VAASAN AMMATTIKORKEAKOULU
VASA YRKESHÖGSKOLA
UNIVERSITY OF APPLIED SCIENCES

Jun Wilhelmsson

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VAASAN AMMATTIKORKEAKOULU
UNIVERSITY OF APPLIED SCIENCES
Information Technology

ABSTRACT

Author	Jun Wilhelmsson
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This thesis, part of Mervento Ltd's China Project in 2011, investigates Chinese wind turbine manufacturers, the available turbines on the Chinese market as well as new developments in the market.

Mervento Ltd is the leading global provider of multi-megawatt direct drive wind turbine power plant solutions for onshore, near shore and offshore applications and the target of this thesis is an analysis of the Chinese wind energy market in order to facilitate Mervento Ltd finding a partner for their Chinese venture.

The thesis goes on to screen possible candidates for partnership according to criteria set forth by Mervento Ltd and then make suggestions regarding potential partners. This research is needed since the Chinese market is not yet transparent enough for foreign companies to draw their own conclusions. Language and informational barriers mean that information has to be accumulated and translated from official Chinese government or other reliable national source, most often officially published documents only made available online and often in separate reports.

The thesis shows that due to regulations being introduced in 2011, the potential for finding a suitable partner is higher than ever. Mervento's PMDD technology and maintenance solution fits well with the current needs of the Chinese market. The screening of companies gives Mervento Ltd several main candidates for partnership as well as some secondary ones.

Keywords	China, Business, Wind power, Clean Tech

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1 INTRODUCTION

It has taken humanity long enough to realize that our planet does not have infinite resources. The rapid industrialization which started more than a century ago has taken a harsh toll on the environment, and the resulting depletion of natural resources is rapidly becoming a problem. (Nielsen, 2006) We have finally come to the realization that unless we act now, we run a very real risk of severely damaging the earth's ecosystem and adding even more challenges to an already difficult situation.

The introduction and development of alternative "green" technology, long held back by old ways of thinking, is finally maturing economically. While green technology is well known as a term, and has been around for decades with moderate success, it has never really been economically viable. Green Tech works, but without economic feasibility, it has never been widely accepted by the industries where it could be used. Enter clean technology, or "Clean Tech", which offers larger returns both in economic terms and sustainability. As a result, Industries have at first slowly, and recently more rapidly, started accepting and developing "Clean technologies" as a serious alternative to normal products (Caprotti, 2009).

The energy sector is one of the main areas which stand to gain through the adoption of Clean Tech energy generation. Our reliance on oil, coal and natural gas is starting to be seen as a problem (Segtrop, 2006). Since oil is used not only as a fuel, but also in worldwide industries and for heating and electrical generation, replacing it is not something which one does overnight. However, by improving access to clean energy sources, we can take a first step in the right direction. Examples of such clean and renewable energy sources are solar energy, hydropower, geothermal energy and wind energy. Industrial energy needs can be fulfilled, electrical cars are soon to be introduced by several major car-manufacturers (IEA, 2010) and oil-consumption can, eventually, be limited to the areas where there are no substitutes, such as production of plastics and other chemical industries.

1.1 Purpose of Study

The purpose of this study, performed during the first half of 2011, is to analyse the Chinese wind power industry in an effort to determine the viability of introducing Finnish Mervento-branded wind turbines on the Chinese market. Mervento Ltd is the leading global provider of multi-megawatt direct drive wind turbines and this thesis is done for Mervento Ltd as part of the company's China Project, with the goal of finding a commercially and technically suitable Chinese partnership in China.

As part of the thesis, Mervento Ltd needs to have a comprehensive study of the following Chinese wind energy facts:

- List of Chinese wind turbine manufacturers
- List of available turbines in the market
- List of new turbines in development by the Chinese manufacturers
- Technology and installed base of the existing and new products
- Ownership, history, staff and turnover of the Chinese turbine manufacturers

1.2 Study Progression

This thesis continues in Section 2 with a short background review of Green Tech, Clean Tech and Renewable Energy in general and wind power in particular, with a particular focus on the Chinese market situation due to the purpose of the study.

In Section 3, the research methodology, including sources of data and screening criteria are presented. After this, the actual analysis is presented in Section 4, with focus on the market and business development in it, attempting to screen the list of wind turbine companies and turbine types available on the market which has been collected. Relevant cultural factors that affect the final analysis are also included in this section.

Based on this information, the thesis goes on to discuss the results and apply the screening criteria in Section 5, before reviewing the selected companies and making suggestions regarding their status of potential partners for Mervento. The final part, Section 6, summarizes the findings and concludes the thesis. Appendices and references can be found in the end of the paper.

2 BACKGROUND

2.1 Green Tech and Clean Tech

Green Tech and Clean Tech are often quite loosely defined and most often interchangeable in everyday discussion. While Clean Tech can at times be a narrower subset of its "parent" Green Tech, they are often distinguishable as separate topics. It is therefore important to note the few key differences they hold.

