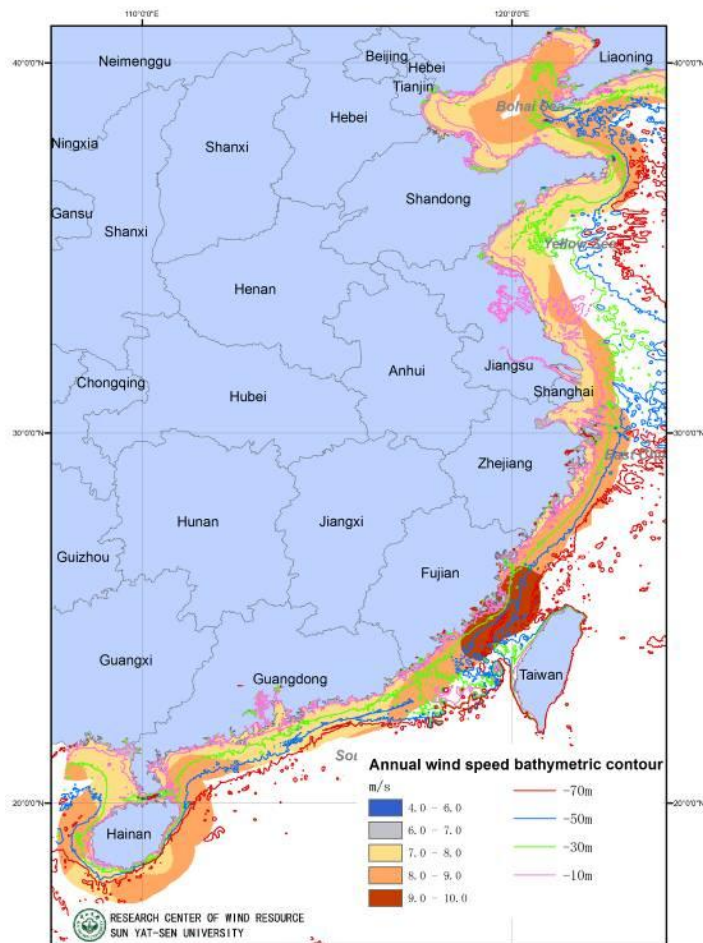


Figure 1: China's offshore wind map

Source: Sun Yat-Sen University

9 Under publication: CWEA. "An Emerging Offshore Wind Development Hotspot." WWF-Norway 2010.

10 EEA Technical Report. "Europe's onshore and offshore wind energy potential." June 2009.

11 Estimates based on figures given in the EEA report above with adjustments made for differences in distance to shore.

**1.1.1 Offshore wind: meeting energy demand in coastal provinces**

China, currently the world's second largest energy consumer, is predicted to reach 1.3-1.4TW (5,500-6,500TWh) by 2020<sup>12</sup> a 40% increase over the 2008 installed energy capacity.<sup>13</sup> Meeting this increasing energy demand driven by exponential economic and industrial growth will require significant developments in energy generation capacity. Even now, energy consumption in coastal provinces already exceeds energy generation up to 25% due to intensive manufacturing and a large population with increasingly energy intensive habits.

Offshore wind may be able to make strong contributions towards offsetting imported energy in China's coastal provinces. This would help reduce significant transmission losses across the country and contribute to the renewable energy goals. Jiangsu province is a particularly encouraging example as its current offshore wind pipeline of 6.8GW (see Section 1.4) could offset 60% of its current 23TWh of imported energy, see Figure 2 below. Only 2% of China's wind generation potential in the coastal provinces would have to be utilized in order to offset the current energy import needs in coastal provinces.

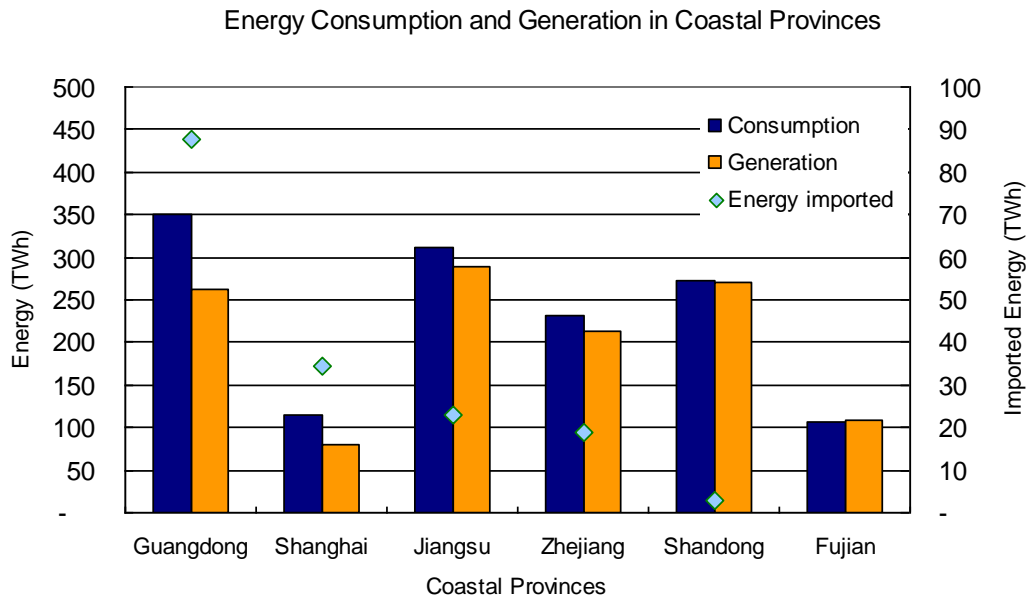


Figure 2: Energy generation and consumption in coastal provinces in 2008, Data Source: China Electric Power Yearbook 2009

China's maximum grid integration for wind thus far has reached 12% installed capacity (an estimated 5% generation capacity) in Inner Mongolia. Using the current energy generation in the coastal provinces listed above, and assuming only offshore wind is installed, 5% wind generation in coastal provinces would equate to approximately 30GW of installed wind.<sup>14</sup> In order to implement this much wind capacity only 2% of the total wind generation capacity within 0-30m water depths would have to be developed in the coastal provinces listed above. Many countries have already achieved much higher levels of wind penetration and as China's energy demand increases and the national smart grid plan is implemented, see Section 2.5.3, increasing amounts of wind energy in coastal provinces will be able to be exploited.

12 Energy Research Institute of the National Reform and Development Commission

13 China Electric Power Yearbook 2009: China's installed energy capacity in 2008 was 793GW

14 Provincial wind technical potential estimates provided by Sun Yat-Sen University

## 1.2 Policy Environment

In order to meet its growing energy needs China has made impressive efforts to expand its renewable energy capacity. The foundation for this expansion was set by the Renewable Energy Law released in 2005. Since the law was published, China has issued a series of targets, including the percentage of renewable energy generation to primary energy consumption, installation capacity targets for each sector, and research and development. The “Medium to Long Term Development Plan for Renewable Energy” sets the goal for the percentage of renewable energy generation to 10% by 2010 and 15% by 2020. Of this 3% should come from non-hydro renewable energy sources including wind, solar and biomass by 2020. For wind energy this goal was translated into an installed capacity target of 10GW by 2010<sup>15</sup>, and 30GW by 2020.<sup>16</sup>

Taking into account that the onshore wind industry has had 100% year-on-year growth in installed capacity since the implementation of the Renewable Energy Law (see Section 1.3.1), it is not a surprise that for onshore wind the most recent 2010 goal of 10GW was met in 2008 with 12.2GW of installed capacity and the current 2020 goal will likely be met in 2010. Due to China’s ever increasing energy demand, the wind industry is looking forward to new targets which will spur further growth. While policies for the offshore wind industry are still in a formative stage, it is likely that the offshore wind industry will see patterns of growth similar to the onshore wind industry.

In order to meet the renewable energy goal of 15% by 2020, China will have to make significant increases to all its national renewable energy installed capacity targets. The Energy Research Institute of the National Development and Reform Commission (NDRC),<sup>17</sup> a national research organization which conducts comprehensive studies on China’s energy issues and provides target advice for the national plans; estimates that the wind installed capacity should to be increased to 100-150GW by 2020. This is 4-5 times higher than the previously set targets and will require significant and sustained industry growth of at least 10GW of annual installed wind capacity until 2020. Considering the ratio of onshore and offshore wind potential, Azure estimates that offshore wind could contribute 20-30GW towards the new target.

The new target for wind installations with specific targets for offshore wind will likely be detailed in the new renewable energy plan. The news of the new renewable energy plan has been changing in the past few months. Information about when it will be published and the time frame it will cover is expected after the National People’s Congress and the Chinese People’s Political Consultative Conference (NPC and CPPCC) meeting which concludes in March or April 2010.

The timeline below outlines the offshore wind industry’s major contributing policies and events which will be addressed in the following sections and throughout the report.

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15 NDRC: Medium to Long Term Development Plan for Renewable Energy

16 NDRC: 11th 5yr Plan

17 The National Development and Reform Commission (NDRC) is a macroeconomic management agency under the Chinese State Council, which has broad administrative and planning control over the Chinese economy. See Appendix A for Chinese Government body descriptions.

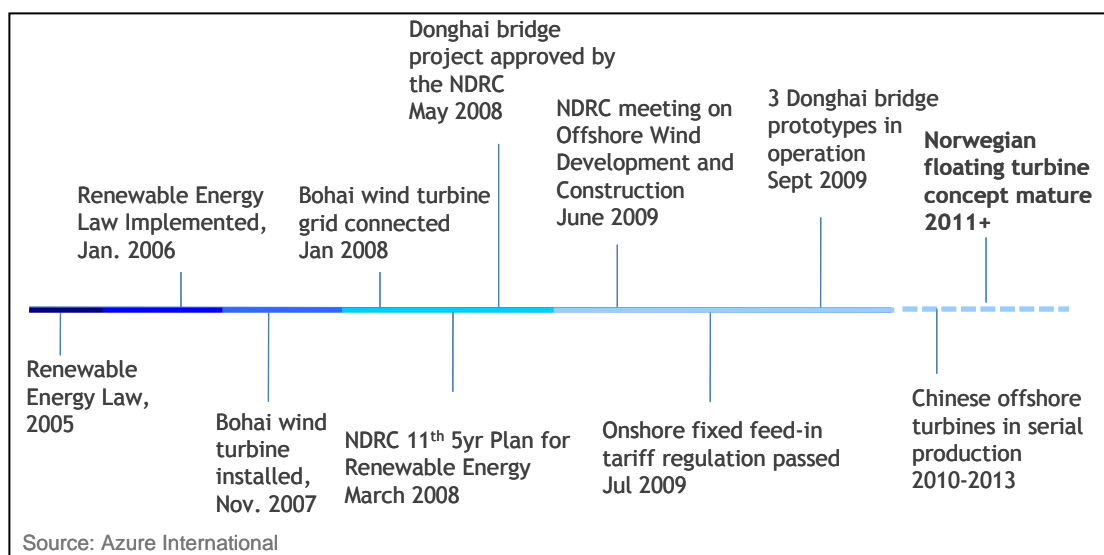


Figure 3: China's offshore wind development timeline

### 1.2.1 Renewable Energy Law and its administrative provisions

The Renewable Energy Law established in 2005 by the National People's Congress of the People's Republic of China and implemented Jan. 1, 2006 has set the stage for the development of the wind industry in China. Designed to promote the development and utilization of renewable energy including wind, solar, hydro, biomass, geothermal and ocean energy, the law sent a clear signal that China's top leadership is serious about ensuring the nation's future energy stability through more reliance on renewable energy sources. The law also formalized the government's commitment to providing electricity to the tens of millions who currently live without grid access.

The administrative provisions of this law still apply for permitting and approval of wind projects throughout China. Wind projects have to follow the provincial level permitting requirements which include but are not limited to wind rights, environmental impact assessment, land use rights, mine suppression, and grid connection pre-approval. If a project is below 50MW then it can obtain project approval at the Provincial Development and Reform Commission level with copy to the NDRC, otherwise the project must be directly approved by the NDRC. Therefore it is common practice in China to implement multiple 49.5MW projects.

Offshore wind projects are not specifically addressed in the Renewable Energy Law; however they will likely follow a similar permitting process to onshore wind projects. At this time permitting for offshore wind project approval has not been standardized and the project approval and feed-in tariff are currently approved at a national level by the NDRC<sup>18</sup>. Offshore wind project approval will have to take into consideration the marine, shoreline, and waterway plans at a provincial level. Therefore the Hydraulic and Hydropower Planning and Design Institute of the Ministry of Water Resources and the Ocean and Fisheries Bureau will play major roles in providing the appropriate permitting.

### 1.2.2 Renewable Energy Law amendment

On Dec. 26, 2009 an amendment was made to the Renewable Energy Law. While the amendment does not change the framework of the law, it provides further detail about how the law should be implemented. One of the noticeable features of the Renewable Energy Law is the "Obligatory Connection" policy, which required the grid companies to buy *all* renewable energy regardless of how it affects the overall stability of the grid. Due to grid infrastructure,

18 NDRC official notice: NDRC[2009]1906

and the energy mix, in areas like Inner Mongolia, where the wind blows strongest in the winter when all the coal fired power plants are running on full load, wind energy was often disconnected due to over production, a clear violation of the law.

The amendment can be seen as a shift in weight of legal obligations for grid companies. Instead of requiring grid companies to purchase *all* renewable energy, it now requires them to purchase a nationally set fixed percentage of renewable energy that meets certain technical requirements with economic repercussions for failing to do so – similar to a renewable portfolio standard. The government, with the development of the Smart Grid Plan (see Section 2.5.3), is putting in place the infrastructure to support increased uptake of renewable energy. However one downfall is that technical grid requirements, released in China in 2005, for wind turbines have not been made mandatory. For both the onshore and offshore wind industries this means that there will be stronger governmental support to balance the quality of electricity on the grid and keep wind turbines connected. This implies that China is starting to move away from just focusing on installed renewable energy capacity to having more performance based targets.

### 1.2.3 11th 5 year plan – most recent offshore industry targets

The most recent targets for the offshore wind industry are detailed in the 11<sup>th</sup> 5 year plan superseding the “Medium-Long Term Development Plan for Renewable Energy.” The plans set the vision for industry development by setting targets, policy, and goals for technology development. The Chinese government releases plans for all sectors of industry every 5 years in its national plans. The section of the plans relating to the renewable energy builds on the framework set in the Renewable Energy Law.

Table 1: China's National Goals for Installed Wind Capacity					
Plan	Date	Year	Overall	Offshore	Note
NDRC: Medium-Long Term Development Plan for Renewable Energy	Sep-07	2010	5GW	1-2 100MW projects	
		2020	30GW	1 GW	
NDRC: The 11th Five-Year Plan for the Development of Renewable Energy	Mar-08	2010	10GW	1-2 100MW projects	Supersedes Medium-Long Plan

Source: China National Development and Reform Commission

The offshore wind development goals include the following objectives:

1. Install 1-2 100MW demonstration projects in coastal provinces such as Shanghai-Jiangsu, Fujian and Guangdong to develop experience in offshore wind farm site assessment, surveying, installation and operations and maintenance.
2. Develop a 3MW offshore wind turbine either through importing technology, joint or independent research and development.
3. Gain experience through installing a 1GW coastal/offshore wind farm in the Shanghai-Jiangsu region.

The goals that have already been set by the NDRC have almost already been accomplished. The offshore wind demonstration project, see Section 1.5.2, is currently under construction, and a 3MW wind turbine was used in the project. Effort is being made towards gaining experience with the installation of 1GW of coastal/offshore wind. Several coastal wind farms have already been built in Yancheng, Jiangsu province and at least two intertidal projects are under construction.

#### **1.2.4 Offshore wind power development and construction meeting – key goals and players for developing a national plan**

The Chinese government is serious about and has already started taking steps towards forming a national offshore wind development plan. The key steps, outlined in a meeting convened on June 2, 2009 by the NDRC and the Ocean and Fisheries Bureau in Nantong, Jiangsu, established a national level action plan that is to be carried out at a provincial level in order to arrange all necessary components for developing the offshore wind industry and forming national level targets. The objectives resulting from the meeting include the following:

- Raise awareness of the importance of offshore wind
- Develop a nationwide plan for the development of offshore wind projects
- Develop an offshore wind transmission scheme
- Accelerate demonstration projects in Shanghai, Jiangsu, and Zhejiang
- Accelerate offshore R&D to decrease construction costs and increase market competitiveness
- Gradually develop an offshore wind feed-in tariff

The key players who will implement the above objectives and will also have significant roles in the continued development of the offshore wind industry are listed below with their assigned responsibilities.

**Provincial Development and Reform Commissions** will work with local design institutes to evaluate the local resources based on marine area availability, wind resource, grid and transmission, and environmental protection in order to develop a provincial level plan. These plans will then be combined to establish a national level plan.

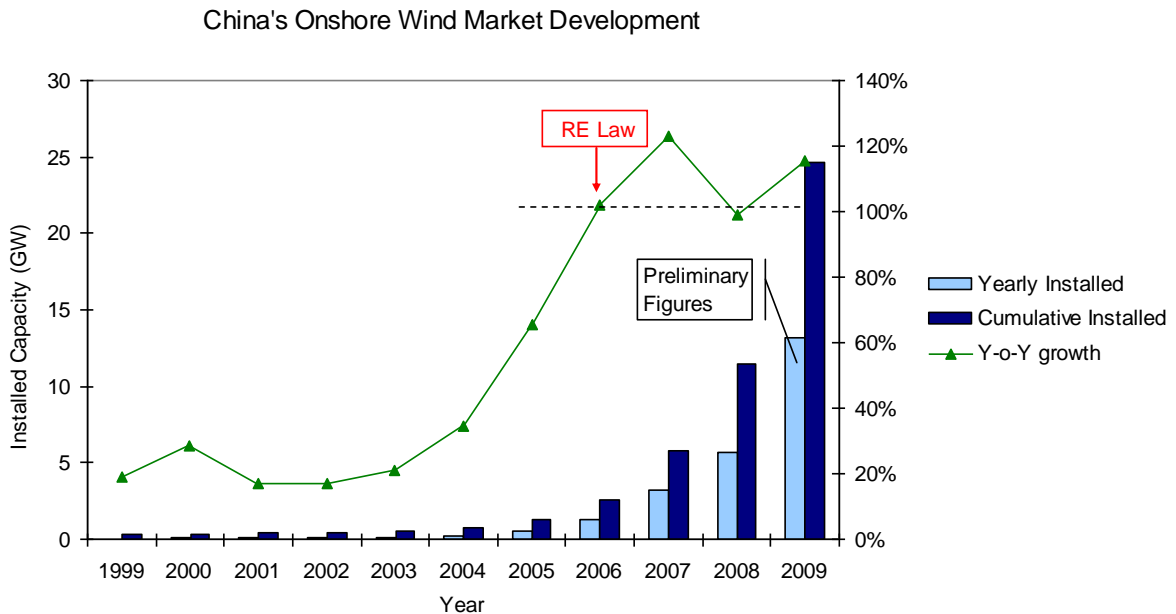
**The State Grid** will coordinate the development of provincial level plans in order that offshore wind energy can be appropriately balanced and integrated into the grid and transmission system.

**The Hydraulic and Hydropower Planning and Design Institute of the Ministry of Water Resources** has a two fold responsibility: the development of national level project construction standards, and overseeing and inspecting the construction of offshore wind projects. It currently has the goal to work with both Chinese and international experts in the development of China's offshore wind national standards.