The most obvious difference has to do with economic feasibility. One can think of Green Tech as the environmental version of "Pure Science" research and Clean Tech as representing the Applied Sciences. Since technology, by definition, means the application of knowledge, this analogy is not entirely accurate however. Much of what constitutes Clean Tech has its beginning in Green Tech, yet while Clean Tech concerns itself with making the technology viable economically Green Tech focuses mainly on making the technology environmentally friendly. Economic feasibility is of course usually a requirement in any case, but due to restrictions in application, market size or reliability, Green Tech often only surfaces in areas where there is no direct competition or the product is highly specialized.

The secondary definition is therefore that of scope. Green Technology scope is not restricted in any way and may consist of either smaller additions to existing technology or entirely new technologies, such as new fuels. In the latter case, if a suitable new fuel really would be found, and would have enough potential to actually be economically viable, it would also be considered Clean Tech. In the former case, Green Tech would be a product which has substantial environmental benefits yet practically no direct economic benefits, such as an exhaust filters for industry. This kind of product is only ever implemented because of regulatory demands or indirect gains through being able to market a product or factory as more environmentally friendly than the competition.

For all their differences, what the two technologies have in common with each other is perhaps the most important, at least in the case of this thesis. At the current stage of development, both Green Tech and Clean Tech have energy production as its greatest concern. Green Tech entails focusing on energy efficiency and developing new fuels while Clean Tech concerns issuing in a “new paradigm” through the introduction of Clean Energy on a mass-production scale. With clean energy, there would be no need for Green Tech to remedy environmental concerns since there wouldn’t be any.

2.2 Clean Energy Production

Energy is an important part of human life. Energy, at this point still mainly stemming from fossil fuels, is used to run everything from cars and computers to factories. Globally, energy use projections point to an increase of 35 per cent over the next 25 years (Pew, 2010). The main reason behind this increase is due to the growth in electricity use and number of vehicles, a large part of this stemming from countries which have previously been mainly agrarian and are now moving into a rapid phase of technological and industrial development, such as China.

The truth is that in less than ten years, clean energy has grown from a tiny, specialized industry to a major source of trade, investment, manufacturing and employment. The Pew Clean Energy Program has stated that the clean energy sector is becoming one of the most active and competitive in the world, with a growth of 630 per cent in finance and investments since 2004.

The WBCSD (2010) has estimated that climate change mitigation alone will require investments of between 30,000 and 50,000 billion EUR in efficient, emission-free energy solutions by 2050 and states that this is comparable to a “new industrial revolution”. With such numbers to clarify the situation, it is reasonable to assume that Clean Technology will become one of the key industries of the near future, and as such also one of the most important targets of global investment.

According to Ahlström Capital's yearly report (2010), one of the investors in Mervento Ltd, equity investments in Clean Tech have experienced "explosive growth" during the past five years. They go on to state that the sector appears strangely unharmed by the recent global recession and that global equity investments in the Clean Tech sector reached a record level of over 5 billion EUR in 2010. According to Ahlström, there are close to 1,000 new Clean Tech companies established every year in the Nordic countries alone, with the sector raising nearly EUR 500 million in equity investments in 2009. According to their report, the global Clean Tech market is currently the fastest growing of all sectors, reaching a total value of EUR 1,100 billion in 2010. Some sectors, such as solar energy and wind power, have reached an average rate of annual growth as high as 40 per cent. From a business standpoint as well as an ecological one, Clean Tech is the future.

2.3 The future of Clean Energy

It is clear that clean energy has become more widely accepted as of late and with renewable energy seeing consistent growth rates of over 30% in recent years it is easy to become optimistic over the future. Carmakers are finally starting their first moves toward mass-introduction of solely electrical Clean Tech vehicles as opposed to Green Tech hybrids and Smart-Grid development is also starting to take off, partly due to the development of and requirements of large scale wind power. Yet while there has been progress made, it is important to note that most of this has been as a result of policy-shifts and cost reduction measures and not new technology. This is of course a stabilizing factor for future growth but more truth can be found in this than is first apparent.

Without political support from the governments involved, it is simply not possible to have advances in cleantech at the level currently seen. Even with current growth, failure in keeping current policies as opposed to opposing them can make or break the market. The current growth in Clean Energy is astounding but even so, the demand for traditional forms of energy, meaning fossil-fuels, remains strong, even outpacing that of clean energy (IEA, 2010).

It is probably true, as stated by Johansson et al. (2004) that clean energy has the potential to fulfil practically all our energy needs, but if the so-called clean energy revolution is to arrive as expected after so many years of hope in new technology which is still to appear on the market, the current growth must be sustained. With the right incentives for industry and consumers alike and with large enough government funding given, this can be achieved. Without it, the diffusion of clean energy being as hard as it is (Jacobsson and Johnson, 2000) the current growth rate will be merely a side note in the larger story of what might very well be called the failed Clean Energy Revolution.

2.4 Wind Power

Wind turbines work by transforming kinetic energy of wind into electricity via blades and a generator attached to the rotor. The usage of wind power energy is, for many reasons, becoming more widely used as a substitute to oil where possible. Wind energy is renewable, and doesn't really cause any significant pollution or environmental damage (Tester et al, 2005), while at the same time being one of the most efficient as well as most quickly installed forms of power generation available (EWEA and Greenpeace, 2005).

Wind power supplied approximately 430Twh electricity in the world in 2010 (World Wind Energy Report 2010). Although this only equals 2.5% of the total world energy consumption in 2010 the sector has grown steadily. According to the Pew Energy Report (2010), wind investment levels increased by 34 per cent in 2010, and wind energy remains the leading recipient of clean energy investments in the world today. The reasons behind this development are many, but generally speaking, wind power is one of the more unused renewable resources available. The environmental effects are generally lower than most forms of hydropower based power generation and the energy production capacity at least at the moment better than solar power, where constant development might be about to change this. Pew states that in 2010, more than 66 billion EUR was invested in the wind sector by members of G-20 and the development rate is still increasing. Offshore wind investments continue to grow at a steady rate, with large projects undertaken off the coast both in the US, EU (Belgium and Germany) and China (Shanghai). Figure 1, below, gives a graphical representation of the investments in different energy sectors in 2010, while Table 1 shows the comparison to 2009 levels of investment and world ranking (GWEC).

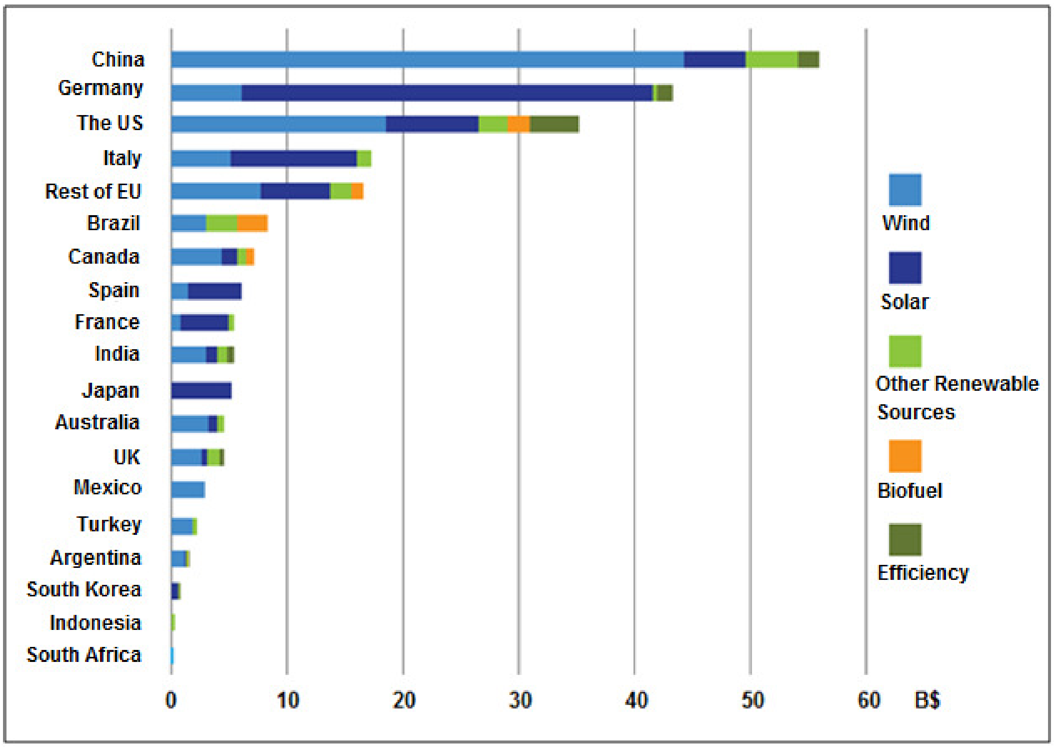


Figure 1. 2010 Global Clean Energy Investments by Sector and Country.

Table 1. Top 10 Clean Energy Investment Countries and Amounts, 2010.

2010 Rank	2009 Rank	Country	2010 Investment	2009 Investment
1	1	China	54.4	39.1
2	3	Germany	41.2	20.6
3	2	United States	34.0	22.5
4	8	Italy	13.9	6.2
5	4	Rest of EU	13.4	13.3
6	7	Brazil	7.6	7.7
7	9	Canada	5.6	3.5
8	6	Spain	4.9	10.5
9	12	France	4.0	3.2
10	11	India	4.0	3.2
Numbers in Billions of $.				

Table 2. Global Top 10 Wind Energy Countries in 2010 by Capacity.