**Look out for new legislation to be published in the first half of 2010 by the National Energy Bureau and the Ocean and Fisheries Bureau about protocol for offshore wind project development, including investment regulations.**

### 1.3 Development of offshore wind: parallels with onshore wind

#### 1.3.1 China meets and exceeds its goals ahead of schedule



Source: Azure International

Figure 4: China's onshore annual turbine installations

The development of the offshore wind industry is likely to follow a similar pattern of growth as the onshore wind industry – meeting and exceeding nationally set goals. In fact, China usually starts acting on its goals before they are published. When Chinese industries have an idea of the direction that is going to be taken at a national level, they start moving as soon as possible. The Renewable Energy Law is a classic example. Consider the graph above, growth in the industry saw slight increases in 2003 when the Renewable Energy Law was just starting to be discussed, then more significant growth started to occur in 2004 a year before the law was released and two years before it went into effect. Now the industry is doubling every year.

Applying China's patterns of growth to the offshore wind industry, it is already clear that the government is developing the necessary plans and experience in order to set a national target. The experience gained by companies engaged in these initial projects will give them an edge to become leading players in the industry. Once the offshore wind targets are set the industry will likely already be in full swing.

#### 1.3.2 Project performance and feed-in tariffs

China's wind industry is known for a lack of transparency in turbine performance with rumors of serial failures. CDM monitoring reports published on the UNFCCC website<sup>19</sup> are starting to provide some transparency to the market in terms of electrical output. Based on the analysis of electrical output from these reports, Chinese wind farms have a capacity factor 10% lower than US projects.<sup>20</sup> Reduced project performance could be due to factors such as quality, poor

19 UNFCCC website: <http://unfccc.int/2860.php/>

20 Meyer, Sebastian. "China Wind Market Growth Prospects- Policy driver update & Chinese WTG exports?" Renewable Energy Finance Forum. 12 May 2009

project micrositing, and grid connection issues. The move towards using feed-in tariffs, established on a national level in 2009, will help to encourage the wind industry in China to develop based on project performance and energy yield rather than installed capacity.

Feed-in tariffs for the onshore wind industry were developed based on experience gained from the national concession projects approved in 2006. The current tariffs range from 0.51-0.61RMB/kWh (0.05-0.06 Euros/kWh) and are weighted based on regional wind resources. The onshore feed-in tariffs are too low for the development of offshore wind projects and it is too early for China to set national feed-in tariffs. Therefore until the national feed-in tariffs are set, projects will be approved and feed-in tariffs determined by the NDRC on a case by case basis.<sup>21</sup> The table below gives some perspective of the potential range for offshore wind feed-in tariffs in China.

Table 2: Offshore Feed-in Tariff		
Donghai Project	0.96 RMB/kWh	0.10 Euros/kWh
100MW Jiangsu Theoretical Feed-in Tariff*	1.27 RMB/kWh	0.14 Euros/kWh
German Feed-in Tariff	1.21 RMB/kWh	0.13 Euros/kWh

Source: \*Sgurr Energy, Azure International

Comparing the three feed-in tariffs in Table 2 above, the feed-in tariff for the Donghai project outside Shanghai is lower than what is expected for profitable project development. Both the feed-in tariff used in Germany, and the theoretical Jiangsu project feed-in tariff based on an 8% internal rate of return (IRR) are considerably higher. An 8% IRR is often used as a bench mark for wind project development; a very good project would have at least a 12% IRR.

The theoretical feed-in tariff was calculated by Sgurr Energy as part of the offshore wind studies funded by the EU-China Environment and Energy Program.<sup>22</sup> The project was located 8km from shore in Jiangsu and at a water depth of 8.5m using a Siemens 3.6MW turbine. The analysis also takes into consideration Chinese taxes and Carbon Emission Reduction (CER) revenue throughout the project's lifetime. If the same model is applied to the Donghai project the project would have a 4.25% IRR, which is low for profitable project development. Therefore it is too early to predict the offshore wind feed-in tariffs, however CER revenue may be needed to help make the projects financially viable.

### 1.3.3 CDM status

Even with the uncertain future of the Clean Development Mechanism (CDM) after the COP15 meeting in Copenhagen failed to secure a commitment to continue the Kyoto protocol provisions post 2012, there are still many projects applying for CERs to improve financial feasibility.

The use of CERs for the development of wind projects in China came under scrutiny after the implementation of China's fixed feed-in tariff. The UN Executive Board (EB) was concerned as China's nationally set feed-in tariff was less compared to previously approved projects, and the number of wind projects continued to increase. There was speculated that the CERs were not being used for *additionality*, but rather as a supplementary feed-in tariff. In the wind industry following CDM protocol, a project is considered *additional* if the project IRR is below 8% without revenue from CERs and above 8% with revenue from CERs.

In December 2009, the EB clarified that this is a sector wide issue, but does not necessarily indicate that wind projects in China will not get CERs. Wind projects, therefore, must clearly prove *additionality*, many of which are doing so by proving the project is *additional* using

21 NDRC official notice: NDRC[2009]1906

22 EU-China Environment and Energy Program – China Meteorological Association, Sgurr Energy “Offshore Wind Energy Resource Assessment and Feasibility Study of Offshore Wind Farm Development in China /EuropeAid/123310/D/SER/CN – Final Technical Report” 6 Nov. 2009

historical feed-in tariffs which are higher than the nationally set feed-in tariff.

This change in the approval of CERs in the wind industry in China will likely not have a negative effect for offshore wind projects applying for CERs while the current methodology is still valid. *Additionality* should be easy to prove due to the significantly higher capital required for offshore wind farm development.

#### 1.4 Current offshore wind pipeline in China (2009)

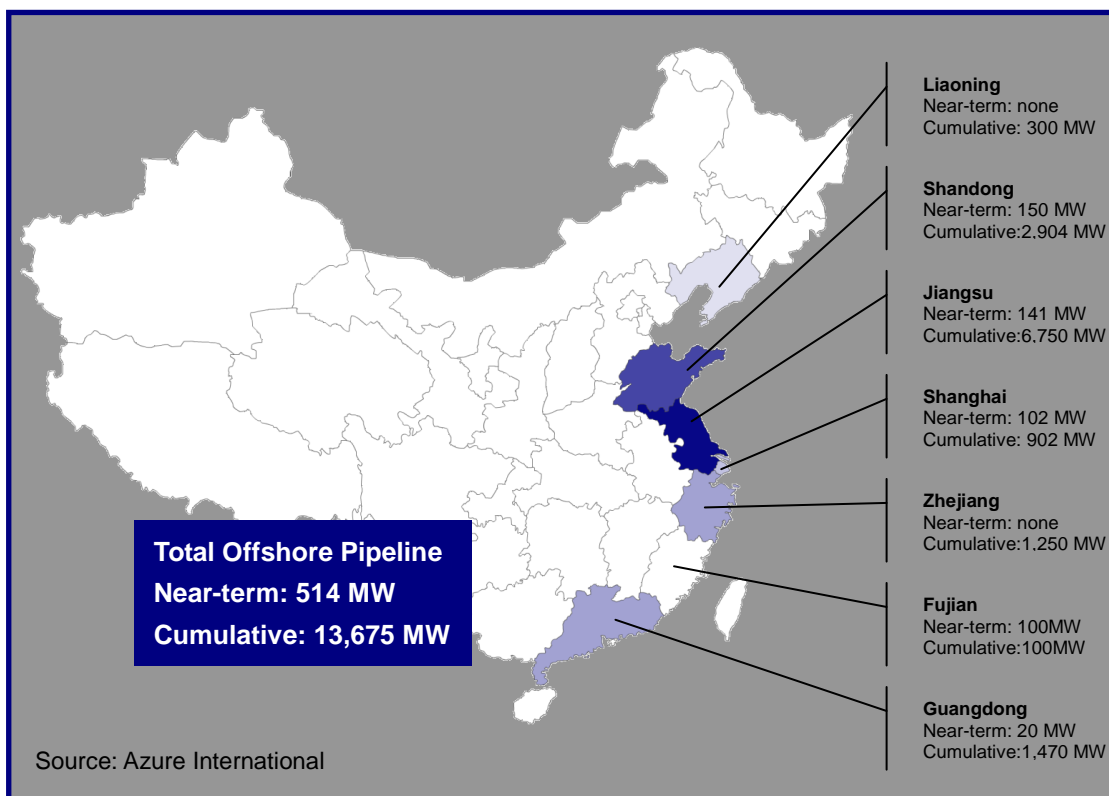


Figure 5: China's current offshore wind development pipeline (2009)

The Chinese offshore wind industry is poised and ready to move with a cumulative pipeline of 13.7GW<sup>23</sup> in place, even though national plans have not been officially released. 17MW have already been installed, 514MW should be installed in the next 3-4 years and the cumulative pipeline is already half way to the estimated future goal of 30GW. Similar to the onshore wind industry, key players have already started taking significant concrete steps in anticipation of national policies which will support the development of the industry.

The developers' plans show that they are confident that there will be strong support of the offshore industry at a national level. Project development will most likely start with lower risk shallow waters in the intertidal zone before moving into deep water. This development means that the shallow water offshore industry is not an empty playing field. The competition will saturate quickly once the national plans are set, but there is still some time before deep sea offshore areas in China will be tapped.

Developers who are not significant players in the onshore wind industry are taking the lead to develop offshore projects in order to gain a strong competitive edge in this new industry. Only half of the offshore developers are strong onshore wind project developers, in Table 3 the top

<sup>23</sup> Azure International keeps a very detailed database of all onshore and offshore wind projects in China. The near-term pipeline includes projects that are expected to be installed within the next 3-4 years. Cumulative pipeline includes all installed, near-term and long-term projects.

onshore competitors are marked in grey by their 2009 onshore industry ranking.<sup>24</sup> China National Offshore Oil Corporation (CNOOC), China Three Gorges, and Guangdong Baolihua New Energy have small portfolios of onshore wind compared to their current offshore plans. CNOOC, for example, has an offshore pipeline of 3.1GW which dwarfs their onshore pipeline of approximately 400MW. A contributing factor towards this trend is the already intense competition in the onshore industry. Therefore many developers want to quickly take advantage of the new opportunity presented by the offshore wind industry sector.

Developers with offshore pipelines over 100MW are included in the table below. Background information for the top 5 offshore developers is given in Appendix B.

Table 3: Top Offshore Wind Farm Developers		Cumulative Pipeline (MW)
	China National Offshore Oil Corp (CNOOC)	3,102
1	Longyuan Power Group	2,465
	China Three Gorges Project Corporation	2,010
3	Huaneng(China) Group (CHNG)	1,302
	Guangdong Baolihua New Energy	1,250
	Guodian Group	800
4	Shenhua Group Limited Liability Company	500
2	Datang Corporation	329
	Changdao Wind Power Development Company	300
	Shandong Sanrong Group	300
	Zhejiang Lvneng Co. Ltd.	196

Source: Azure International

## 1.5 Offshore demonstration projects – Bohai and Donghai

The beginnings of the offshore wind industry have started to materialize: first with the installation of a single turbine in Bohai Sea, followed by the construction of the Donghai demonstration project near Shanghai. Initial experience is now also being gained with two pilot projects in the intertidal zone in Jiangsu province.

### 1.5.1 Bohai project – first offshore project

The Bohai offshore wind turbine owned and operated by CNOOC went into operation in November 2007. The Goldwind 1.5MW turbine used in the project was jointly adapted by Goldwind and CNOOC for offshore conditions. It was installed on an old oil platform jacket in Bohai Sea (closest city is Tianjin) 70km from the shore at a depth of 32m. The electricity generated from the project is used directly by the offshore oilfield.

One of the only foreign companies involved in the project was Det Norske Veritas (DNV) who reviewed the foundation calculations for reliability. The 5.4km of submarine cable was manufactured by Zhongtian Technologies Submarine Optic Fiber Cable Co. Ltd and the foundation, previously an oil platform jacket, was fabricated by COOEC.



Figure 6: Bohai turbine installation  
Source: CNOOC

<sup>24</sup> Azure International. "Project Developer Tracker." 31 December 2009.

**1.5.2 Donghai project – official demonstration project**



Figure 7: Donghai project – China’s first offshore demonstration project Source: China Daily News

The Donghai project, China’s first offshore demonstration project, located just outside of Shanghai, serves as a litmus test for the development of offshore projects in China. A showcase project for the Shanghai Expo in 2010, the project was invested in by China Guangdong Nuclear Investment Holding Company, China Power Investment Corporation, Datang Corporation, and Shanghai Green Energy.

In order to prove that China has the domestic capability to develop an offshore wind industry, no foreign company is known to be involved in the development, construction or installation of the project.

The 102MW project uses 34 3MW Sinovel turbines and is located 8-13km from the coast and 1-5km from the East Bridge in Shanghai. The first three 3MW prototype turbines went into operation on September 4, 2009, 13 additional turbines have been installed as of January 2010. The wind farm is erected in soft seabed conditions using a multi-pile foundation structure designed by Shanghai Investigation and Design Institute. The 78km of submarine cable was manufactured by Zhongtian Technologies Submarine Optic Fiber Cable Co. Ltd and the turbines were installed by CCCC Third Harbor Engineering Co., Ltd.

**1.5.3 Intertidal projects – under construction**

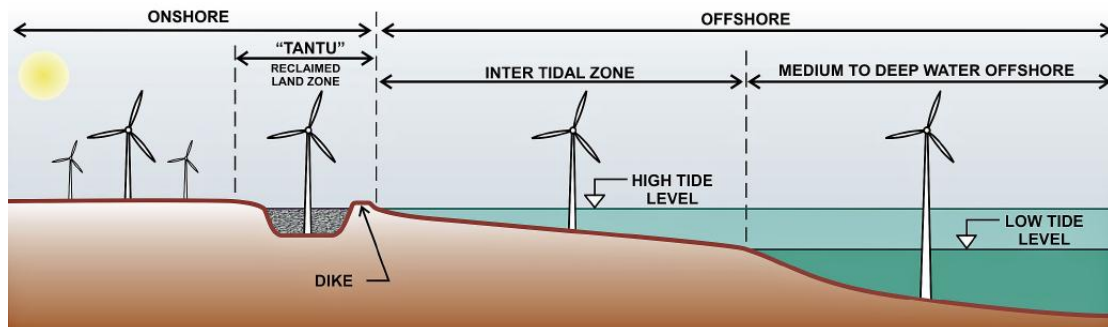


Figure 8: Offshore water depth depiction. Source: World Bank

The intertidal zone, a substantial region located along the coastline of Jiangsu province, is a unique offshore development zone to China and provides many challenges, as it consists of both land and sea. In this zone wind turbine foundations are submersed in several meters of water at high tide and un-submersed during low tide, requiring a unique combination of equipment for installation. Once Chinese developers have mastered offshore projects in the intertidal zone they will easily be able to develop deeper offshore wind projects.

The offshore wind industry is starting to take off as Chinese developers get their feet wet with pilot projects in the intertidal zones. There are two projects which are currently under development.

The first intertidal pilot project is the 30MW Rudong Intertidal Project developed by Longyuan Group in Jiangsu. The pilot project is likely to use turbines from various manufacturers as a



testing ground for future development plans. The first turbines were erected on Oct. 20, 2009 – one 1.5MW Mingyang (Guangdong) Wind Power Technology turbine and one 1.5MW Guodian United Power Technology turbine. The project is located 3.5km from the coast and uses pile foundations.

The second project, Xiangshui, is a 6MW project developed by China Three Gorges Project Corp. in Jiangsu. The project will consist of three 2MW turbines manufactured by Shanghai Electric. The first turbine was erected on Nov. 23, 2009. The project is located 3.5km from the coast at approximately 4m water depths. It is expected to be completed by Feb. 2010.

Many more intertidal projects can be expected in the next few years as China's offshore wind industry learns the necessary skills for offshore wind project deployment, and as appropriate installation technology is developed.

## 2. Industry Developments and Trends

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### 2.1 Development of Chinese offshore wind turbines for the world

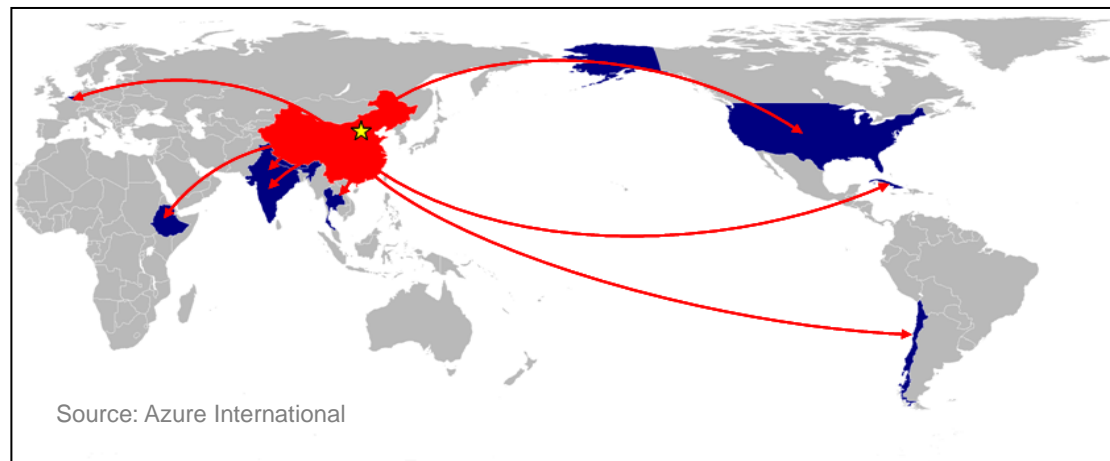


Figure 10: Map of Chinese wind turbine exports

Chinese wind turbine manufacturers are taking active steps to export turbines internationally by making international sales, and establishing international headquarters. Figure 10 above, highlights the countries where Chinese turbine manufacturers have made sales. The same manufacturers who are making international plans are also developing offshore wind turbines; therefore it will not be long before Chinese offshore wind turbines will be present in the international market.

The Chinese onshore wind market is already flooded with more than 90 turbine manufacturers<sup>25</sup> and many of them see the international market as a way of getting around the intense competition in the domestic market. Larger manufacturers such as Goldwind and Sinovel have already installed wind turbines abroad in the US and India respectively.

There is no set trend for Chinese turbine manufacturers' export approach, some start conservatively with a small pilot project of less than 10 turbines to develop the skills and protocol for working with international clients, while others sign large contracts up front. The largest publicly announced order is for a 600MW Texan wind farm, where 240 Chinese turbines will be supplied by A-Power Energy Generation Systems, a previously unknown Chinese turbine manufacturer.

In addition, to exporting turbines Chinese manufacturers are looking to establish headquarters in strategic locations throughout the world including Europe, and the US. Two companies that have already made the move include Goldwind with manufacturing and R&D facilities in Germany and Envision with its Global Innovation Center in Denmark.

The same Chinese manufacturers who are interested in exporting onshore turbines are also committed to developing turbines appropriate for offshore wind applications. They will likely export these turbines once the technology is prototyped and in serial production. The Table 4 outlines the offshore turbine development plans of the top five turbine manufacturers by 2009

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25 Azure Research Team

market share,<sup>26</sup> see Appendix C for turbine manufacturer descriptions.