Top 10 Installed Capacity in 2010			Top 10 Newly installed Capacity by Dec 2010		
China	42287	21.8	China	16500	46.1
USA	40180	20.7	USA	5115	14.3
Germany	27214	14.0	India	2139	6.0
Spain	20676	10.6	Spain	1516	4.2
India	13065	6.7	Germany	1493	4.2
Italy	5797	3.0	France	1086	3.0
France	5660	2.9	UK	962	2.7
UK	5204	2.7	Italy	948	2.6
Canada	4009	2.1	Canada	690	1.9
Denmark	3752	1.9	Sweden	603	1.7
Rest of the World	26546	13.7	Rest of the World	4750	13.3
Top 10 Total	**167844**	**86.3**	**Top 10 Total**	**31052**	**86.7**
World Total	**194390**	**100.0**	**World Total**	**35802**	**100.0**

As for capacity, Table 2, above, shows the world's top ten countries in regard to new installed and total installed capacity. It illustrates that China installed a record 16.5 GW of wind energy in 2010. China's total installed capacity is already 42.28GW and from the time of writing this to when this thesis is finished it will have risen by several GWs more. Both numbers occupy the 1st rank in the world (GWEC, 2010).

The numbers differ slightly from the once reported above since they are valid only up until December 2010, meaning not all of December's developments are included. The numbers from the GWEC are the most up to date publicly available global numbers however, and as they demonstrate, China's development is rapid indeed. In only one month, China managed to install 2.44 MW of capacity, which, in comparison, is almost 2/3 of the total cumulative capacity of Denmark so far.

The future potential of wind power is affected by several factors. The fact that it is renewable and does not pollute, gives a solid base for belief in future development of the industry. Power supply to services such as railways and computer servers has large potential considering that they can function almost entirely on electrical means.

There are however, some important barriers that prevent developments of renewable energy (Bergek, 2002). Such possible barriers can be country or region-specific and relate to cost and pricing, technical factors or legal and regulatory issues. Removal of these barriers requires supporting policies for the development of the industry. Relevant factors relating to these barriers are discussed at length in Section 4, the analysis section of this thesis.

2.5 Wind Power in China

Wind power has been one of the fastest growing sectors in China since the country began increasing its wind power capacity a little over five years ago (Martinot and Junfeng, 2007). Since then, through massive government support, China has attained the status of the world's largest wind energy market. China currently has more than three times the installed capacity of India. Through projects like the 11th Five-Year Plan in 2006, China has managed to create strong incentives for private investment. Support exists for state-owned companies who invest in Wind Energy R&D. Through these measures, and by steady reform of wind-power related legislature, such as the tender-system for on-grid prices being replaced with at fixed regional Feed-in Tariff in 2009, China has been able to actively govern the development of wind-power. It comes then as no surprise that China's 2010 installed wind capacity exceeded the target by 320% (China Electricity Council, 2010).

The 11th 5-year plan included national targets for wind of 5 GW installed in 2010 and 30 GW installed in 2020. The 12th 5-year plan raised the target to 150GW by 2020 and the next 5-year plan, in 2016, might very well increase it further. These targets are decided by the National Energy Bureau and fulfilled by the provinces and by electricity producers through required shares of renewable energy.

According the Pew Energy Report (2010), what we are seeing is the rapid rise of China as the world's clean energy superpower and looking at the numbers in the report it is hard to disagree. Private investment in China's clean energy sector increased by 39 per cent in 2010, to a total of almost 38 billion EUR, a new world record. China is also the world's leading producer of wind turbines and solar modules. That is has already surpassed the United States as the country with the most installed clean energy capacity may be surprising to some, but what is even more telling is that this happened already two years ago.

China's continued success in attracting investment for clean energy projects, in great part due to the efforts of the Chinese government, has made it possible to reach this level of development in wind power. China's rise has been incredibly fast and stable as comparisons from the Pew report shows. In 2005, China attracted less than 2.1 billion EUR worth of private investments in clean energy. In 2009, on the other hand, China led the world, with 27.2 billion EUR invested. In 2010, investment in China's clean energy sector again increased 39 per cent above the already high 2009 levels. As comparison, 2010 clean energy investments in China alone are equal to total global investments in 2004 and the speed shows no signs of decreasing. With some of the most aggressive clean energy targets in the world (Etfchina.org, 2008) and a government mandated goal of dominating both manufacturing and power generation of clean energy, China is leaving the rest of the world in its wake. According to the Pew report, in 2010, China accounted for almost 50 per cent of all manufacturing of solar modules and wind turbines. When it comes to China's installation of solar energy capacity, numbering at less than 1 GW, it is clear that most of its production is still for export markets. In contrast, 17 GW of wind energy was installed in China in 2010, which has helped the nation move quickly toward its ambitious target of installing 150 GW of wind power by 2020. In 2010, China accounted for 47 per cent of all wind energy investments globally. The situation is the same when it comes to asset financing, where China leads the pack with $47.3 billion in private investments in clean energy generation.

Another important thing to take note of is that a lot of countries do not want to be reliant on energy resources controlled by other countries, such as when having to import oil. This gives some nations major incentives to become energy independent, China being one of these countries. To illustrate and clearly show the development of Wind Power in China, Table 3 below shows the cumulative and newly installed capacity divided by province. As can be seen, the total cumulative capacity of the top Chinese provinces are on the same level as that of the total cumulative capacity of other top ten wind power nations.

Table 3. Chinese Wind Power Capacity by Province, 2010.

No	Province (Autonomous region or municipality)	Cumulative installed capacity in 2009	Newly installed capacity in 2010	Cumulative installed capacity in 2010
1	Inner Mongolia	9,196.16	4,661.85	13,858.01
2	Gansu	1,187.95	3,756	4,793.95
3	Hebei	2,788.1	2,133.4	4,921.5
4	Liaoning	2,425.31	1,641.55	4,066.86
5	Gilin	2,063.86	877	2,940.86
6	Shandong	1,219.1	1,418.7	2,637.8
7	Heilongjiang	1,659.75	710.3	2,370.05
8	Jiangsu	1,096.75	371	1,467.75
9	Xinjiang	1,002.56	361	1,363.56
10	Ningxia	682.2	500.5	1,182.7
11	Shanxi	320.5	627	947.5
12	Guangdong	569.34	319.44	888.78
13	Fujian	567.25	266.45	833.7
14	Yunnan	120.75	309.75	430.5
15	Zhejiang	234.17	64	298.17
16	Shanghai	141.9	127.45	269.35
17	Hainan	196.2	60.5	256.7
18	Shanxi	-	177	177
19	Beijing	152.5	-	152.5
20	Anhui	-	148.5	148.5
21	Henan	48.75	72.25	121
22	Tianjin	-	102.5	102.5
23	Hunan	4.95	92.3	97.25
24	Jiangxi	84	-	84
25	Hubei	26.35	43.4	69.75
26	Chongqing	13.6	33.15	46.75
27	Guizhou	-	42	42
28	Qinghai	-	11	11
29	Guangxi	2.5	-	2.5
30	Hong Kong	0.8	-	0.8
	Total (MW)	**25,805.3**	**18,927.99**	**44,733.29**

A graphical illustration of the development is given below in Figure 2, effectively showing the two major development areas of wind power in China, the northern and coastal areas.

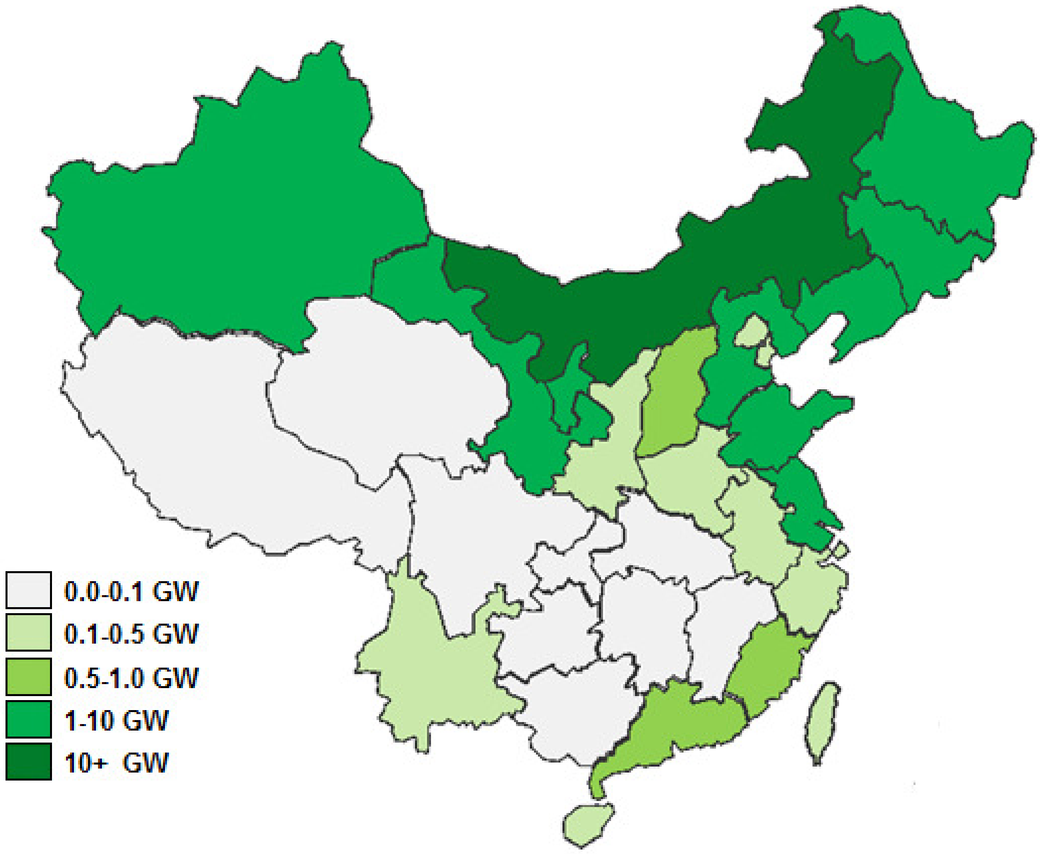


Figure 2. Map of Chinese Wind Power Development.