Table 4: Offshore Turbine Design Development Pipeline				
Company	Turbine	Design company	Prototype	Serial
Sinovel	3MW	AMSC and Sinovel	5 erected, 3 operating	2010
Sinovel	5MW	AMSC and Sinovel	2010	na
Dongfang	2.5MW	AMSC	2010	2012
Dongfang	5MW	AMSC and Dongfang	2012	2013
Goldwind	2.5MW	Vensys and Goldwind	1 erected onshore	2010
Goldwind	3.0MW	Independent	1 erected onshore	2010
XEMC	5MW	XEMC Darwind B.V.	2H 2010	2011
Shanghai Electric	2MW	Aerodyn	1 erected offshore	na
Shanghai Electric	3.6MW	Independent	2010	na

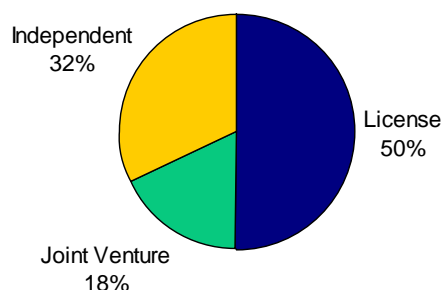
Source: Azure International

In addition, to those in the Table 4 above, there are other manufacturers who are gaining market share and may take on leading roles in the offshore wind industry, included in this group are Mingyang (Guangdong) Wind Power Technology who is developing a compact coastal and offshore 3MW turbine, and Guodian United Wind Power Technology who is developing a 3MW offshore turbine.

## 2.2 Technology transfer modes influencing turbine exportability

Half of the established Chinese turbine manufactures license technology, which may impact their ability to export, see Figure 11. The terms of exportability will be determined by the company that holds the intellectual property rights. Geographical limitations may be imposed particularly if the license has been sold to other licensees in other countries, or if the licensing company produces turbines themselves. Geographical restrictions are more likely for highly competitive markets such as the US and Europe; thereby forcing turbine manufacturers to focus on secondary developing wind markets. Chinese turbine manufacturers are not unaware of these restrictions in Sinovel's most recent deal with American Superconductor Corporation (AMSC) to develop a 3MW turbine they stipulated to have full IP rights.

Chinese Established Turbine Manufacturer Technology Transfer Mode



Source: Azure International

Figure 11: Chinese established turbine manufacturer technology transfer mode

Technology development trends are changing as Chinese turbine manufacturers go from simply buying licensed technology from abroad to developing their own technology. The Chinese government in the 11<sup>th</sup> 5yr plan has particularly encouraged the independent development of 1.5MW and 3MW turbines for the Chinese market. As Chinese manufacturers increasingly develop their own technology they will have greater freedom and access to the international market.

Several turbine manufacturers are getting around this issue by acquiring their own R&D

26 Azure International. "Turbine Tracker." 31 December 2009.

centers abroad. Goldwind, for example, went from licensing a 1.5MW turbine from Vensys Energy AG to owning a 70% stake in the company in 2008. Similarly XEMC bought Darwind, a Netherlands based company who is developing a 5MW offshore turbine, after its previous owner Econcern went bankrupt in 2009.

### 2.3 Industry shift towards international certification

There is little incentive in the Chinese wind market for turbine manufacturers to get international certification; however, as Chinese turbine manufacturers look abroad they are starting to reconsider its importance. China's wind developers and banks do not require international certification for project financing and most turbine manufacturers choose the Chinese certification process administered by the China General Certification Center (CGC). The CGC has been working to develop a set of design standards and turbine certification process since 2003. While CGC is widely accepted in the solar industry, it is not yet clear if the turbine certification process is comparable with international certification bodies such as Germanischer Lloyd (GL), TÜV Rheinland and DNV.

The international certification that comes with the licensed designs bought by Chinese manufacturers is often not valid due to unapproved design changes made at a local level. Manufacturers who are serious about international sales are starting to the certification process with internationally recognized certification bodies. The table below outlines several manufacturers who are taking the necessary steps to have their turbine designs certified by certification bodies such as GL.

<b>Table 5: Chinese Turbine GL Certification</b>			
Company	Turbine	Type	Date
Envision	1.5MW - 68m	GL - D	17-Oct-08
Mingyang	1.5 MW NH 75m TC IIA	GL - C	12-Jun-07
Sinovel	3MW 90m (Offshore)	GLO - A	applied
Sinovel	3MW 100m	GL - A	applied

Source: Germanischer Lloyd, Nov. 2009

### 2.4 Localization

Commerce Minister Chen Deming announced the repeal of the 70% localized content requirement at a press conference in Hangzhou, Zhejiang province, during the China-US Joint Commission on Commerce and Trade in Nov. 2009. The act set by the NDRC has been in place since 2007 and particularly enforced during biddings for China's large concession projects. To date most international turbine manufacturers have already reached 70% localized content, which is not too challenging considering that there at least 350 active component suppliers in the market. Therefore lifting the requirement will not likely change the development of China's domestic wind industry or make the market more open to foreign entrants.

The justification to repeal of the act was more likely to prevent the US from applying a similar localized content requirement for Chinese turbines being exported to the US. The repeal came after red flags were raised by politicians in Texas about USD\$450 million dollars (approx 324million Euros) of stimulus funding that would go to a project which uses Chinese turbines.

The repeal may be beneficial for China's offshore wind market as it would not require international offshore turbine manufacturers to have a China specific offshore wind turbine design. It may also mean high grade steel, large bearings and other materials not readily available may be more readily imported and thus have less pressure to expand in China.

## 2.5 Developments in supporting industries for offshore wind

Only 50% of the development cost of offshore projects goes towards the turbine costs. This leaves a large market for supporting industries including foundations, installation vessels, and grid interconnection and transmission. Chinese industries are developing capacities in these areas and in some cases have already started supplying to the European offshore wind industry. Even so, there is still room for innovative designs, especially to improve cost effectiveness.

### 2.5.1 Foundation design

Chinese companies have started building capacity for offshore wind turbine foundation design based on their previous experience with offshore structures. Some have already started supplying wind turbine foundations internationally. As each offshore wind farm requires a unique set of foundations, there is still room for foreign collaboration on foundation design.

The first two offshore projects installed in China used two different foundation designs due to different water depths. The Bohai project near Tianjin used a jacket foundation design which was originally used for an offshore platform. It was fabricated by COOEC an EPC contractor who has the capacity to fabricate jacket structures up to 200m water depths and has world class fabrication facilities. The Donghai project on the other hand used a concrete multi-pile foundation, not commonly seen in the offshore wind industry, designed by Shanghai Design Institute and installed by CCC Third Harbor Engineering Co., Ltd.



Figure 12: Shanghai Zhenhua Heavy Industry monopile transportation

Source: Shanghai Zhenhua

While Chinese fabrication yards have started to supply to the European offshore wind industry such as Shanghai Zhenhua Heavy Industry Ltd., which supplied 140 monopiles to the Great Gabber project in England, internationally known foundation design companies are starting to establish branch offices in China. P.E Concepts, based out of Germany and known for design and analysis of dynamically stressed structures and Earth Systems Southwest specializing in P&H Tensionless Pier Foundations, used mostly in the US for onshore turbines established branch offices in China in 2009. In addition, DeMaas SMC with its design for a light weight jacket structure for water depths above 20m, signed a 10 year exclusive frame agreement in August 2009 with a certified Chinese fabrication company location near Nantong in Jiangsu Province, China, for the EPC construction and (global) transportation of offshore wind-energy foundation including monopiles and jackets. It is important to keep in mind that any design to be constructed in China must be verified and sealed by a local design institute in order to be valid<sup>27</sup>.

As the offshore wind industry in China takes off there will be more demand for foundation design, especially since China's offshore seabed conditions are very different from those found in Europe.

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27 The Provisional Regulations on the Administration of Foreign Enterprises Engaging in Construction Engineering Design Related Activities ("Decree 78") was issued by Ministry of Commerce on May 10, 2004, effective on June 10, 2004.

### 2.5.2 Boats

Installation vessel needs found in Europe do not necessarily match those for China; however, the two industries already have close collaboration through vessel fabrication.

European windfarms use mostly jack-up vessels for wind turbine installation which may not be appropriate for China's conditions. China's offshore windfarms will be in the intertidal zone which has shallow water depths and very soft sea bed conditions where jack-up vessel legs cannot be used. Chinese companies such as Sany Heavy Industry are developing machinery specifically targeted toward installing wind turbines in the intertidal zone and plan to have a prototype constructed by 2010.



Figure 13: CNOOC floating crane

Source: Shanghai Zhenhua

Offshore wind projects installed in China have used mostly revolving floating cranes for installation. CNOOC, for example, used its 7500t 360° self-propelled floating crane which sails at 8m water depths and crane operation at 14m water depths to install the Bohai wind turbine. This crane and similar cranes are manufactured by Shanghai Zhenhua Heavy Industry Ltd.

There are several Chinese shipbuilders who are in the process of building installation vessels for the European offshore wind industry. Most of the ship designs have been done by European firms. Norway's strong vessel designing experience could easily utilize this trend.

- China Yantai Raffles Shipyard owned by Yantai Raffles, a Singaporean company traded on the Oslo stock exchange, is doing basic development and engineering for new offshore wind turbine installation boat design. Swiv concept ("Semi submersible wind turbine installation vessel) is designed by Leenars, a Dutch marine engineering outfit.
- Cosco Nantong yard in China is fabricating two 137 meter-long wind turbine installation vessels designed by GustoMSC. These two vessels are due to be handed over to the operators in the Netherlands in 2011. They are larger versions of the wind turbine installation vessel Resolution operated by VOS subsidiary MPI Offshore based in Stokesley (UK).
- DeMaas SMC together with Ocean Services plans to market "Wind Jack" a self-elevating turbine installation vessel designed by Global Maritime to the European wind market. DeMaas will oversee the detailed engineering, quality control and construction of the vessel.

The various sea conditions throughout Europe and Asia necessitate specific installation solutions that will require bringing innovative designs to market quickly.

### 2.5.3 Grid and transmission

In May 2009 China released its nationwide smart grid development plan which is expected to be completed by 2020 and cost 4 trillion RMB (approx. 390 billion Euros)<sup>28</sup>. The plan includes the construction and development of ultra high voltage nationwide transmission. The national transmission plans include a total of 6000km of UHVDC 800kV and UHVAC1000kV lines. The improvement of China's grid has significant implications for the wind industry as it will allow higher levels of wind penetration. China has the opportunity to leap frog many developed

<sup>28</sup> 21st Century Business Herald, July 23 2009

[http://www.21cbh.com/HTML/2009-7-14/HTML\\_6WWONQUW6WE9\\_3.html](http://www.21cbh.com/HTML/2009-7-14/HTML_6WWONQUW6WE9_3.html)

countries to using the most advanced technology available. China is currently developing an implementation plan, therefore now is the time to get involved. Western companies with experience in smart grid development and managing high levels of wind penetration may find synergies in the Chinese market.

China's smart grid development plan:

- 2009-2010 Planning and Testing
  - Development plan
  - Technical and operational standards
  - Developing technologies and equipment
- 2011-2015 Construction and Development
  - Accelerating UHV
- Urban and rural grid construction
  - Establishing basic framework for smart grid operation
- 2016-2020 Upgrading
  - Completion of the Strengthened Smart Grid with most advanced technology and equipment

In addition, to nationwide transmission, several Chinese companies are starting to manufacture high voltage 110kV submarine cable. Two of the offshore projects installed in China have chosen to use Chinese manufactured submarine cable

- Zhongtian Technologies Submarine Optic Fiber Cable Co. Ltd has been the most active in the wind industry supplying to both Bohai and Donghai projects. Starting as an optical cable company it has now moved into 110kV cables. Its product was approved by the China Electricity Council in Oct. 2009.
- Shanghai Fujikura Cable Co. Ltd a JV company set by Shanghai Cable Works Co. Ltd, Shanghai Municipal Electric Power Company and Japanese Fujikura in January 2005 with a registered capital of USD 10m.
- Ningbo Orient Wires & Cables is a subsidiary company of the Orient Group. Started manufacturing 110KV submarine cable in 2007. Its cable has been used in grid connection in Zhanjiang and Shantou.

There are opportunities for Western companies to get involved not only with large scale transmission but also offshore wind farm grid integration.

## **2.6 Keeping up with China's pace**

China's very rapid wind industry growth is fueled as companies vie to bring technology to market and take the position as market lead. This high speed, high risk strategy should be taken into serious consideration as Western companies prepare their entrance strategies.

The development of turbine prototypes, see Figure 14 below, provides a strong example of this market trend. The three leading turbine manufactures all went from prototype to serial production in less than two years. In the case of Sinovel and Dongfang, it was their first turbine ever manufactured. Goldwind on the other hand has more experience having previously brought two other turbine models to market.

### 1.5MW Turbines - Prototype to Serial Production

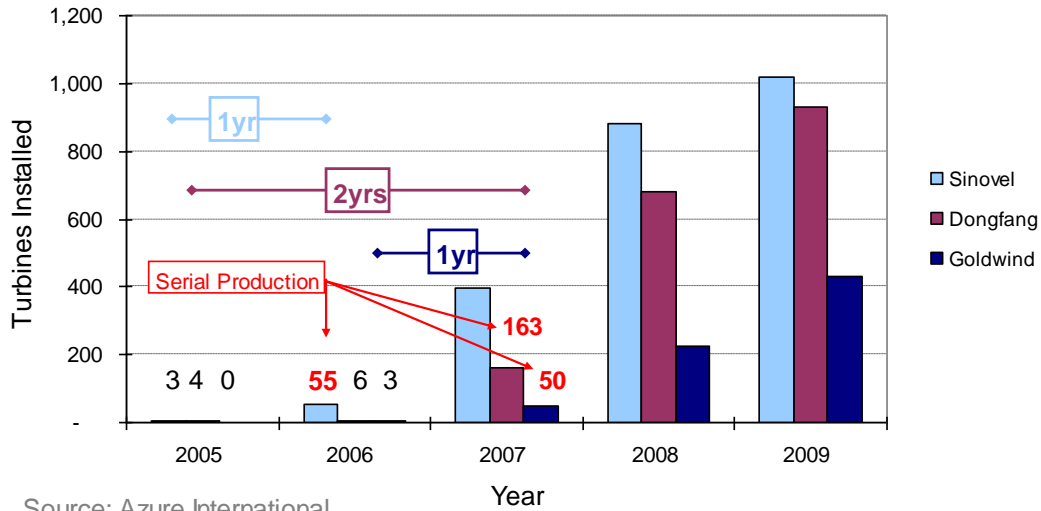


Figure 14: Turbine prototype development in the Chinese wind market

For companies working with and sourcing to Chinese turbine manufacturers it is important to understand where a product is positioned in terms of the pace and size of the industry. For products which are “bottlenecks” to the industry such as bearings, Chinese turbine manufacturers will collaborate with suppliers to establish strategic partnerships and encourage the expansion of production facilities to meet their growing needs. For example Sinovel and SKF Bearings signed a memorandum of understanding to supply bearings, training and engineering support for Sinovel’s 3MW turbine as SKF was expanding their production facilities in Dalian.<sup>29</sup> Another example is Goldwind’s strategic relationship with LM blades. LM is opening its third production facility in China in Qin Huang Dao located in northeastern China, which will primarily supply to Goldwind.<sup>30</sup>

For other components which are in less demand in the wind turbine supply chain, Chinese turbine manufacturers will not necessarily wait for a supplier’s manufacturing capacity to meet their needs before finding another supplementary supplier. Relationship development can also strongly influence product development and a solid well established relationship may help to overcome competition.

29 SKF Press Release. “Strategic Partnership” 16 Dec. 2009  
<http://evolution.skf.com/zino.aspx?articleID=15227>

30 “LM and Goldwind Agreed on Blade Supply Contract” March 16, 2009  
<http://www.renewable-energy-sources.com/2009/03/16/lm-glasfiber-and-goldwind-agreed-on-a-blade-supply-contract/>

## 2.7 Competing international wind clusters in China's market

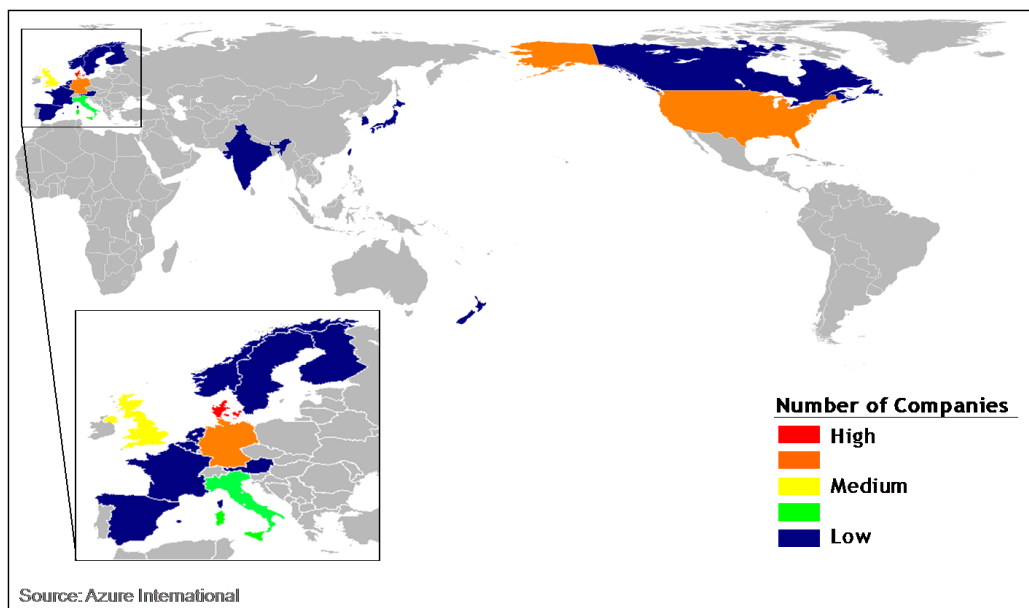


Figure 15: Number of international companies engaged in China's wind market

Figure 15 above graphically represents the number of companies from each country actively participating in China's wind energy conferences and exhibitions. A high level in red represents more than 30 companies actively engaged in China's wind industry, and blue represents less than 5 companies represented. Denmark, Germany and the UK are the best positioned European countries to capture the Chinese market. They not only market their wind clusters actively in China, but have also developed long-term relationships with governmental institutions related to the wind industry. Since they have been building relationships in the onshore wind industry, transitioning to the offshore industry may happen quite smoothly. In terms of presence and visibility in China in the wind arena, Norway is among the bottom rung European nations.

Denmark, Germany and the UK not only have a good representation of companies in China's wind industry, but they also have a clear cluster presence. At China's largest wind energy exhibition, they organized country specific booths and several made presentations to advertise the strength of their cluster particularly in the offshore wind sector. While many companies from the US are actively engaged in China's wind industry, there is no significant cluster presence.

Denmark and Germany have been building long-term relationships in the wind sector with the Chinese governmental institutions through capacity building, training and renewable energy center development. Several of the more significant programs are described below.

Denmark has two programs: the *Danish-Chinese Wind Energy Development Programme (WED)* which ran from 2006-2009, and the *Sino-Danish Renewable Energy Development Programme (RED)* running from 2009-2013. WED's goal was to build capacity through training programs focused on wind planning and wind project performance evaluation. The program was overseen by the NDRC, Ministry of Commerce, and The Royal Danish Embassy, Beijing and worked closely to build capacity with three Chinese companies including: The China Electric Power Research Institute (CEPRI), The China Meteorological Administration (CMA) and The China Hydropower Engineering Consulting Group Corporation (CHECC). RED, the new program, is working very closely with the Energy Research Institute to develop plans for the implementation of a consolidated nationwide Renewable Energy Research Center, similar in function to SINTEF, Risø, ECN, or NREL.