2.5.1 Wind Power Bases

The development of the wind power bases started in 2008 under the leadership of the National Energy Bureau and is progressing fast. According to the plan, the 8 bases include in Table 5 below, will contain a total installed capacity of 138 GW by 2020.

It is however important to note that this is only a target as long as the supporting grid network is established to support the capacity. The minimum development target for each base is set at 10 GW, meaning a minimum goal of 80 GW in total. A significant problem related to the grid development is that many of these bases are located not only in remote areas with a currently weak transmission grid but also at a long distance from China's main electricity load centres.

Table 4. Chinese Wind Power Base Development and Plans.

Wind Power Base	2010 (installed)	2015 (planned)	2020 (planned)
Heibei	4,16	8,98	14,13
Inner Mongolia East	4,211	13,211	30,811
Inner Mongolia West	3,46	17,97	38,32
Jilin	3,915	10,115	21,315
Jiangsu	1,8	5,8	10
Gansu Jiuquan	5,16	8	12,71
Xinjiang Hami	0	5	10,8
Total (MW)	**22,706**	**69,076**	**138,086**

At the current date, the number of wind power bases, while actually numbering 8, is soon to be increased, with Guangdong, Shandong, Zhejiang and Fujian competing for a spot and not yet having any official development figures. Development is progressing rapidly however, and official numbers should be released soon. It is important to note that these areas are all on the coastline, the frontier of new wind power development in China.

2.5.2 Grid Integration

Data from the Chinese Wind Electricity Regulatory Commission shows that, as of the end of 2010, the total official wind energy output capacity was over 44.73 MW, out of which connected capacity was only 31.07 MW. This means that due to factors such as a manufacturing overcapacity and rapid installation of wind turbines compared to grid development, only 69.5 % of the total installed capacity had been integrated into the power grid at the end of 2010. Although the installed capacity was still enough to reach the number one position in the world in 2010, out of the 2010 newly installed capacity of 18.93 GW only 13.99 GW has been integrated into the grid. While this amount, at 73.9% of installed capacity, is quite low, the situation for new installations is improving according to the State Electricity Regulatory Commission. Just in case the situation was not made clear enough with the figures stated in terms of production capacity, the unused wind-generated electricity amounted to 2.8 TWh in the first six months of 2010, mainly due to insufficient transmission capabilities and grid connections. (SERC, 2011) To put this number in perspective, 2.8 TWh equals the energy amount of almost 300 million litres of oil, simply being thrown away, in only half a year. Still, as comparison, idled wind energy in the U.S. was around 25TWh and will probably exceed 40 TWh in 2011 (Doty, 2011), so the situation is far from unique and could be much worse than it is.

The situation has not gone unnoticed, with the 12th “Five-Year Plan” making it clear that in the next five years, network construction needs to be emphasized in order to solidify the fast development of wind power. Nevertheless, the variability of wind power generation and the effect it has on grid operation are enormous economic challenges that will require hard support on many levels of government. To support large-scale wind power development, the State Grid Corporation (SGC) had, at the end of 2010, invested a total of 41.8 billion RMB (about 4.5 billion EUR) in power grid construction, putting into operation a total of 23,200 km of routing. The State Grid, China's largest power distributor, plans to spend more than 500 billion RMB

(52.65 billion EUR) to upgrade the grid during the 12th Five-Year Plan (2011-2015). The SERC report also states that the Inner Mongolia autonomous region accounts for 75 per cent of the unconnected wind-power generation in the country, owing to the lag in grid construction.

The SGC has also acknowledged the problem, making statements officially recognizing the fact that the rapid increase in the installed capacity of wind power means that there is an urgent need to speed up the construction of peak power regulation facilities, such as for example pumped storage hydro-electrical power stations. The output of such plants is more flexible and can adjust to the load and requirements of power, ensuring smooth power grid operation. Unfortunately, there has been very little, if any, money earmarked for the construction of such power stations in the previous development plan. In fact, the SGC has previously suggested that the goals of a smoothly operating power-grid should, at least currently, be mainly achieved through a coal base. This may seem contradictory when considering the inflexibility of coal-fired power stations. The SGC has also declared that by 2015 the smart grid will be completed. There is however no contradiction, only a clear indicator of the long term planning necessary in bringing the Chinese smart gird to international standards. The hope of the SGC is that by 2015 the grid will have the ability to integrate power from wind farms up to 100 GW, this being in line with planned for the installed capacity (SGC, 2010). Part of this plan does in fact now consist of the State Grid Corporation planning and constructing pumped storage reservoirs. To accomplish the successful integration of these power stations and reach the renewable energy goals, the State Grid Corporation has, in its own words, formulated the world’s most complete set of smart grid technical standards.