Germany works through GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit) who is focused on promoting sustainable development and has a history of working with China for over 25 years. "Wind Power Research Training Center" (2005-2010) is its current project for developing technical wind capacity. Since the establishment of the project, ten training courses on wind resource assessment and large scale wind-power integration have taken place. Representatives from planning and design institutes, various utilities, developers and manufacturers attended including CEPRI. The program has also established the Suzhou Longyuan Bailu Wind Power Vocational Training Center in 2007 to offer regular technical training and specialized courses for engineers by the center's instructors, foreign experts and experts from the local Chinese and foreign wind-power industry.<sup>31</sup>

*EU-China Energy and Environment Programme* has made significant contributions particularly to the offshore wind industry funding, including but not limited to, an offshore wind resource assessment from Shandong to Jiangsu, with significant capacity building for CMA in coordination with Risø, a feasibility studies of a theoretical wind farm in Jiangsu, and a typhoon impact study. The work for this project was carried out predominately by CMA and Sgurr Energy based out of Scotland with an office in Beijing.

Scotland, similar to Norway, has a large potential for offshore wind development and is also experienced in the offshore sector. Aberdeen, previously an offshore cluster, is committed to becoming the renewable energy capital of Europe looking towards developing offshore wind as the oil resources in the North Sea start to run out. Aberdeen Renewable Energy Group, a strong consortium of companies and governmental institutions, has identified China as a, "powerful and priority renewables' force to be reckoned with and is urging Scotland's renewable players to be ahead of the game by starting to exploit the opportunities already materializing in China – particularly its wind energy sector."<sup>32</sup>

Several Scottish companies and governmental delegations are mobilizing to create relationships with China in order to engage in China's renewable energy sector and particularly offshore wind. One company Sgurr Energy, a renewable energy consulting firm, is a particularly strong example, having established an office in Beijing in 2006. It has been involved in several significant consulting projects such as wind resource assessment in Fujian province, the development of an offshore operations and maintenance manual, and a theoretical feasibility study for a Chinese offshore wind farm. In addition, the Scottish SeaEnergy, a leading offshore wind developer, is already making headway in the development of the Asian offshore wind market, as it prepares to invest in a 500MW wind farm off the coast of Taiwan. As Scottish companies become successful entrants in Asia's offshore wind industry it may create opportunities for more to follow suit.

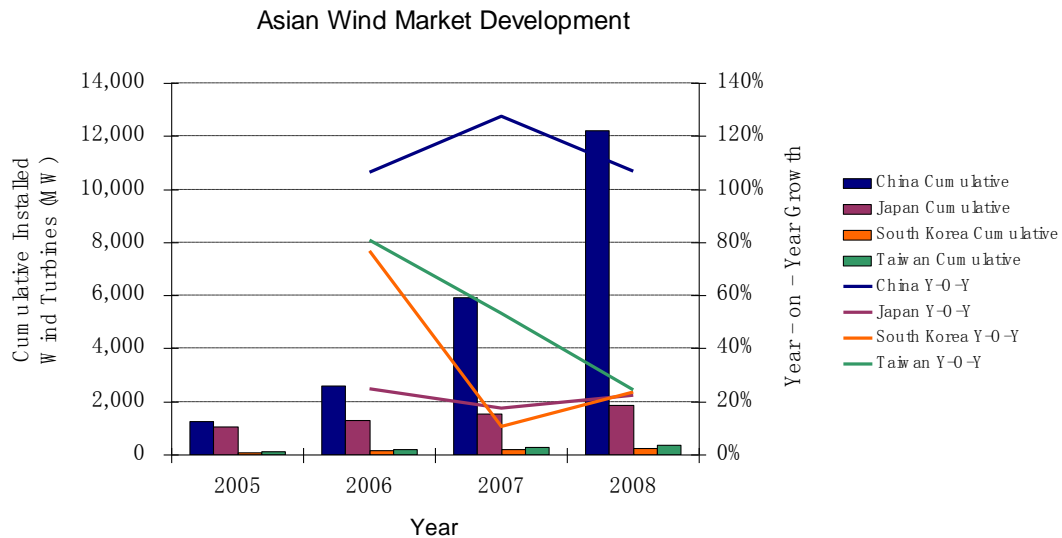
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31 "Wind Power Research and Training Centre", GTZ,  
<<http://www.gtz.de/en/weltweit/asien-pazifik/china/8641.htm>>

32 AREG News Release. "Get Wind of China's Compelling Renewables' Force" 8 January 2009.  
<http://www.aberdeenrenewables.com/default.asp?ContentID=47&nID=27&sID=51>

### 3. Offshore wind potential – regional perspective

#### 3.1 Overview and comparison of wind market development in Asia



Source: GWEC - Global Wind Report

Figure 15: Asian wind market annual installations

Beyond China, the broader Asian wind industry is slow to develop, see Figure 16, due to geographical and policy related constraints. Unlike China - Japan, Korea and Taiwan each have limited land resources to develop onshore wind farms, as most of the country is either densely populated urban areas or mountainous, large portions of which are protected national reserves. Even if permitting is possible, then implementing the appropriate infrastructure and constructing in mountainous regions can be prohibitively expensive. Therefore offshore wind, which is less geographically constrained, provides a strong opportunity for these countries to add more wind capacity into their renewable energy mix

Figure 17 summarizes the strengths and weakness of the engagement potential for Asian countries in the offshore wind industry from both a project development and manufacturing standpoint. The figures may be a useful reference in order to grasp the subtleties of each industry throughout the following analysis.

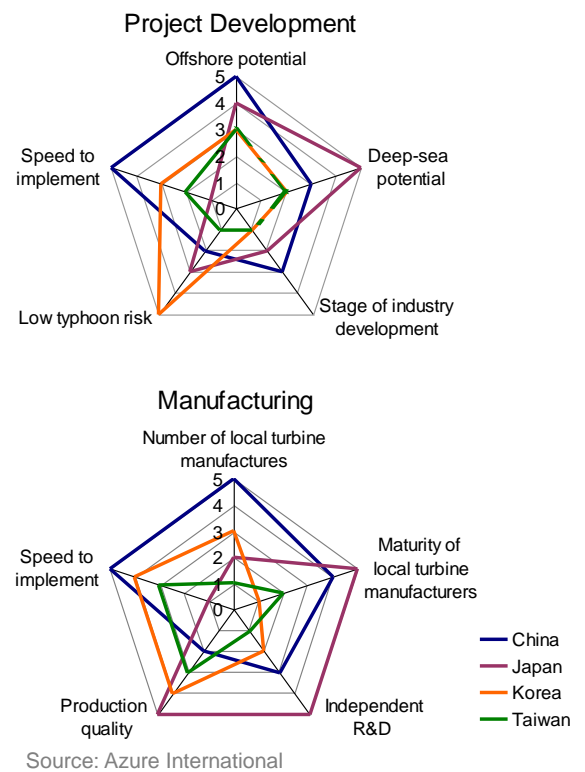


Figure 16: Broader Asian Qualitative Comparison

New policies have been implemented that will help spur on the growth of the wind industry across Asia. Korea enacted a new renewable energy plan in 2008 and is looking to set a renewable portfolio standard by 2012. Taiwan published its renewable energy act mid-2009 and has already set fixed feed-in tariffs for both onshore and offshore wind in Dec 2009. Therefore Taiwan, which has had declining year-on-year growth, will likely start to see new development in the coming years which Scottish Sea Energy has already acted upon. Japan, on the other hand, was early to implement a renewable energy policy and develop wind turbine technology, yet has only seen slow conservative market growth and is unlikely to meet its 2010 target for installed wind capacity. Regardless Japan has had long-term research in the offshore wind implementation and may still have growth.

China has the greatest potential for offshore development. Most of this offshore capacity is in shallow waters and the intertidal zone. China will likely develop these areas first before tapping into its deep sea zones.

The Korean industry falls in the middle of the spectrum between the Chinese and Japanese industries. While overall net offshore development potential is lower, Korea implements faster than Japan and with higher quality than China. In addition, Korea has much less environmental risk due to typhoons.

Norwegian companies have already started to branch out into the broader Asian market. The DNV who has had a long-term established headquarter in China and recently opened a Sustainability Center, is branching out to establishing a port center in Korea which can support offshore wind; providing floating foundation training in Japan in early 2010 and establishing a center of excellence for ships and ports in Singapore.

Table 6: Deep Sea Offshore Wind Industry Overview (East Asia and Norway)					
Country	Offshore pipeline	Policy support	Strengths	Weakness	Deep Sea Potential
<b>China</b>	13,675MW	Likely Supportive	Low cost High speed to implement High potential for offshore wind industry development Ambitions for large scale offshore wind	Developing experience Typhoon risk Quality gap compared to international companies	40GW
<b>Japan</b>	NA	Likely Supportive	Strong deep sea wind research and development Long term wind industry experience	Slow industry development	265GW
<b>Korea</b>	NA	Likely Supportive	High quality products due to experience in the technology and ship building industry Relatively quick to implement technology	Very limited experience in wind industry	25GW
<b>Taiwan</b>	~500MW	Supportive	Offshore wind feed-in tariff already in place	Very limited experience in wind industry High typhoon risk	limited
<b>Norway</b>	350MW	Limited	High quality offshore cluster and R&D, especially deep sea activities. Increasing experience with large scale offshore wind projects in the North Sea	Weak domestic wind industry. Domestic offshore wind market still not developed.	125GW

Source: Azure International

### 3.1.1 Japan's Wind Market

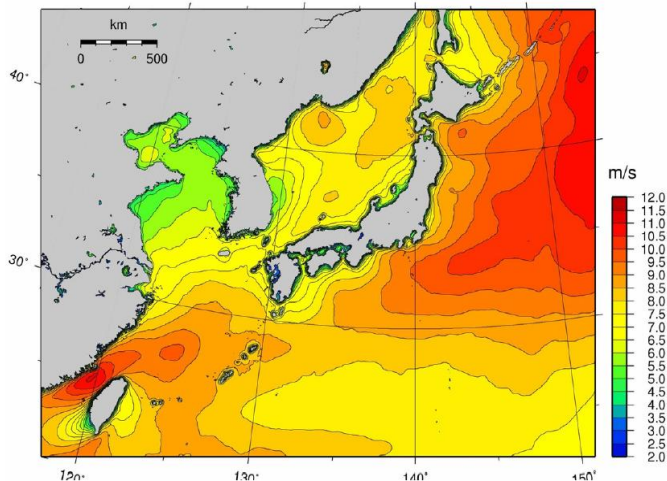


Figure 17: Japan's offshore wind map (at 60m hub heights) Source: Ohsawa et. al 2007

Japan has had long-term involvement in the wind industry with Mitsubishi manufacturing wind turbines since 1980. As China's wind industry has taken off, Japan has maintained a more conservative growth path. It currently has the goal of achieving 3% of its total energy from renewable energy by 2010, 2.1% of which would be from wind, equating to 3000MW of wind.<sup>33</sup> Japan must to accelerate its growth rate in order to meet 2010 national target.

The barriers to developing the onshore wind industry in Japan may spur the development of the offshore wind industry. Optimal locations for building onshore wind farms are limited in Japan due to the high density of people, agriculture and infrastructure. Many rural roads are very narrow with tight curves which do not easily allow the delivery of large blades and nacelles. In addition there are very stringent regulations for projects which can cause delays in project permitting. Being an island nation with an independent grid means, adding a large portfolio of wind to the mix may cause destabilizing effects, if the appropriate technologies are not simultaneously applied.<sup>34</sup> Offshore wind may be a viable solution for Japan as construction will not be limited by land space, local infrastructure, and power transmission.

Japan has a history of severe weather including typhoons, strong lightning, and high turbulence. Due to severe damage to several turbines in 2004 and 2007, the New Energy and Industrial Technology Development Organization (NECO) and the Japan Electrical Manufacturers' Association are supporting the development of a 'J (Japanese)-class' wind model to integrate the IEC and Japanese standards. This design standard would provide guidelines for designing to withstand Japan's severe weather conditions.<sup>35</sup>

Most of Japan's offshore wind resources are located in deep sea areas; therefore, they have actively researched the application of the floating turbine concept. Japanese researchers have been investigating floating turbine concepts as early as 2002 and have also considered the development of concrete spar type design.<sup>36</sup> Several mesoscale wind studies have been done

33 Matsumiya, Hikaru. "Wind Power in Japan." REVE – Regulacion Eolica con Vehiculos Electricos. 2009. National Institute of Advanced Industrial Science and Technology, Japan. 25 Oct. 2009 <[http://www.evwind.es/noticias.php?id\\_not=1963](http://www.evwind.es/noticias.php?id_not=1963)>

34 ibid

35 "GWEC-Global Wind 2008 Report" p.40-41

36 Utsunomiya, T., Nishida E. "Wave Response Experiment on SPAR-type Floating Bodies for Offshore Wind Turbine" Proceedings of the Nineteenth (2009) International Offshore and Polar Engineering

for offshore wind in Japan, and more detailed wind research is continuing to be done by Tokyo Electric Power Company (TEPCO) and the University of Tokyo to investigate offshore wind power using a wind observation system off the Pacific coast of Japan. The project will run through March 2014 using an offshore observation tower placed off the south coast of Choshi City, Chiba Prefecture.<sup>37</sup>

The Japanese market has many established international turbine manufactures. Japan's local manufactures include Mitsubishi Heavy Industry (200kW – 2.4MW), Fuji Heavy Industry (2MW), Japan Steel Works (2MW), and Komai Tekko (300kW). Mitsubishi has stopped selling its turbine in the local market and is focusing primarily on international markets.<sup>38</sup>

### 3.1.2 Korea's Wind Market

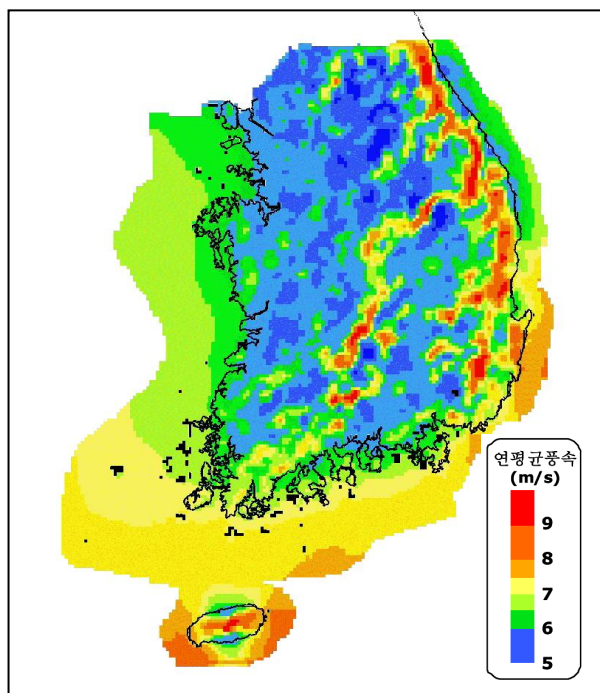


Figure 18: South Korea's national wind map (80m hub height)

Source: Korean Solar Energy Society

Korea has had much more limited development in the wind industry; however activity has picked up particularly in manufacturing as ship builders turn to turbine manufacturing as a new source of income.

The Korean government announced the national renewable energy plan in 2008. According to the new plan, of the total energy mix, renewable energy will account for 4.3% in 2015, 6.1% in 2020 and 11% in 2030. The initiative will cost 111.5 trillion won (about 68.5 billion Euros) of which 100 trillion won (about 61.5 billion Euros) will go towards renewable energy and 11.5 trillion won (about 7 billion Euros) will go to green technology development. The government plans to achieve a 37-fold increase in wind energy compared to the 2007 levels to contribute to the renewable energy goals. There are also plans for implementing a renewable energy portfolio standard in 2012.<sup>39</sup>

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Conference Osaka, Japan, June 21-26, 2009

37 "Offshore Wind Profiling to Start for Future Wind Farm Installation" Japan for Sustainability. 2009. <<http://www.japanfs.org/en/pages/029513.html>>

38 "GWEC – Global Wind 2008 Report" p40-41

39 Korean National Renewable Energy Plan: "Korea Unveils National Renewable Energy Plan". Ministry

The Ministry of Knowledge and Energy published that the Korean government plans to promote Korean made wind turbine generators with an initial project by installing 26 Korean made wind turbines in four locations, 17 of which will be installed on Jeju Island.<sup>40</sup> Plans to develop a 500MW wind farm on Jeju Island were announced in June, 2009 at the 8<sup>th</sup> Annual World Wind Energy Conference which focused on both offshore and onshore wind farm developments. The wind farm will be supported by a 250kV submarine interconnection cable which will link Jeju Island to Korea's southern most province.

Korea has at least 8 domestic turbine manufacturers. The primary manufacturers include Samsung Heavy Industry who is developing a 2.5MW onshore turbine consulting with Romax for the drive train, and Daewoo, who in 2009 bought DeWind with turbine designs up to 2MW and implements Voith WinDrive technology. In addition, Daewoo is also building an offshore turbine vessel for RWE Innogy, and looking to establish wind turbine manufacturing in China. Other key players include Hyundai Heavy Industries (1.65MW), Doosan (3MW), Hyosung (750kW, 2MW) STX Corporation (Harakosan – 2MW), and Unison (750kW, 2MW).

Barriers to developing onshore wind farms are higher than those faced by offshore wind development in Korea. This is particularly because onshore areas with good wind resources are located in mountainous areas away from large population centers and often are natural preserves. Therefore legal permitting for these areas is often very difficult if impossible to obtain.<sup>41</sup>

The Wind Energy Research Center, part of Korea's Institute of Energy Research, published an offshore wind energy potential study. Estimations were made using a 3MW offshore wind turbine with an 80m hub height. Its study estimates an offshore theoretical potential of 309.0GW and implementable potential of 7.9GW.<sup>42</sup>

### 3.1.3 Taiwan's Wind Market

After nine years of debate, Taiwan passed its renewable energy act in June 2009. The new legislation is expected to boost the renewable energy industry with an investment of nearly 30 billion Taiwan dollars (approximately 650 million Euros). With the enactment of new legislation, the renewable energy generation capacity will increase from 6.5GW to 10GW in the next 20 years. According to the figures given by Taiwan Power Co. (a state-run company), the contribution of renewable energy resources to the total installed capacity in the country at present is 5.8% or 2,278 MW.

On Dec. 31, 2009 the Ministry of Economic Affairs approved the final fixed feed-in tariffs for all renewable energy projects in Taiwan. The feed-in tariffs will be effective for 2010 and will be reviewed and adjusted on an annual basis. An approved project's feed-in tariff will remain fixed over 20 years.

Project type	NT / kWh	eqv. Euro / kWh
Over 10kW	2.38	0.05
Offshore	4.20	0.09

Source: Taiwan Ministry of Economic Affairs

of Knowledge Economy. 22 Jan. 2009; "Korea Goes for 'Green Growth'" International Energy Association Press Release. 11 Sept. 2008. <[http://www.iea.org/papers/roundtable\\_slit/korea\\_oct08.pdf](http://www.iea.org/papers/roundtable_slit/korea_oct08.pdf)>

40 "2009 New and Renewable Energy Project (2)". Ministry of Knowledge and Economy. 10 Dec. 2010. 82-2-2110-5401

41 "GWEC-Global Wind 2007 Report". p56-57

42 Kim, Hyun-Goo. "Onshore/Offshore Wind Resource Potential of South Korea". Wind Energy Research Center, Korea Institute of Energy Research. 2009.

Taiwan has had limited wind farm installments, which may be due to the lack of policy support and frequent typhoons. However, recently the Scottish company SeaEnergy and Taiwan Generations Corporation have announced plans to develop a 500MW offshore project. The Changhua Offshore Wind farm will be located in the Taiwan Strait off Changhua county on the West Coast of Taiwan, about 2.5-10 km from shore in water depths up to 30 m. If this wind farm is constructed it would more than double Taiwan's cumulatively installed wind capacity.

The most significant Taiwanese turbine manufacturer is TECO. In 2008 TECO teamed up with AMSC to manufacturer AMSC's FC2000 a 2MW - IEC Class I turbine. It started construction of a manufacturing plant in 2009 in Fuqing, Fujian province, China and plans to start producing turbines in 2011.

### 3.2 Typhoon Risk

Typhoon damage will prove to be a challenging barrier to the development of the offshore wind industry in Asia especially in China and Taiwan. Typhoons can easily cause a turbine's light fiberglass blades to be destroyed, and in some cases have also caused significant damage to towers and nacelles. The safety design standards set by IEC 61400-1: 2005 specify that the wind speeds for IEC class I turbines, which correspond to a turbine design for the highest wind speeds, cannot exceed 50m/s once in 50 years.

The National Climate Center of the China Meteorological Administration recently published an in depth report<sup>43</sup> about the impact of typhoons for the development of the wind industry on China's coast. The report addresses where conditions exceed wind turbine design standards by studying the 579 tropical cyclones which have occurred in China from 1961-2007. The most extreme conditions outlined are *super typhoons* with wind speeds from 41.5-50.9m/s and *severe typhoons* with wind speeds greater than 51m/s. The dominant paths of these two types of typhoons are in Appendix D.

To obtain a map with the maximum wind speeds which occur once in 50 years, see Figure 20, the wind speeds and wind fields of the tropical cyclones were statistically modeled. While typhoons affect the entire coast of China, the worst hit areas are in southern China in Guangdong and Hainan. In addition, the eastern coast of Taiwan is hit especially hard.

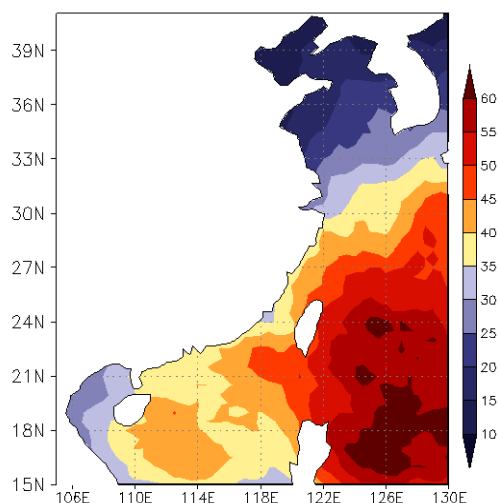


Figure 19: Maximum wind speed of 1/50-year influence of tropical cyclones

Source: China Meteorological Administration

43 China Meteorological Administration. "Feasibility Study for the Impact of Typhoons on Offshore Wind Farm Operations in China". EU-China Energy and Environment Programme, Renewable Energy Component. Beijing. 30 April 2009.

### 3.3 Deep sea potential in Asia

Japan has the greatest deep sea (50m+) potential in Asia, followed by China and Korea. Estimates from a preliminary assessment<sup>44</sup> for water depths between 50-300m are given in the table below. A 25% constraint to the overall theoretical potential was applied to account for shipping, environmental factors, low wind speeds, and tourism.

Table 8: Deep Sea Potential - Floating Turbine		
Country	Potential (GW)	Foundation Type
China*	40	TLP
Japan	265	Spar and TLP
Korea	25	Spar and TLP
Norway	125	Spar and TLP
Foundation Type Classification		
Classic offshore	0-50m	
Tensionless Leg Platform (TLP)	50-300m	
Spar (Floating foundation)	150-500m	
*Rough deep sea estimate		
Source: Garrad Hassan 2009		



Figure 20: Broader Asia deep sea locations

The map combines information from several sources to give an approximate representation of the deep sea areas throughout Asia. Closer investigation is needed to determine if there might be other areas along the coast of Southern China.

It is likely that Japan will take the lead in applying deep sea offshore technology as most of the waters off the coast of Japan are very deep. In order for Japan to move forward, policies and incentives will have to be applied to make deep sea offshore wind development economically viable. Korea may initiate the deep sea industry in Asia, as it started making efforts to develop its offshore industry. Taiwan will likely not play a role in the deep sea offshore industry as its deep sea areas are on the eastern side of the island which is heavily hit by typhoons. As China is surrounded by a great deal of shallow water it is likely that these areas will be developed first before investing in deep sea offshore. Therefore the deep sea offshore industry is several years down the road.

44 Henderson A., Witcher D., Morgan C., "Floating Support Structures Enabling New Markets for Offshore Wind Energy". Garrad Hassan & Partners. 2009

## 4. The Norwegian offshore cluster and the potential in China

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### 4.1 Norway's emerging offshore wind cluster

Norway has the possibility of becoming a leading exporter of renewable energy in Europe. In the EEA study comparing the offshore wind potential of all European countries Norway ranks among the top 5.<sup>45</sup> Enova SF has estimated Norway's offshore potential at 14,000TWh up to 300m water depths and 1,000TWh up to 60m water depths.<sup>46</sup> The development of the 'Super-grid' interconnection in the North Sea could further enhance Norway's participation in the offshore wind industry with its balancing capacity using hydropower. While Norway's offshore industry has developed around the export of oil and gas, wind balanced with hydropower may be the way of the future.

Surveys show that there is a large interest from companies in the offshore oil and gas sector to branch out into the offshore wind sector.<sup>47</sup> Encouraging steps are being taken at a governmental level with the draft Act submitted in June 2009 to the Norwegian Parliament which provides legal framework for offshore wind development. The objective of the Act is to outline the areas which may be suitable for offshore wind and a revised offshore wind implementation plan will be issued in 2012.<sup>48</sup>

Despite the strong offshore wind potential, the domestic market growth has been very slow to develop. Norway has only installed 2.3MW of offshore wind capacity in 2009, 0.1% of Europe's 2.1GW cumulative installed offshore wind capacity.<sup>49</sup> Norwegian companies such as Statoil and Statkraft, which have the skills and resources for significant offshore wind development, have had to look beyond the shores of Norway to projects in markets with stronger policy support, such as the UK. Financial policy support is needed for offshore wind, especially if projects such as Havsul I, Norway's first offshore wind farm which was just given consent in September 2009, are to be successfully developed.

There are still some strong barriers to transforming the Norwegian offshore cluster into an offshore wind cluster:

- Norway has little installed wind power and therefore modest industry experience with wind power.
- Norway has no domestic offshore wind farms, especially preventing small and medium-sized Norwegian offshore companies to gain experience with offshore wind.
- Norway lacks a domestic wind turbine company which could serve as a hub for the industry cluster.
- Norway's offshore cluster suffers from a general shortage of engineers hampering the capacity to follow-up and leverage potential for up-scaling and diversifying.

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45 EEA Technical Report "Europe's onshore and offshore wind energy potential" June 2009

46 Enova SF "Potensialstudie av havenergi i Norge" 23 Oct. 2007

47 SINTEF "Vindkraft offshore og industrielle muligheter", 2009.

48 Norwegian Ministry of Petroleum and Energy Press Release "The Norwegian Government proposes new legislation on offshore renewable energy" 26 June 2009

49 EWEA. "The European wind industry – key trends and statistics 2009". January 2010

Norwegian energy needs are relatively stable and almost exclusively supplied by clean hydropower. Thus there are few domestic incentives for development of comparatively expensive offshore wind power. Norway has also been slow to utilize its potential as a clean technology exporter. A recent world wide country ranking of clean energy technology sales (2008) in absolute and per capita terms, found Norway on the last position (26) listed in both categories.<sup>50</sup>

In order to realize Norway's potential as an international offshore wind energy facilitator and provider, policy frameworks need to be improved and targeted efforts are necessary to promote the Norwegian cluster in international markets. Today, Norway is behind countries like Denmark and Germany, where the companies Vestas and Siemens are leading the efforts. In Norway, the companies Statoil and Statkraft have the potential to play a similar role in a global push to position Norway as a key offshore wind energy facilitator and provider.

#### 4.2 Engaging in China's offshore wind industry

Norwegian companies stand out for innovation and high standards of excellence, coupled with strong experience in the maritime and offshore oil and gas industries. This combination of skills provides the necessary expertise for large scale offshore wind project development demonstrated by the recent winning of the 9GW Dogger Bank project bid.

"Offshore wind is a strategic pillar for Statoil's New Energy business."

~ Executive Vice President of Statoil  
Margareth Øvrum

Upon winning the bid for the Dogger Bank project Executive Vice President of Statoil Margareth Øvrum commented that, "Offshore wind is a strategic pillar for Statoil's New Energy business." Developing the project will potentially require between 3,000-4,000 wind turbines, this presents an opportunity for Norway to create a path for Chinese turbine manufacturers to enter the Norwegian market, as well as serve a gateway to the greater European market.

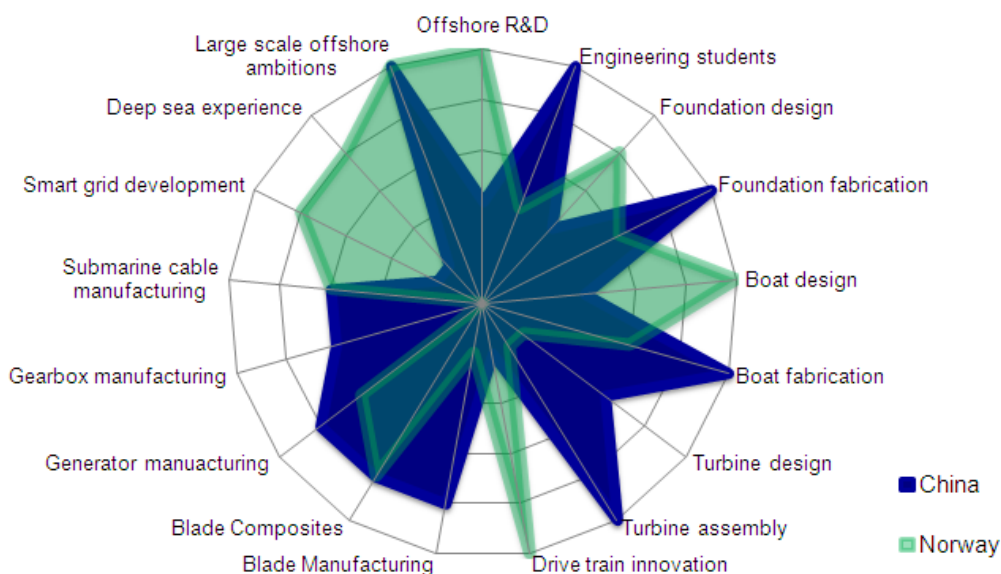
The Dogger Bank project may also serve as a catalyst for a longer term Norway-China wind relationship. Since Norway has a limited number of domestic turbine manufacturers (Scanwind now owned by GE and Sway AS piloting the development of a 10MW turbine supported by Enova), Norway can encourage a Chinese manufacturer to establish in Norway, thus meeting the needs of the potential domestic offshore wind market, and more importantly large scale projects already in the pipeline. This type of collaboration also provides the opportunity for greater exchange of knowledge and human capital.

Even though China has just started to install smaller offshore wind projects, its plans for future wind farms are on the 1-2 GW project scale. Norwegian and Chinese companies will thus both face similar challenges in order to address the economy of scale and methodology for large scale wind farms. This opens a possibility for Norwegian companies engaged in offshore wind in the North Sea, in the short to medium-term perspective, to transfer experience and engage in the Chinese offshore wind market provided necessary resources are available.

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50 Roland Berger Strategy Consultants: "Clean Economy, Living Planet. Building Strong Clean Energy Technology Industries", WWF 2009.

### Offshore Wind Industry Comparison



Source: Azure International

Figure 21: Norway and China offshore wind industry qualitative comparison

The potential to engage and collaborate in the mutual development of large scale offshore wind is largely due to the complementary characteristics of the Norwegian and Chinese offshore wind industries, qualitatively represented in Figure 22. Areas of Norwegian strengths where there are Chinese needs include: offshore R&D, foundation design, boat design, drive train innovation, grid development and general ocean installation and service experience (especially deep sea).

Norwegian companies if they actively pursue opportunities in the Chinese market have the possibility of capturing a good market share. An estimated 74 billion Euros will be spent on the development of the Chinese offshore wind industry over the next decade. Of this foreign competitors are likely able to capture 30%<sup>51</sup> of the industry. Considering the Norwegian offshore cluster and Norway’s maritime presence in East Asia, suggests that Norwegian companies could capture 10% of the market available for foreign competitors. Then applying standard offshore project breakdown and accounting for Norwegian companies’ technical strengths, Norway has the potential to secure a total of approximately 930 million Euros over the next decade. These estimates do not take into consideration China’s large market potential for installation vessel fabrication and *exported* offshore wind products such as foundations.

Table 9: Estimated Norwegian Economic Potential in China's Offshore Wind Market 2010-2020		Market potential (Euros)
Foreign market		22 billion
10% of Foreign market		2 billion
Norwegian potential based on industry strengths		930 million
Foundations		580 million
Electrical infrastructure		130 million
Electrical installation		220 million

Source: Azure International

51 Azure Research Team – estimated portion of the market occupied by foreign competitors based on dynamics of the onshore wind industry

In a long-term perspective once China has exhausted its near-shore offshore development opportunities, it may consider engaging in deep sea wind farm development. Japan or Korea will likely have started developing deep sea offshore wind farms already. It would thus be strategic for Norwegian companies with deep sea offshore wind technology and expertise to in the short to medium-term perspective develop contacts and cooperation with Korean and Japanese stakeholders. Norwegian companies may want to simultaneously develop projects in coordination with Chinese companies in order to leverage resources in China for broader Asian and European development. Then as China starts to deploy deep sea projects, Norway will already have developed the appropriate networks and technology to work closely with China on deep sea projects.

#### **4.2.1 Applying Norwegian technology in China's market**

Designs, regardless of how innovative they are, have to make it to the market to impact industry development. China's companies as discussed in Section 2.6 will take designs from prototype to serial production very quickly in order to stay competitive in the market. Norwegian companies, can take advantage of this industry trend to bring an innovative design to market quickly. In China there are an increasing number of options for foreign companies to enter the market from licensing to establishing a branch company in China. It is important to investigate the advantages and disadvantages of each option to make sure that they will meet the needs of your business structure. Currently there are four options for establishing a company: representative office, joint-venture with a Chinese company, wholly owned foreign enterprise and foreign invested commercial enterprise (see Supplementary Section 6 for details).

Innovative designs from Norway, to name a few, which may be manufactured in China for the European market or marketed directly to the broader Asian wind industry include but are not limited to: Sway and Hywind deep sea floating turbine designs, ChapDrive hydraulic drive train solution, SmartMotor permanent magnet gearless generators, and Windflip Hywind turbine installation design.

Even though China's intertidal offshore conditions require specialized offshore equipment, China has already started supplying wind turbine installation vessels and foundations to Europe, see Section 2.5. Vessels being supplied to the European market will have to work closely with the DNV to be classified according to European standards.<sup>52</sup>

Norway's involvement in the European 'Super-grid' connection and balancing wind power with hydropower may be a point of collaboration with China as it develops its grid implementation plan, see Section 2.5.3. This development will significantly increase China's possible wind penetration levels.

Norwegian companies, who work with Siemens and Vestas, may find it helpful to know that both companies have established plants and offices for offshore wind in China. Siemens started constructing a 64 million Euro plant in Shanghai in May 2009<sup>53</sup>. The plant will first start with manufacturing blades for 2.3MW and 3.6MW turbines. Vestas Offshore announced in a local press release in June 2009 that it had plans to establish an office in China. Anders S e-Jensen, President of Vestas Offshore Denmark says, "Being the first mover in building offshore power plants and a global leader in offshore wind energy...We see the Chinese offshore market as one of most important future wind energy markets in the world."<sup>54</sup>

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52 DNV recently established the offshore wind installation vessel classification standards. Press-release: [http://www.dnv.com/press\\_area/press\\_releases/2009/dnvlaunchestheworldsfirstclassnotationforoffshorewindturbineinstallationunits.asp](http://www.dnv.com/press_area/press_releases/2009/dnvlaunchestheworldsfirstclassnotationforoffshorewindturbineinstallationunits.asp)

53 Siemens Press Release. "Siemens China continued to grow in fiscal 2009 despite economic recession" 16 Dec. 2009

54 Vestas Press Release. "Vestas Offshore Sets its Sights on China" Local Press Release, June 2009

#### 4.2.2 Strengthening educational and research platforms - together

“Offshore wind energy may become the next adventure for the Norwegian industry and energy sector.”

~ Norwegian Minister of Petroleum and Energy, Mr. Terje Riis-Johansen

The availability of human resources may be a limiting factor for the development of large scale offshore wind farms as it requires hundreds of skilled and experienced staff to carry out project development, installation and operations and maintenance. Especially to achieve the hopes of Norwegian Minister of Petroleum and Energy Mr. Terje Riis-Johansen that “Offshore wind energy may become the next adventure for the Norwegian industry and energy sector.”

Installing large scale offshore wind farms is at least 5-10 years down the road, therefore planning can be made now for future human resource needs. Norway’s resources may feel particularly stretched in the future as only 2,721 students graduated with bachelor degrees, 2,328 with masters and 542 with doctorate degrees in natural sciences, vocational and technical subjects in 2008.<sup>55</sup> A clear opportunity exists for Norway to leverage human resources and talent from China. Norway has already developed several strong relationship platforms for educational exchange with China particularly in the offshore and marine sectors. These relationships can be further developed to integrate Chinese engineers and Norwegian research and development to promote the offshore wind industry.

Research centers will play a strong role in creating ties between Chinese and Norwegian governmental institutions, industry, and international exchange programs. Norway has two such research centers: Nowitech - Norwegian Research Center for Offshore Wind Technology and Norcowe – The Norwegian Center for Offshore Wind Energy. The centers actively research wind technology innovation, including the drive train and blades, deep sea foundations, grid connection and integration, and operations and maintenance.

Norwegian companies have started cultivating relationships with Chinese educational institutions. The DNV and the Shanghai Maritime University recently established a strategic partnership to develop an international cooperation center. The center’s functions will include maritime research and training and also provide scholarships. In addition, Statoil has been involved with collaborative research activities at Tsinghua University.

On a governmental level the Norwegian Association for Higher Education Institutions has developed the “China Meeting Place”<sup>56</sup> a platform for higher education and research exchange in November, 2009: The goal of the institution is to promote bilateral higher education between China and Norway, bringing both Chinese engineering students to Norway and sending Norwegian students to China for masters or PhD programs. It also has the goal of encouraging research institutions to build up R&D centers in both countries.

The first efforts made under the umbrella of the “China Meeting Place” included a trip to China by Agder University, Telemark University College and Gjøvik University College to visit several universities throughout Harbin, Hubei and Beijing. Resulting from that trip Telemark University College signed a strategic agreement with Harbin Institute of Technology.

There is still significant room to expand collaboration on research and development, especially on a governmental level, in order to establish stronger relationships with research bodies and institutions throughout China.

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55 Statistics Norway – Students in tertiary education for 1998, 2007,2008 <http://www.ssb.no/>

56 Royal Norwegian Embassy Website. “China Meeting Place for Higher Education and Research Development” 2 December 2009 [http://www.norway.cn/News\\_and\\_events/Education-and-research/Education/China-Meeting-Place-for-Higher-Education-and-Research-Development/](http://www.norway.cn/News_and_events/Education-and-research/Education/China-Meeting-Place-for-Higher-Education-and-Research-Development/)

### 4.3 Building on existing Sino-Norwegian relationships

At present there are only four Norwegian companies who have a presence both in China and in the wind industry: Statoil, DNV, Jotun, and Grieg Group. Regardless, Norwegian companies have a long history in China's marine and offshore industries, which can provide a strong foundation for development in China's offshore wind market.