This in turn brings up another regarding the current development of power delivery in China. In order to meet the demands of large-scale development in wind power and other renewable energy, the operating costs of the power grid will increase significantly. The SGC expects the 2020 target for installed wind power capacity to increase from 100 GW to 150 GW. In this case, the grid would require a corresponding increase in investment, meaning 4.8% of the grid capacity stemming from pumped storage or other similar sources. The entire power system operating cost is then expected to increase, which could push up electricity prices.

The SGC's expectations regarding future goals of installed wind power notwithstanding, there are enough problems with power delivery as it is. As an example, one can look at the three wind farms in East Mongolia, Jilin and northern Hebei, which rank among the top areas in terms of installed capacity as a proportion of the total net maximum load. In these areas, even though power-grid construction is increasing rapidly, so is grid instability. The progress in power grid construction is simply not fast enough to keep up with the increase in wind power capacity. Again, this is not something which has been overlooked, and several areas with lower wind power potential are in fact being developed while grid-development progresses. One must also remember that the grid development in service of China's wind power expansion is one piece of a larger plan to build-out the basic structure of a robust smart grid in China by 2020 and that even with rapid development, it will still take years. The Chinese expect to invest upwards of 2 trillion RMB (about $216 billion EUR) during the 12th Five Year Plan Period (2011-2015) and likely another 2 trillion RMB from 2015-2020. SGC (2011)

Still, there is some cause to take the bad news a little less seriously. It is true that there are problems with grid integration and that these problems are not trivial, but the problem is at least partially explainable by a simple confusion when it comes to the methodology used for calculating installed capacity. It seems that the Chinese Federation of Power Generation, which provides China's energy statistics, only counts wind farms as operational when the last turbine of a project has become grid-connected (GWEC). This is not the standard outside of China since in reality most of the installed wind turbines of a project are connected to the grid and generating power before this.

It is however true that the importance of a well functioning power grid and power delivery cannot be overstated and this is well demonstrated by looking at the so called "2/24 wind power accident". On February 24th, the Northwest Power Grid in the Gansu Jiuquan wind power base suffered a catastrophic short circuit fault, leading to the loss of 840 MW of output from 598 turbines. The underlying reason for the fault was a typhoon in the area which caused high wind speeds, but both the wind turbines as well as the power grid were expected to handle the situation without ill effect, which unfortunately didn't turn out to be the case.

After the accident, the Chinese State Electricity Regulatory Commission attached great importance to the establishment of an accident investigation team, implementing a thorough analysis on the causes of the accident, and how they relate to wind power development in the country. The investigation, which focused on existing safety issues in the currently implemented development plans and the rectification of these issues, showed that major safety problems exist in four separate areas of current wind power development.

Firstly the majority of currently manufactured wind turbines do not have any low voltage ride through capability (LVRT), meaning that during a power failure the turbines cannot be guaranteed react according to what is needed, like disconnecting from the grid. It turns out that the Jiuquan wind power base was completed in 2008, at which time the low voltage technical requirements were still not clearly defined. The turbines in question were therefore not in full compliance with currently existing regulations as is the case with later versions of the same turbine models.

The second issue was found in wind farm construction quality control, where it turns out that parts of wind farm project quality management have been entirely under owner control, and not an independent entity. Construction quality management was found to be lacking or in some instances not in place at all. The National Grid Energy Research Institute has been quoted as stating that the wind turbine supply contract for the Jiuquan wind power base has very clear technical requirements which simply have not been followed.

Third, it was found that regulations on wind farm access to the power grid need to be urgently strengthened, since some power grid enterprises have been found to have poor knowledge of wind farm management. New companies should not be permitted access to wind farms power grids without authorization and network security evaluation, as has previously been the case.

The fourth factor concerns the operation of wind farms, where some of the wind farm safety management systems have been found lacking, with imperfect field operating procedures, management, and secondary reactive power which fails to meet the safety requirements. Power companies need to further strengthen the wind farm scheduling management.

The 2/24 incident had a big impact on the Chinese wind energy industry with the SERC taking the accident as an important warning: ignoring technical standards and lack of coordination with relevant parties may very well become the future energy and power grid risks. Goldwind and Sinovel only recently started development of the LVRT technology two years ago and before 2/24 the technology did not get much attention at all. At the moment LVRT's key technical issues are still controlled by foreign brands and during 2011, the Chinese Government is set to release new wind turbine technical regulation standards which will make the situation even harder for turbine manufacturers.