This relationship goes as far back as 1878 when 15 ships were registered at Norway's Consulate in Shanghai, one of which was the first steam ship to call into a Chinese port the Haakon Adelsteen from Bergen<sup>57</sup> - currently home to Norcowe.

More than 100+ Norwegian companies have offices and are actively involved in business in China. In order to speed up the process of engaging in China's offshore wind industry, the existing resources and networks of the maritime and offshore oil and gas industries should be utilized. Table 10 outlines the number of Norwegian companies in China which work in industries that could possibly cross over into the offshore wind industry.

Table 10: Norwegian Companies in China Suitable for Wind Industry Development	
	No.
CDM	1
Development zone	1
Finance	5
Law	1
Marine and Shipping	>32
Offshore	>3
Wind industry	4
<b>Total</b>	<b>47</b>

Data Source: Norwegian Business Forum Beijing

Prominent existing relationships and experience of Norwegian Companies in China include the following:

- Statoil's long-term working relationship with CNOOC in offshore oil both in China and the US. In 1997 they jointly established an offshore oil project Lufeng 22-1 in China's South Seas. The project produced twice what was expected and was handed over to CNOOC for decommissioning in 2009.<sup>58</sup>
- Aker Solutions' working relationships with PetroChina, Sinopec and CNOOC in China which they hope to expand.<sup>59</sup>
- DNV's long-term establishment in China with the first surveyor starting in 1888 – it now has 900 employees. Beyond its wind turbine certification and wind farm technical support capabilities, it opened a Sustainability Center in Beijing in 2009, and has strategic relationships with COOEC for the development of offshore and onshore oil and gas technology.<sup>60</sup>
- Statoil and Seadrill's operations in China's South Seas gives them first hand experience successfully addressing typhoon related the issues, which will be critical experience for the developing wind energy in China.
- Grenland Group's project related work to construct a semi-submersible rig at Yantai Raffles with COSL Drilling Semi AS,<sup>61</sup> and offshore engineering training programs with China National Petroleum Offshore Engineering, a subsidiary of PetroChina.<sup>62</sup>

57 DNV, "DNV's China Journey" 2008

58 Scandinavian Oil and Gas. "StatoilHydro, CNOOC to shutdown Lufeng oil field in South China Sea" 20 April 2009

59 Zheng Lifei. "Aker Solutions braces for flat revenue growth" China Daily. 07 April 2009

60 DNV Press Release. "DNV and COOEC Sign Strategic Cooperation Agreement" 27 October 2009

61 Grenland Group Press Release. "Breakthrough for Grenland Group in China" 15 May 2009

62 Grenland Group Press Release. "Grenland Group teaching PetroChina personnel" 28 Nov. 2008

Nordic companies already have a naturally formed cluster of businesses at the Norwegian owned Nordic Industrial Park (NIP) located in Ningbo, a port city on the Yangtze River near Shanghai. Several of the businesses established there are also involved in the marine and offshore industries. Starting at NIP can make for a logistically convenient solution for small to medium businesses that are looking to establish in China.

Established in 2003, NIP offers a full package solution from business support to facilities. To date it has worked to bring 45 companies to China and by 2010 it will have a floor area totaling 175,000m<sup>2</sup>. Business support includes company licensing, HR support, and accounting. Facilities include high quality office space, and assembly space for light production, assembly and logistics.

Norwegian companies have many well established relationships with some of China's top companies which are also expanding into the offshore wind industry. Taking advantage of and mobilizing around that network will be key to successfully entering China's offshore wind market and engaging with the broader Asian market.

Norwegian Companies at NIP	
Aarbakke Group	
Grenland KSI	
Kitron ASA	
Kvilvang	
Marine Aluminum	
Mascot	
New Store Asia	
Scansafe	
TKS	
Ulstein Group	
Contact Information	
Nordic Industrial Park	
No. 8 Jinchuan Road	
Zhenhai, Ningbo 315 221	
Phone: (+86) 574-8630 5980	
Fax: (+86) 574-8630 5990	
<a href="http://cn.nip.com.cn">http://cn.nip.com.cn</a>	
Ove Nodland - Chairman, CEO	
<a href="mailto:ono@nip.com.cn">ono@nip.com.cn</a>	
Source: NIP	

#### 4.4 Strategies for engaging with China

When considering where to start in China, the options and opportunities may seem overwhelming. However, in the development of the offshore wind industry, China and Norway are, in a way, on an equal footing, in terms of offshore experience and planned pipeline. Establishing an appropriate strategic partnership may be more manageable than trying to tackle the whole country and industry. Norway already has one bilateral strategic relationship at a provincial level between Telemark County and Hubei Province.

##### 4.4.1 Potential bilateral strategic relationships

There are three possible tactics which Norway might consider in developing strategic bilateral relationships to engage in China's offshore wind market: country - province relationship, company - company relationship and working with existing clusters in China

##### Country - province example: Norway - Shandong Province

Creating a bilateral agreement with Shandong would enhance Norway's ability to take advantage of the broader Asian market. Shandong, due to its location, has had historically strong trade relations with both Korea and Japan. In addition, it has the second largest offshore pipeline in China, a large portion of which will be developed by CNOOC. Compared to Jiangsu which has the largest offshore pipeline most of which is in shallow water, Shandong will have more of its offshore wind development in water depths over 30m.

CNOOC is very serious about offshore development in Shandong. Local media reported on 9 March 2008 that the sixth hi-tech offshore wind meteorology mast in the world was built in Weihai for an offshore wind farm. CNOOC also signed an agreement with Weihai Hi-Tech District to build a wind farm with a capacity of 1GW offshore and 100MW onshore in June 2007.

The Norwegian School of Business (Norges Handelshøyskole) has also made particular effort to visit Shandong province and cultivate a relationship of friendship and cooperation between Shandong and Norway.

Yantai Raffles Shipyard, who is fabrication wind farm installation vessels and COOEC, who has a world class fabrication yard in Qingdao, recently established a strategic relationship with the DNV<sup>63</sup> are also both located in Shandong province.

Norway following this tactic may consider working with a Korean wind turbine manufacturer such as Daewoo. Korean manufacturers have already met international standards in many areas and are more likely to enter the international market faster. Daewoo having bought DeWind this year stands in a good position to be able to produce high quality offshore turbines quickly. However, there may be barriers to for Korean manufacturers aiming to sell turbines in the Chinese wind market, as they will have to compete with China's low turbine costs while still providing high quality products and proving their track record. In addition, Chinese developers often tend to prefer Chinese manufacturers over international ones.

### **Company – company example: CNOOC – Statoil**

CNOOC and Statoil already have a strong working relationship in China and abroad in the United States through the development of offshore oil fields. With experience in the oil and gas industry both companies have the skills and experience to deploy large scale projects, such as those in offshore wind. Yet experience globally in this area is limited and requires significant human and material resources. CNOOC and Statoil are on similar standings in terms of experience: CNOOC has already installed one wind turbine and Statoil has installed one deep sea offshore wind turbine and 315MW project at Sheringham Shoal will be well under construction by May 2010 and should be operation by the end of 2011.

CNOOC in the past has shown some interest in working with international offshore developers and may still be open to doing so. However, since the Chinese State Council restructured the value-added tax policy in 2008, foreign investors in the wind industry no longer have advantageous tax incentives over domestic investors. Therefore added value for working with foreign investors would have to come from experience and risk mitigation. CNOOC may have interest in investing in the European offshore wind industry to gain experience.

Statoil will need to develop a supply chain and have the resources available for large scale offshore wind development. Working with a Chinese partner such as CNOOC would provide an easy entry point to China's offshore supply chain. Were Statoil to co-invest in the Chinese offshore wind industry, this would potentially create open up the opportunity for Norwegian companies who work with Statoil in offshore wind farm development in Europe to expand their business to China.

Statoil and CNOOC working together to develop offshore wind projects in Europe and China could establish the largest portfolio of offshore wind world wide. Investing in a Chinese manufacturer to support growth and development would have a strong added value for secured project sourcing. CNOOC's current development pipeline does not indicate if it has a preferred domestic or international turbine manufacturer, however it tends to use more domestic manufacturers such as Goldwind, Sinovel and Dongfang for onshore development. CNOOC will be likely be looking to use a manufacturer which it can create a collaborative relationship in order to achieve the necessary quality needed for offshore wind turbines.

### **Working with existing clusters in China**

The Norwegian offshore cluster could also consider developing a strategic relationship with another North European offshore cluster, in order to more fully meet Chinese demands for scale and a broad set of competences. In this context, Scotland (Aberdeen) provides a similar cluster to Norway's (no strong turbine producer) and there are cultural links and common experience from the North Sea which could make strategic cooperation easier. On the other hand, the Norwegian cluster could possibly strengthen and complement the Danish and or German (Bremerhaven) clusters revolving around world leading turbine producers Vestas and Siemens. These different options may not exclude each other, and on a day-to-day level

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63 DNV Press Release. "DNV and COOEC Sign Strategic Agreement" 27 October 2009.

different Norwegian companies are likely to cooperate with different North European clusters according to opportunity.<sup>64</sup>

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<sup>64</sup> Once offshore wind becomes a truly global industry some time in the future, the present North European clusters may in reality have become so entangled as to in reality have become one cluster.

## 5. Recommendations

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To realize the potential for offshore wind engagement in China, the Norwegian Government, offshore wind cluster, and key companies must develop a shared vision about how to strategically approach China and the broader Asian market, using the strengths of the cluster to build on existing relationships.

In order to become a key player in China's large scale offshore development, by leveraging both Norway's innovation and China's ability to quickly mobilize and bring products to full scale production in a short period of time, Norway will want to position as a "cluster" that clearly has:

- Experience with large scale offshore wind development
- Innovative designs necessary for the development of the offshore wind industry
- Complementary offshore and marine industrial resources and capacities
- Opportunities for Chinese offshore wind companies to establish in Norway as a gateway to the European market

The Norwegian Government should implement renewable energy policies to help support the development of offshore wind domestically in order for it to be an attractive base for international companies and developers, and to systematically promote clean tech export.

- The Norwegian Government should ensure that at least some offshore wind farms are constructed in Norway and establish an offshore infrastructure for research and testing of offshore clean energy technologies.
- The Norwegian Government should start publishing data for Norwegian clean tech export to monitor this trend and design policies that systematically position Norway as a global clean technology provider.

Norwegian companies should tap into the offshore wind industry in China, which has similar potential to the North Sea.

- Strategically position to engage in the offshore wind industry in China and the deep sea offshore wind industry in broader East Asia, through presence at relevant forums and exhibitions, developing relationships and (pilot) projects. .
- Norwegian companies with relevant existing contacts should actively develop these with a focus on strategic offshore wind cooperation. This especially applies to Statoil which has a long relationship with CNOOC (China National Offshore Oil Exploration) which is developing a 3GW offshore wind pipeline.
- Leverage China's strong onshore wind and offshore supply chain to meet the needs of large scale growth in the North Sea and the broader Asian market.
- Continue to develop relationships with Korea and Japan through deep sea offshore wind training and position to be prepared for these markets when their development accelerates.

The Norwegian Government should continue to support and encourage a Sino-Norwegian bilateral educational exchange and research and development.

- Norwegian institutions should systematically cooperate with Chinese partners to design undergraduate training programs in relevant fields for Chinese students in China and

foster participation in exchange programs with Norwegian institutions. Provide advanced research program scholarships for technical Chinese graduates in Norway in line with industry needs.

- Encourage Chinese technical students to continue working in Norwegian companies after graduation. Provide guidance and support at university level for finding a job in Norway.
- Establish research collaboration for offshore wind development with Chinese research institutions.

The Norwegian Government and the regional clusters should further investigate the potential for strategic bilateral relationships with a Chinese province constituting a core area for offshore wind industry development, for instance Shandong.

- Prepare a trade mission to explore relationship potentials, and market the Norwegian offshore wind industry strengths and potential collaborations with China.
- Support domestic Norwegian offshore wind development to encourage investment from China.

## **6. Supplementary Section: Company Entrance Strategies - Issues of IPR**

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### **6.1 Entrance strategy – choosing your company structure in China**

Foreign companies beyond licensing technology have an increasing number of options for entering the Chinese market. Currently there are four options which are described below. It is important to understand the advantages and disadvantages of each possible company structure and choose one that meets your company's needs. Note that there may be restrictions based on industry, see Section 6.3.

#### ***Representative Office (RO)***

A quick and inexpensive means for establishing a presence in China, ROs are often used for market research, planning a long-term venture and liaison with a home country company. They require no financial capital and a small budget covering office space, utilities and salaries. When renting an office space proper rental certification is needed as RO applications cannot be processed without it. ROs cannot engage in direct business transactions and any income cannot go through the ROs local bank account. ROs can issue work permits for international employees, but all local employees must be hired through local agency such as FESCO.

#### ***Joint venture (JV)***

The earliest type of entrance strategy for foreign investors, JVs have fallen out of popular use and may only be advantageous if the partner has concrete benefits such as providing access to markets restricted to foreign investment or have strong channels for marketing and distribution. They are known to be high risk due to: management challenges, staff liabilities, technology/IP risks, and exaggeration of assets during negotiations. A JV, an entity in itself, is a limited liability company formed between a foreign party with more than 25% of the shares and a Chinese company. A JV cannot be formed with a Chinese individual.

#### ***Wholly foreign owned enterprise (WFOE)***

Before 1986 foreign investors could only enter China's market through a Chinese partner. WFOEs were created to increase export and bring advanced technology to China. They are 100% foreign invested limited liability company, and are not considered JVs even if the shares are split between multiple foreign entities. Established mostly by manufacturing companies for sales and export, they have a flexible business scope and provide security for technology/IP. Establishing a WFOE in China and contracting out to potential partners is often celebrated as the most secure entrance mode into the Chinese market.

#### ***Foreign invested commercial enterprise (FICE)***

A type of WFOE established in 2004 specifically for trading, retail and distribution. A limited liability company, it allows foreign direct investors to get their own import-export licenses and establish fully operational, 100% foreign - owned retail and trading companies that can buy and sell in China; thereby opening up the flexibility to combine export facilities with sourcing and quality control activities. One disadvantage is that it requires high registered capital to establish.

## 6.2 IPR Enforcement

Although China's leadership has recognized the importance of improving the protection of intellectual property (IP), IP theft remains a major challenge to foreign companies. Entering into the World Trade Organization (WTO) has increased China's awareness and effort to protect IP and along with international pressure to do so, but there is still a long way to go. As part of joining the WTO, China has entered into the following international agreements for IP protection:

*Madrid System for the International Registration of Marks* - Offers a trademark owner the possibility to have his trademark protected in several countries by simply filing one application directly with his own national or regional trademark office.

*The Berne Convention for the Protection of Literary and Artistic Works* – Requires member countries to protect copyrights as if from their own country.

*The Paris Convention for the Protection of Industrial Property* – Allows inventors to apply for patents in several countries with the same priority date, and thus not lose novelty.

### 6.2.1 Legal protection

In order to receive legal recognition and protection for IP, products must be registered in China. Not taking this basic step will leave room for "IP-squatting".

**Patents** - In order to increase its international competitiveness, China revamped its patent law in Dec. 2008. China follows the first-to-file system, therefore even if you are not the original inventor you can still claim a patent. China following the Patent Cooperation Treaty of 1994 will perform international patent searches for patent applications. In order to get legal patent rights standards of novelty, inventiveness and practical applicability must be met. Patents are processed at a national level and filed at the State Intellectual Property Office in Beijing; note that, foreign applicants can also include China when they file a Patent Treaty Cooperation agreement.

**Trademark** – The current Trademark Law went into effect in Oct. 2001. China's first-to-file system leaves a lot of room for "trademark squatting" as it does not require proof of prior use or ownership. Therefore it is highly advised to register internet domains and trademarks in both English and Chinese before distribution at the Trademark Office of the State Administration for Industry and Commerce in Beijing. Registration usually takes 24-30 months and the owner must apply to each class of goods and services for which protection is sought following the International Classification of Goods and Services.

**Copyright** – Copyrights do not have to be registered in China as long as the work was also copyrighted in country who is a member of the Berne Convention. Registration at the State Copyright Bureau may be helpful if legal enforcement is pursued. Works protected under China's copyright laws include:

- Literary works
- Oral works, musical, drama, dancing
- Fine art, photography
- Movie, television, and video works
- Engineering design, product design with illustrations
- Maps
- Other works protected by laws and administrative regulations

China has three tracks for seeking enforcement of IP rights – civil, criminal and administrative. However, the lack of effective and deterrent enforcement of IP rights remains a serious problem. Enforcement efforts, particularly at the local level, are restricted by poor coordination among Chinese Government ministries and agencies, local protectionism and corruption, high thresholds for initiating investigations and prosecuting criminal cases, lack of training, and inadequate and non-transparent processes. If a company does not register its IP rights in China, China's three enforcement tracks not only are not available to you, but also may be used against you. Sophisticated counterfeiters manipulate the loopholes in the Chinese system to prevent market access for foreign technology.

### **6.3 Legal framework**

As of Jan 1, 2008 China phased out its two-tier income tax system for domestic and foreign enterprises. Now foreign enterprises are subject to the same corporate taxes as domestic companies. Generally corporate income tax rates are 25% and 20% for small companies. Tax incentives are now provided for specific encouraged business activity.

It is very important for companies to plan and define clearly where they are effectively managed in order to avoid being taxed by China's tax laws on their global income. Under China's Corporate Income Tax Law (CIT) a "resident enterprise" (RE) is a company registered under China law or a foreign company effectively managed in China. CIT defines "the place of effective management" as "the place where the exercising, in substance, of the overall management and control of the production and business operation, personnel, accounting, properties, etc. of a foreign company is located." A RE is subject to CIT tax rules on worldwide income whereas a non-RE is subject to corporate income tax only on the China-sourced income.<sup>65</sup>

There are two significant legal points to consider with regards to offshore wind farm development by foreign investors. The interim measure expected to be published by the National Energy Bureau and the Ocean and Fisheries Bureau in the first half of 2010 will likely stipulate that that project developers must have a majority share in ownership by a Chinese company. While there is no such requirement in the onshore industry, in practice there are currently only two foreign project developers who have developed wind farms without Chinese investment. Having a majority share from a Chinese company may make development decisions more challenging, however it does allow the project to be eligible for CDM credits.

In addition up until the beginning of 2009 foreign wind project developers could receive a VAT refund if purchasing domestic wind turbines. Now the playing field has been leveled between foreign and domestic project developers, so that both only have to pay 8% VAT on power generated. This is an improved situation for domestic developers; however, the change has given foreign developers less incentive to stay active in the market.

A comprehensive guide to China's customs regulations is available in the Customs Clearance Handbook compiled by China's General Administration of Customs. It contains the tariff schedule, national customs rules, and appropriate regulations. This guide can be purchased at bookshops in China.

#### **Restrictions on Foreign Direct Investment**

Although the Chinese Government encourages foreign investment in the wind energy and clean tech industry, the "Catalogue for the Guidance of Foreign Investment Industries (2007 revised)," does limit foreign firms to some degree. In the catalogue, which came into force December 1, 2007, foreign industries are divided into "encouraged" – 351 industrial areas, "restricted,"- 87 industrial areas, and "prohibited." – 40 industrial areas.

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<sup>65</sup> China's New Corporate Income Tax Laws and their Effects on Foreign Investment  
[http://www.ibls.com/internet\\_law\\_news\\_portal\\_view.aspx?s=latestnews&id=2132](http://www.ibls.com/internet_law_news_portal_view.aspx?s=latestnews&id=2132)

The industrial areas related to the offshore wind industry fall into the “encouraged” sector and are listed below. “Restricted” and “prohibited” sectors are often those which may cause high pollution, compromise national security, rely on cheap Chinese raw materials and energy, are focused solely on export, or use low technology and high employment such as toys and apparel. It is advised to consult the catalogue when making investment decisions.

**Encouraged Sectors (relevant to the offshore wind industry):**

- Construction and management of new energy power plants (solar, wind, magnetic, geothermal, tide, and biomass energy).
- New energy power equipment, such as manufacturing of wind turbines over 1.5MW- limited to equity joint ventures and contractual joint ventures.
- Design of new and high technology vessels and equipment for ocean projects - limited to equity joint ventures and contractual joint ventures.
- Maintaining, design, and manufacturing of vessels and ocean related equipment – Chinese partner must hold majority shares.
- Design and manufacture of communication systems for vessels.

Foreign investment is approved based on the total investment and industry sector. Approval at a local or city level is usually faster and less expensive. For “encouraged” industries, if the total investment amount is less than US\$100million approval at the local NDRC and MOFCOM is sufficient. Above US\$100 million, the project must obtain approval from the national NDRC and MOFCOM. Any projects above US\$500million shall be submitted to the State Council for verification.<sup>66</sup>

**6.4 Contract law**

The Contract Law came into force on October 1, 1999, and contains both general and specific provisions. Technology Contract Regulations were published in 2002. There are some other laws and regulations regarding contract enforcement, such as:

- Administration of Technology Import and Export;
- Administrative Measures on Prohibited and Restricted Sectors;
- Technology Exports;
- Technology Imports;
- “Catalogue of Technologies Prohibited and Restricted for Import”;
- Circular (Ministry of Foreign Trade and Economic Cooperation & State Administration of Foreign Exchange) Administration of Foreign Exchange Sale and Payment Related to Technology Import Contracts (February 20, 2002).

Technology contract regulation is divided between domestic technology contracts ruled by the Contract Law of 1999, and technology contracts with at least one foreign party, ruled by the Technology Regulations of 1985 and a long string of closely related legislation. The greatest problem for technology contracts remains dual regulations and unfair restrictions. The technology transfer sub-section has many parallel articles to the regulations and leaves additional room for maneuvering by the contract parties themselves.

Contracts are approached from a different attitude in China thus affecting how contract enforcement is understood and applied. In the Chinese legal system, the main principles applying to contracts are ‘equality, freedom to enter into a contract without duress or

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66 NDRC “Interim Measure for the Administration of Examining and Approving Investment Projects” 2004 No. 22

interference, fairness and good faith.’ Therefore the terms of the contract are understood more as a starting point to a business relationship which both parties will follow on good faith and cooperate based on changing circumstances, rather than a binding set of conditions. From a Chinese legal standpoint a contract can be revoked if it is considered unfair when it was signed. This leads to a great deal of informal contract negotiation as conditions of the business engagement change. Regardless, it is important to engage professional legal service which is competent in both Chinese and international law.<sup>67</sup>

## **6.5 Payment security**

Letters of credit and documentary collection are common methods for payment, under which foreign exchange is allocated by the central government for an approved import. Although the Bank of China dominates China's trade-finance business, most Chinese commercial banks, such as the China Construction Bank, Industrial and Commercial Bank of China, and the Agricultural Bank of China, have the authority to issue letters of credit for imports. Foreign banks with branches or representative offices in China can also issue letters of credit.

China has been a member of the International Chamber of Commerce since 1995 and is subject to the Unified Customs and Practice (UCP) 500 Code regarding international trade payments. Nevertheless, terms and conditions are generally negotiable in practice and determined on a transaction-by-transaction basis in the form of a "silent" confirmation.

Documentary collection is less formal and more flexible. The exporter submits a full set of trade documents for payment collection to the bank designated in the contract. The Chinese bank sends the documents to the home office for examination and in some cases passes them on to the buyer for further examination. Payment is made after the documents have met the approval of all parties. This method of payment provides less coverage against default and should be used with caution. It is the responsibility of the exporter to determine the specific instructions to be used in the collection letter.

E-commerce in China has great potential. However, Internet security needs to be taken into account. In April 2005, the Law on Electronic Signatures took effect and enhanced the safety of on-line transactions.

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<sup>67</sup> China-British Business Council “Market Intelligence – Tax, Law & Banking”  
[http://www.cbcc.org/market\\_intelligence/law/contracts.html](http://www.cbcc.org/market_intelligence/law/contracts.html)

## 6.6 Understanding the cultural nuances of business in China

Business, legal framework, and political relationships are highly influenced by cultural habits and norms in China. Engaging in business requires sensitivity and awareness as to how cultural habits may enhance or impede a business objective. Norwegian and Chinese companies in developing business relationships can draw on common cultural values of social welfare, social stability and maintaining a harmonious society.

### 6.6.1 Intercultural issues

China



- **Low trust society** – relationship building is the first step to business. Trust is developed on a personal level.
- **Culture of people**
- **Hierarchical business structure** – fear of punishment
- **Indirect** context based communication
- **Polychronic time** (multi-taskers)
- **Limited distinction** - work / personal life
- **Risk takers and action oriented** – Once the decision is made they will get there no matter how long and unstructured the path may seem.
- Value **flexibility** and honesty

Norway



- **High trust society** - systematic
- **Culture of nature**
- **Flat business structure** – open flow of information and teamwork, learning oriented
- **Direct** frank communication
- **Monochronic time**
- **Clear distinction** - work / personal life
- **Consensus based** decision making, **efficient action** taking
- Independently **innovative**

Source: Making it in China

Intercultural sensitivity is critical, and should be considered a core focus for any company working in China. Between the two countries the ideas of law, profit, decision-making, market orientation, business relationships, and technical standards are quite different. Low awareness of how to navigate these differences will cause misunderstandings and miscommunication which can cause conflicts of interest as time goes on.

To give an example, China a low trust society, where people are defined by their relationships to others, often start a business relationship by first having a large dinner. This offers the chance to voice appreciation for the partner; explore objectives for the upcoming business relationship; develop trust through hospitality; and understand the partner's social hierarchy. The conversations can weave between work and private life. Those doing business in China for the first time may find that going to a company just for a meeting has fruitless results, however after such a dinner things can seem to run with amazing swiftness and relative ease.

A good way to prevent cultural conflict is to visit China in order to gain a better perspective and understanding, which can provide a company great insight into the country, the culture, the business climate, and its people. Chinese companies prefer and respect face-to-face meetings, which demonstrate a Norwegian company's commitment to working in China. Note that China has many different regions and that each province is unique both economically and socially.

### 6.6.2 Lack of governmental regulations

In China, *Guangxi* (relationship) is a complicated matter. Building quality government relationships should be a primary business development focus for many Norwegian firms, especially for those firms entering the Chinese market for the first time. There will be unpredictable challenges and it is important for Norwegian firms to coordinate with the Chinese Government when dealing with issues of foreign trade and economic cooperation. Lack of a government relationship will create unnecessary difficulties and delays in acquiring government approvals. A good relationship can pave the way. In addition, the Chinese

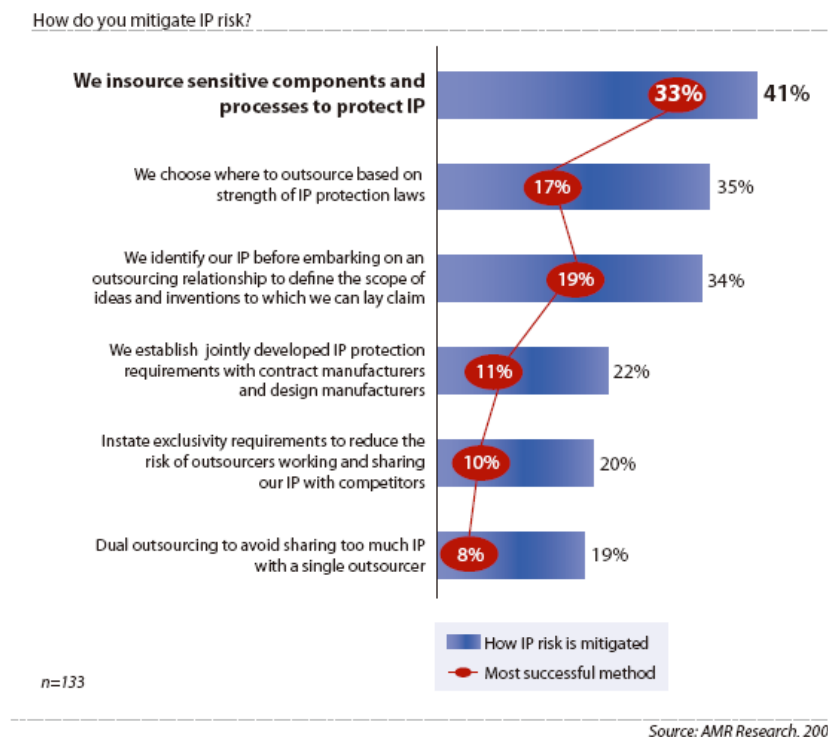
Government tends to protect local firms, especially state-owned firms, from imports, while encouraging exports. Although WTO accession is certainly helping in this area, progress is being made only gradually.

There are resources available to help Norwegian firms develop relationships with the Chinese Government and companies. The Royal Norwegian Embassy and Innovation Norway provide a wide range of services to assist Norwegian companies to find the right Chinese partners and learn how to navigate various business sectors.

### 6.7 Robust strategies and mitigating risk

While China has implemented laws for IPR based on international standards, enforcement of these laws still lags behind. Entrance into the WTO has increased pressure for China to respond to IPR infringement, but there is still a long way to go. Having the appropriate legal procedures in place is one step, but a proactive approach to protecting your technology is needed. In the case of technology copying or IP infringement, it is important to have strong evidence before engaging in a potentially lengthy and expensive legal battle.

When establishing a sourcing system, think along every part of the value chain about what the impact would be if the part/idea is copied. Then make a plan about how to make changes to decrease the chances of this copying. Outsourcing to multiple suppliers and creating “packets” which you assemble can decrease the possibility that an entire product is copied and re-sold to the market. If information or technology is sensitive, it is best to in-source. Having a regular face-to-face contact with suppliers is necessary not only for quality control but also for keeping track of whether your technology is being used. AMR research<sup>68</sup> suggests that beyond IP infringement, risk in China also includes supplier and internal quality failures. Therefore, there may be a trend for companies to look towards countries with higher quality and lower infringement issues.



68 O'Marah, Kevin. "Supply Chain Risk, 2008-2009: as Bad as It Gets" 21 May 2009

# Abbreviations and Acronyms

<b>AMSC</b>	American Super Conductor
<b>CCCC</b>	China Communications Construction Company
<b>CDM</b>	Clean Development Mechanism
<b>CEPRI</b>	China Electrical Power Research Institute
<b>CER</b>	Carbon Emission Reduction
<b>CGC</b>	China General Certification Center
<b>CHECC</b>	China Hydropower Engineering Consulting Group Corporation
<b>CIT</b>	Corporate Income Tax Law
<b>CMA</b>	China Meteorological Association
<b>CNOOC</b>	China National Offshore Oil Corporation
<b>COOEC</b>	China Offshore Oil Engineering Corporation
<b>CPOE</b>	China National Petroleum Offshore Engineering
<b>CPPCC</b>	Chinese People's Political Consultative Conference
<b>CWEA</b>	China Wind Energy Association
<b>DNV</b>	Det Norske Veritas
<b>DRC</b>	Development and Reform Commission
<b>EB</b>	United Nations Executive Board
<b>ECN</b>	Energy research Centre of the Netherlands
<b>EPC</b>	Engineer procure construct
<b>ERI</b>	Energy Research Institute
<b>EU</b>	European Union
<b>GL</b>	Germanischer Lloyd
<b>GTZ</b>	Deutsche Gesellschaft für Technische Zusammenarbeit
<b>GW</b>	Gigawatt
<b>GWh</b>	Gigawatt-hour
<b>IEC</b>	International Electrotechnical Commission
<b>IP</b>	Intellectual property
<b>IRR</b>	Internal Rate of Return
<b>km</b>	Kilometer
<b>kW</b>	Kilowatt
<b>kWh</b>	Kilowatt-hour
<b>MOFCOM</b>	Ministry of Commerce
<b>MW</b>	Megawatt
<b>MWh</b>	Megawatt hour
<b>NDRC</b>	National Development and Reform Commission
<b>NECO</b>	New Energy and Industrial Technology Development Organization
<b>NIP</b>	Nordic Industrial Park
<b>Norcowe</b>	Norwegian Center for Offshore Wind Energy
<b>NPC</b>	National Peoples Congress (China)
<b>NREL</b>	National Renewable Energy Laboratory (US)
<b>RE</b>	Resident enterprise
<b>RED</b>	Sino-Danish Renewable Energy Development Programme (2009-2013)
<b>RMB</b>	China's National Currency
<b>SINTEF</b>	Scandinavians largest independent research institution
<b>TEPCO</b>	Tokyo Electric Power Co.
<b>TW</b>	Terawatt
<b>TWh</b>	Terawatt-hour
<b>UHV</b>	Ultra high voltage
<b>UHV AC</b>	Ultra high voltage alternating current
<b>UHV DC</b>	Ultra high voltage direct current
<b>UK</b>	United Kingdom
<b>UN</b>	United Nations
<b>US</b>	United States of America
<b>VAT</b>	Value added tax
<b>WED</b>	Danish-Chinese Wind Energy Development Programme (2006-2009)
<b>WTO</b>	World Trade Organization
<b>XEMC</b>	Xiangtan Electric Manufacturing Corporation

# List of Appendixes

## **Appendix A – Relevant Chinese governmental bodies**

National Development and Reform Commission (国家发展和改革委员会)

Energy Research Institute (国家发展和改革委员会能源研究所)

Ministry of Commerce (商务部)

State Administration for Industry and Commerce (国家工商行政管理总局)

## **Appendix B – Offshore Developer Profiles – Top 5**

Baolihua (Guangdong) New Energy Stock Co. Ltd. (广东宝丽华新能源股份有限公司)

China Three Gorges Project Corporation (中国长江三峡工程开发总公司)

China National Offshore Oil Corporation (中国海洋石油总公司)

Guodian Group (中国国电集团公司)

Longyuan Power Group Company (龙源电力集团公司)

## **Appendix C – Offshore Turbine Manufacturers – Top 5**

Dongfang Steam Turbine Works Co. Ltd (东方汽轮机有限公司)

Goldwind (Xinjiang) Science & Technology Co., Ltd (新疆金风科技股份有限公司)

Shanghai Electric Wind Power Co., Ltd. (上海电气风电设备有限公司)

Sinovel Windtec Co., Ltd. (华锐风电科技有限公司)

Xiangdian (Xiangtan) Wind Energy Co., Ltd. (湖南湘电风能有限公司)

## **Appendix D – Chinese Typhoon Paths**

## Appendix A – Chinese National Governmental Agencies

### National Development and Reform Commission

The National Development and Reform Commission (NDRC) is a macroeconomic management agency under the State Council, which studies and formulates policies for economic and social development, maintains a balance of economic aggregates and guides the overall economic system restructuring. The NDRC regulates the wind industry through influencing permitting at a local (under 50MW is approved by the Provincial DRC) and national level, feed-in tariff regulation.

### Energy Research Institute

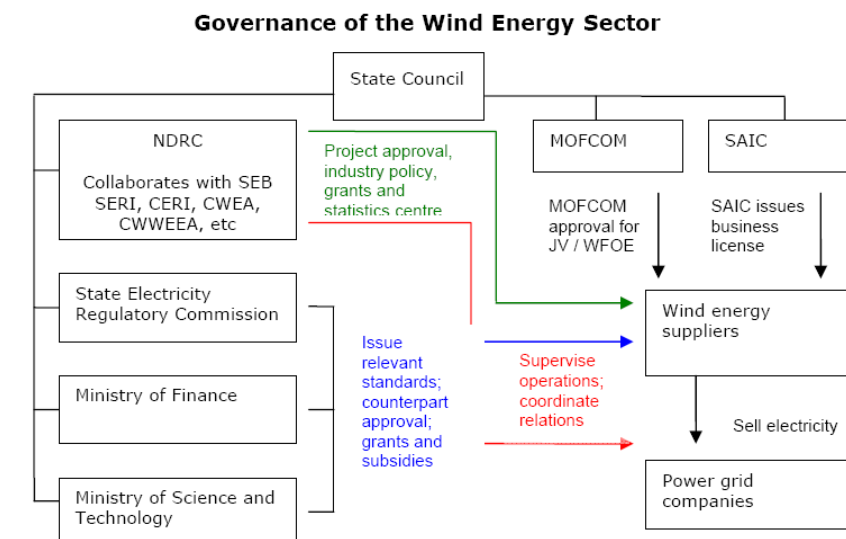
The Energy Research Institute (ERI) of the National Development and Reform Commission (NDRC) was established in 1980. It is a national research organization conducting comprehensive studies on China's energy issues. Since its establishment, it has been affiliated with the former State Commission and the former State Economy Commission. Throughout, it was guided by the Chinese Academy of Sciences in many aspects of its research work. In 1988, ERI was put under the administration of the now former State Planning Commission. Further reforms in 2003 made ERI part of the NDRC. The ERI is also one of 7 research institutes administrated by the Academy of Macro-economic Research (AMR) of the NDRC. They have 100 staff.

### Ministry of Commerce

The Ministry of Commerce of the People's Republic of China, formerly Ministry of Foreign Trade and Economic Co-operation (MOFTEC) is an executive agency of the State Council of China. It is responsible for formulating policy on foreign trade, export and import regulations, foreign direct investments, consumer protection, market competition and negotiating bilateral and multilateral trade agreements. The current Commerce minister is Chen Deming.

### State Administration for Industry and Commerce

The State Administration for Industry and Commerce (SAIC) is the authority in the People's Republic of China responsible for drafting and putting new legislation concerning the administration of industry and commerce in the People's Republic. The current minister is Zhou Bohua.



Source: China – British Business Council

## Appendix B – Offshore Developer Profiles – Top 5

### **Baolihua (Guangdong) New Energy Stock Co. Ltd. (广东宝丽华新能源股份有限公司)**

[www.baolihua.com.cn](http://www.baolihua.com.cn) (SZS:000690)

The former name of the company is Guangdong Baolihua Industry Stock Co. Ltd., which was listed in Shenzhen on 28 January 1997. The company is also known as Baoxin Energy. It started to engage in the new energy business in 2003 according to company sources. There are three subsidiary companies: Guangdong Baolihua Power Co. Ltd., Meixian County Baolihua Real Estate Development Co. Ltd., and Guangdong Baolihua Construction Co. Ltd. According to Baolihua, revenue associated with renewable energy was RMB 894.5m (US\$ 117.7M) in 2006.

Up until 2008 Baolihua had not installed any wind turbines. Its first wind turbines were installed in 2Q 2009. By the end of 2009 it will have completed its first project, a 49.5MW wind farm in Lufeng, Guangdong.

### **China Three Gorges Project Corporation (中国长江三峡工程开发总公司)**

[http://www.ctgpc.com/owner/owner\\_a.php](http://www.ctgpc.com/owner/owner_a.php)

The Three Gorges Project Corp. is most known for the development of the Three Gorges Dam on the Yangtze River. It started showing interest in the wind industry in 2006 bidding in the national concession projects. In late February 2006 the company announced its entry into the wind project area upon receiving NDRC approval to develop a 200MW project in Jiangsu province near Yancheng city. They have also announced a 2020 wind capacity target of 4GW. To date they have installed 144MW.

To better utilize idle wind power, China Three Gorges Corporation started in 2006 to build four pumped-storage power plants with 1.2GW of capacity in Hohhot, the capital of Inner Mongolia, according to the region's development and reform commission, which approved the project. The plants are expected to be completed in 2013 at a cost of 5.6 billion RMB.

As of 22 October 2008 China Three Gorges has acquired *China Water Investment Group Corporation* which is a large state-owned water investment corporation under the direct administration and supervision of the State-owned Assets Supervision and Administration Commission of the State Council. It was founded in 1980 which was known as the "Water Resource Ministry Water Project Integrated Operating Corporation." The company now has at least 5 wholly owned companies, 5 holding companies and 9 shareholding companies. Goldwind is one of the 9 shareholding companies, and it is the largest equity shareholder of Goldwind. Additionally, the company has invested in wind blades, tower and weld assembly in Beijing, Baotou and Xi'an respectively.

The group's wind-related subsidiaries include:

Goldwind (Xinjiang) Science & Technology Co. Ltd. which was founded in 1998. It is focused on the manufacturing of WTG.

Sinoma Science & Technology Wind Turbine Blade Co, which was founded in January 2007. It is focused on blade manufacturing. CWIC holds 15% of the shares.

China Water Investment Group (Baotou) wind Power Science & Technology Co. Ltd., which was founded on 16 January 2007. It is focused on the research, design, manufacturing of WTG.

China Water CWIC Huayi Diaobingshan Wind Power Co. Ltd. which was founded on 23 January 2007. It is focused on the construction and operation of wind farms.

China Huatong Energy Investment Co. Ltd. which was founded on 5 February 2007 which also

does wind project investment..

### **China National Offshore Oil Corporation (中国海洋石油总公司)**

[www.cnooc.com](http://www.cnooc.com)

The China National Offshore Oil Corporation (CNOOC), founded in 1982, is one of the largest state-owned oil companies in China, as well as the largest offshore oil and gas producer. It is authorized to cooperate with foreign partners for oil and gas exploitation in China's offshore areas.

Headquartered in Beijing, the company has a total staff of 51,000 with a registered capital of RMB 94.9 Bn. CNOOC has established six business sectors, namely, oil and gas exploitation, technical services, chemical and fertilizer production and refining, natural gas and power generation, financial services, and logistic service and new energy development. In 2007, the company achieved sales income of RMB 160 Bn and a net profit of RMB 56.5 Bn, meanwhile paying a tax of RMB 35 Bn to the state, amounting to more than 60% of the total profit. The total and net assets of CNOOC have reached RMB 300 Bn and RMB 170 Bn respectively.

CNOOC entered into wind industry in 2007. It installed 1 x 1,500 kW (Goldwind) offshore WTG in Bohai, near Tianjin. The company won the bid of Sigeng Wind Farm (Hainan) in 2007 which is expected to start construction in 2008. Also, CNOOC signed agreements with the local government to develop a 2 x 49.5MW wind farm in Xilinguole League, Inner Mongolia.

Local media reported on 9 March 2008 that the sixth hi-tech offshore wind meteorology mast in the world is being built in Weihai for an offshore wind farm. CNOOC signed an agreement with Weihai Hi-Tech District to build a wind farm with a capacity of 1GW offshore and 100MW onshore in June 2007. The first phase of the wind farm with capacity of 50MW of onshore capacity will be started this year.

According to Azure records in 2008 it had 1.5MW cumulatively installed and will add at least 30MW to their installed portfolio in 2009. It is using a variety of turbine types.

### **Guodian Group (中国国电集团公司)**

<http://www.cgdc.com.cn>

Guodian is one of the five state power producers created in the 2002 breakup of China State Power Co. The business scope of Guodian includes project development, management, construction and investment in energy industries, and sale of energy to the grid. At the end of 2003, the company held 3 100%-owned subsidiaries, 43 holding companies, and 14 participatory interests. It is organized into 10 regional administrative branches.

Established on the basis of partial assets of former State Power Corporation of China, China Guodian Corporation is one of the five largest nationwide power generation groups approved by the State Council of China in the power industry restructuring. It is a pilot state holding enterprise approved by the State council to carry out the state-authorized investment with the registered capital of 12 billion RMB Yuan (equivalent to 1.5 billion US Dollar).

Wind power activities of the Guodian group are mainly carried-out through its wholly-owned subsidiary Longyuan Power Group Company, and public listed company GD Power Development. The Guodian parent company itself is a newcomer to the wind business announcing its first non-Longyuan projects in 2006. The company has announced a 3-4 GW wind capacity target for 2010, which includes the activity of its Longyuan subsidiary (also announces target of 3-4GW).

According to Azure data Guodian (not including Longyuan) installed 184MW in 2008 and cumulatively 248MW. In 2009 it will have added at least 400MW to its portfolio. It uses predominantly Guodian United and Sinovel turbines.

## **Longyuan Power Group Company (龙源电力集团公司)**

<http://www.clypg.com.cn>

Longyuan is the most active player in the Chinese wind power industry. It has been active in the industry since its infancy, and has set a target of 3 - 4 GW by 2010, and 7 GW by 2020.

On 21 Sep 2009, China Longyuan Power Group Co., Ltd, signed an MOU with China-Africa Development Fund and South Africa Mulilu Renewable Energy in Beijing to jointly develop a wind project in South Africa. The company did not disclose any further details.

South Africa's Energy Minister Dipuo Peters said earlier that South Africa plans to commission 400 MW of wind power by independent power producers by the end of 2012. SA currently has 5.2MW of generating capacity from one wind farm. SA's wind-energy capacity could be 300 MW by 2012, according to media Regulación Eólica con Vehículos Eléctricos.

Longyuan Power Group Company raised USD 2.2Bn through a Hong Kong listing in early December 2009. Longyuan sold 2.1 billion shares at HK\$8.16, at the top of a range of the possible price range being considered by investors. Investors included the China Investment Corporation, who purchases USD 400m worth of shares, as well as US billionaire Wilbor Ross (USD 100m), and China Life Insurance (USD 180m). Guodian Corp., Longyuan's parent company, still holds a 65.66% stake in Longyuan after the IPO. Longyuan has said it will use the IPO proceeds to help fund capital expenditures needed to grow capacity to a consolidated capacity figure (equity weighted) of 6,500 MW by 2010 which will require USD 6.86Bn.

According to Azure records, Longyuan has installed 1,033MW in 2008 cumulatively 2,181MW. In 2009 at least 1,000MW has been added to its portfolio. Longyuan uses a fairly diverse portfolio of turbines, but has preferences towards Gamesa and Goldwind turbines.

## Appendix C –Offshore Turbine Manufacturers – Top 5

### **Dongfang Steam Turbine Works Co. Ltd (东方汽轮机有限公司)**

[www.dfstw.com/english/index.asp](http://www.dfstw.com/english/index.asp)

Dongfang Steam Turbine Works (DFSTW) was founded in 1966 by Dongfang Electric Corporation (DEC). In 1Q07, DFSTW was acquired by Dongfang Electric Machinery a power generation manufacturer traded on the Hong Kong and Shanghai stock exchange and a daughter company of DEC.

In November 2004, DFSTW signed a technology license agreement with REpower for products including the MD 77A / MD70A 1.5MW turbines. Dongfang has worked to increase profits by improving vertical integration through internally sourcing hubs, transducers, blades, and generators. To date they have installed 2,892MW.

DFSTW has its main manufacturing facility in Deyang Sichuan. Additional facilities include Tianjin Dongqi Wind Blade Engineering Co. Ltd which went into production in August 2008 and a manufacturing facility in Tianjin. The new plant will produce 600 units of 1.5MW and 200 units of 2.5MW wind turbines annually.

### **Goldwind (Xinjiang) Science & Technology Co., Ltd (新疆金风科技股份有限公司)**

[www.goldwind.cn](http://www.goldwind.cn) (SZ:002202)

Goldwind was founded in 1998 by Xinjiang Wind Energy Company, China Water Investment Group Corp, Xinjiang Wind Energy Research Institute and several individual investors. Currently it is 41.3% state owned with its largest share holder being China Three Gorges. In 2007 Goldwind acquired a 70% stake in German-based Vensys.

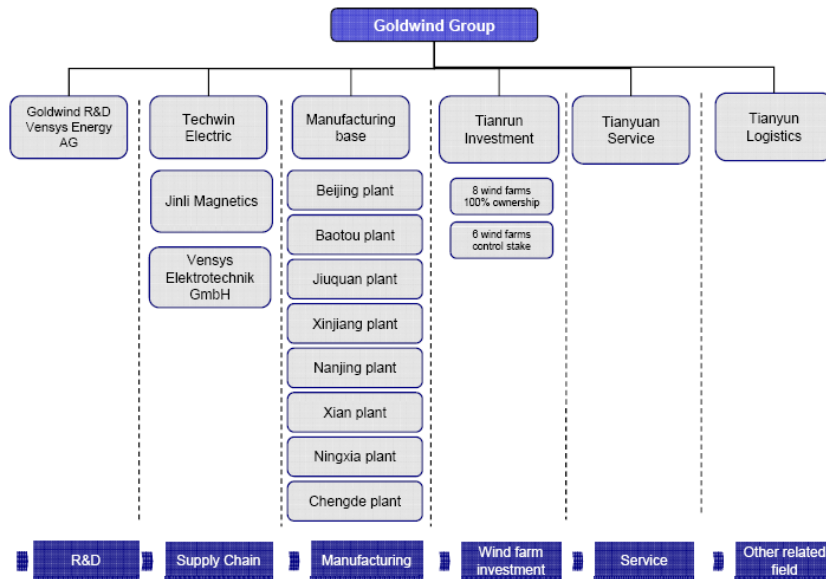
Goldwind listed on the Shenzhen exchange 25 December 2007, raising RMB 1.7Bn (US\$ 254.7m) from its IPO. A recent announcement on 9 September 2009 was made to float shares on the Hong Kong stock. It will issue no more than 15 percent of its enlarged equity capital after the Hong Kong share offer to overseas institutions, corporate and individual investors, according to a filing at the Shenzhen Stock Exchange. The offer is expected to be completed within one year of the announcement date.

Goldwind's product line includes: 750kW (Repower) licensed turbine; 1.5MW, 2.5MW direct drive technology co-developed with Vensys and a 3MW turbine independently developed. To date it has installed 3,963MW.

They also have one R&D and assembly plant in Germany. Goldwind in China has 5 assembly plants in operation, 2 in construction and 1 in the pipeline. They have one assembly plant in Germany. They also have 2 generator manufacturing facilities under construction. In addition, they have strategic relationships with Sinoma and LM for blades.

Goldwind announced it will construct an offshore wind base in Dafeng, Jiangsu Province on 18 August 2009. Goldwind will set up a fully-owned subsidiary company in Dafeng, named Goldwind (Jiangsu) Wind Equipment Manufacturing Co. Ltd, with registered capital of RMB 65m. The total investment is RMB 105m, of which RMB 65m is fixed assets. The planned capacity is 300 units of offshore WTG. The construction period is September 2009 to October 2010

They have exported 6 x 750kW turbines to Cuba and 3x1.5MW to the United States.



Source: Goldwind Science and Technology

### Shanghai Electric Wind Power Co., Ltd. (上海电气风电设备有限公司)

[www.shanghai-electric.com/en](http://www.shanghai-electric.com/en)

Shanghai Electric Wind Power Co. Ltd. was founded by Shanghai Electric Machine Factory (70%) and Goldwind (30%). Initially called Shanghai Shenxin Wind Power Generation Co. Ltd., the JV was re-named Shanghai Electric Wind Equipment Co. Ltd. in October 2006, and is now a direct subsidiary under the parent company – Shanghai Electric Power Generation Group. Registered capital is RMB 30m.

In 2006, the company finalized license agreements with DeWind. The company will produce 1250KW turbines using DeWind license and it will develop 2000KW turbines with Aerodyn. These are early stage activities. They have installed 368MW to date.

Shanghai Electric has two factories, one in Shanghai and one in Tianjin. The company held an opening ceremony for its WTG facility and an experimental wind farm in Ligang (near Shanghai) District on 18 December 2008. Planned manufacturing capacity is 600 units for 2MW turbines (1,200MW).

3 Shanghai Electric 2.0MW WTGs have been installed: one was installed in Xiangshui offshore wind farm, one in Longyuan Rudong wind farm and another in Chongming Island wind farm

Shanghai Electric is also developing 3.6MW WTG with a diameter of 116m. The prototype is expected to come

### Sinovel Windtec Co., Ltd. (华锐风电科技有限公司)

[www.sinovel.com](http://www.sinovel.com)

Sinovel Windtec is a subsidiary company of Dalian Heavy Industry. It started its wind business in 2004. The company produces 1.5MW turbines under a license form Furländer of Germany, and has a strategic relationship with American Super Conductor (AMSC). In 2006, Sinovel made a successful market debut as the second major domestic WTG manufacturer after Goldwind. The company has so far shown an ability to deliver on plans, with 78MW of product installed in its first year of capacity scale manufacturing and has installed 4,105MW to date.

Sinovel's production is organized around its headquarters including R&D in Beijing and factories in Dalian, Hohhot (Inner Mongolia), Yancheng (Jiangsu), and Baotou (Inner Mongolia)

– in construction. They have strategic relationships with Sinoma for blades and SKF for bearings. They have a joint development agreement with Romax for the 3MW gearbox. Where Romax will offer full technical and design support.

Sinovel has a very strong strategic relationship with American Superconductor Corporation (AMSC) and the wholly owned subsidiary Windtec. They have had several multi-million dollar development and sourcing contracts. In addition, to AMSC sourcing electrical components for the 1.5MW turbine (US450 million), they have a joint design development contract for 3MW and 5MW turbines. Sinovel will have exclusive ownership and complete industrial and intellectual property rights for the two turbines under this contract.

Sinovel has exported its first turbines to India, 10 x 1.5MW to a project, Karnataka, being developed by the Doddanavar Brothers. The turbines have all been erected to date.

### **Xiangdian (Xiangtan) Wind Energy Co., Ltd. (湖南湘电风能有限公司)**

[www.xemc-wind.com](http://www.xemc-wind.com)

Xiangdian Wind Energy was founded in June 2006 by Hunan Xiangtan Electric Manufacturing Co. Ltd. (XEMC, SHSE: 600416) 50% and Japanese-based Harakosan Co. Ltd. 27% and Xiangtan Electric Manufacturing Group (XEMG) 22%. In 3Q2008 Harakosan sold its share due to cash flow constraints during the financial crisis. Following the transaction, XEMC will still be the largest shareholder by a 51% stake and its parent XEMG will hold a 49% interest.

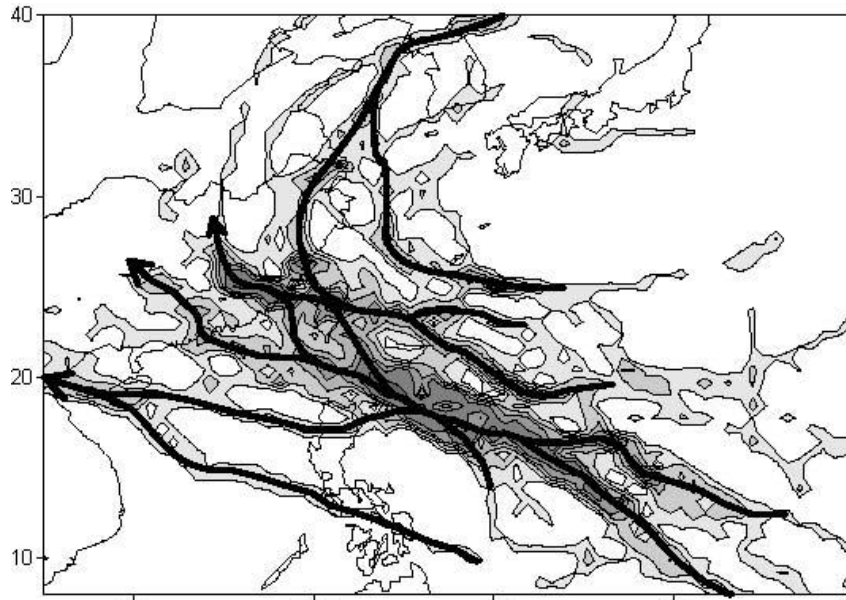
Xiangdian produces turbines using a Lagerway/Zephyros license. They are first Chinese manufacturer to produce a 2MW direct drive turbine. To date they have installed 286MW.

Xiangdian has benefited from government funding under the 11th 5-year National Sustaining Science & Technology Program RMB 20m was granted to fund three R&D demonstration projects for megawatt scale direct drive technology. Construction at a new production facility has just begun, with the official foundation laying on 14 January 2007. According to a company spokesperson, the unofficial production plan calls for the production of 70 turbines in 2008, 100 turbines in 2009 and 150-200 units, and over 300 units by 2010 .

Xiangdian took over Darwind on 3 August 2009 from Dutch holding company Econcern after Econcern went bankrupt. A new company named XEMC-Darwind B.V. will focus on the research and production of a 5MW offshore wind turbines, which will be officially put into operation in 2010. The 5MW offshore wind turbine uses direct drive technology. XEMC-Darwind B.V. aims to have two prototypes erected by the end of 2010, one in Europe and the other in China.

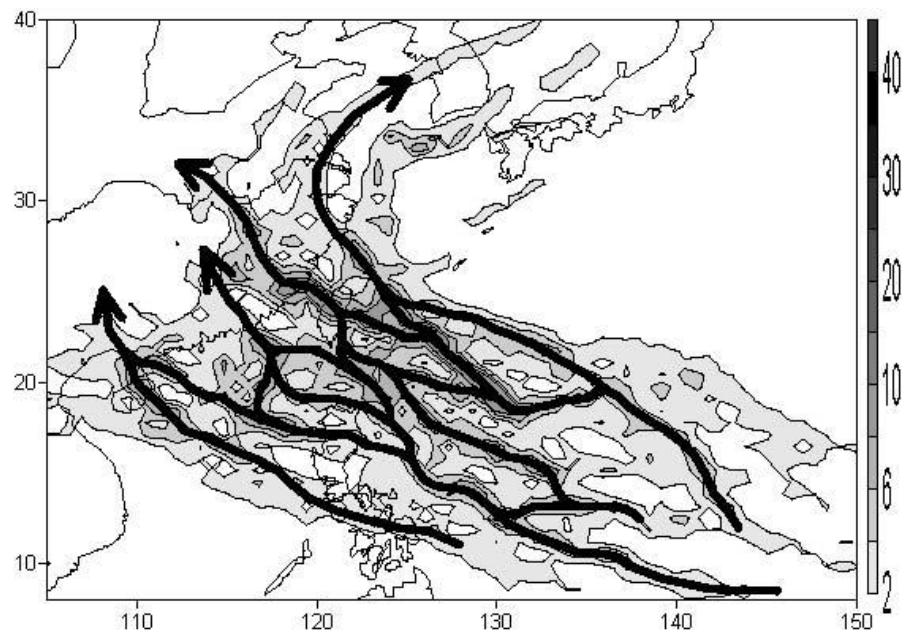
## Appendix D – Typhoon Paths in China

Super typhoon paths across China - 41.5-50.9m/s



Source: China Meteorological Administration

Severe typhoon paths across China - greater than 51m/s



Source: China Meteorological Administration

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