The current LVRT regulations for turbines require that when the voltage at the point of interconnection of wind farm is above what is specified, as can be seen in Appendix 1, the wind turbine should stay connected to the power grid and keep operating. Under the values specified by the blue line, the wind turbines are allowed to disconnect from the grid. The turbine must also have the ability to keep operating for 625ms when the voltage at point of interconnection of wind farm drops to 20% of rated voltage. 3 seconds after the drop of voltage at the point of interconnection, the voltage can revert to 90% of the rated power, and the turbine can keep operating. The wind farms currently in operation which lack the LVRT capability are now required to be actively rebuilt to make sure the turbines have the LVRT capability not only on paper but also in practice (SGC, 2010).

2.5.3 National Policies, Laws and Regulations

Pricing policy shortfalls has been a stumbling-block for wind power development ever since China's renewable energy program started. As an example, one of the things that China's 2006 Renewable Energy Law tried to do was to place pricing standards for energy produced through renewable energy sources. The general goal of the law was to increase the renewable energy generation in China as well as diversify the energy sources and thereby increase stabile power generation overall. The pricing was based on the same type of feed-in tariff models used in for example European energy markets (Zijun, 2006), but unfortunately, there were no clearly defined links between pricing at the source and grid distribution, only a statement of the on-grid price being "economic and reasonable" which proved to be vague enough to still be a problem. The problem stems from the fact that utility companies often have few if any reasons to actually connect a wind farm to the power grid, since once they are connected they are required by law to buy the power generated by it even though it is higher than the price of conventional, coal-generated, energy. For this reason, the sad fact is that there seems to be a quite extensive history of wind-power projects which have not been connected to the grid at all. (SERC, 2010) This situation was somewhat remedied in 2009 with the tender-system for on-grid prices being replaced with a fixed regional Feed-in Tariff. The provinces have been divided into 4 different regions with tariffs of 0.51, 0.54, 0.58 and 0.61 RMB/kWh coupled with some local additional support, a system infinitely more clear than before, where similar areas could have hugely different prices on their wind power.

Appreciating the key role that subsidies play in incentivizing the development of clean energy, the Chinese are also committed to gradually increasing the subventions applied to developers of wind energy, which now stand at an additional 0.004 RMB per produced kWh, and which likely will double over the course of the next two years as it did in 2009 when it was raised from 0.002. (SGC, 2011)

The current Chinese regulations for near shore and off shore measurements, another factor to mention here, are presented below in Table 5 to facilitate an easier understanding of their consequences.

Table 5. Chinese Regulations for Near Shore and Offshore.

<table>
<tr><th></th><th>Distance from coast</th><th>Ocean depth</th></tr>
<tr><td>Near shore</td><td rowspan="2">< 100 KM</td><td rowspan="2">< 25 meters</td></tr>
<tr><td>Off shore</td></tr>
<tr><td>Restrictions before 2020</td><td>=< 40 KM</td><td>< 15 meters</td></tr>
</table>

As can be seen, the restriction enforced until 2020 will in some cases limit the development of off-shore wind power. These restrictions are in place partly due the lack of necessary grid development and partly due to the lack of necessary engineering knowhow concerning large scale wind power projects. Other factors include the higher cost of development, larger maintenance costs as well as the possible risks of typhoons. China is rapidly improving its knowhow along with technical expertise, but nonetheless, the restrictions will impact the choice of suitable areas to develop for the near future.

It is important to mention at this point that since the regulations on development restrict new off shore wind-farms to an area less than 40 kilometres from the shore until 2020, this effectively means that until then, the Chinese definition of “offshore” is close to the “near shore” definition used elsewhere. This is important to remember in the screening section further on.

Regarding the general policies for renewable energy in China, the following summary, a shortened version of data compiled by the American council on renewable energy (Acore, 2010), provides an easy overview of the present situation.

- Grid enterprises should acquire the full amount of generating capacity from renewable energy projects
- Grid enterprises must give a reasonable on-grid price (reasonable cost + reasonable profit)
- The surcharge to cover disparity from the conventional electricity price is shared by all electricity customers
- Starting from June 2008, developers received an additional 0.002 RMB for every kWh generated from renewable sources. In November 2009, the rate was increased to 0.004 RMB/kWh
- Currently, four feed-in-tariff levels exist for wind power generation (0.51-0.61 RMB/kWh)

Also, now that the new national standards for wind-power are to be implemented, it will limit a lot of manufacturers who, as it stands, simply do not have the necessary technology to reach these standards. Because the new rules will contain more restrictions than before, the new standards will most probably cause the merger of some companies. The new standards come in several parts, with some already having been released by the government in February. They contain restrictions for wind power equipment manufacturers regarding their turbines, which must be rated 2.5 MW or above. Manufacturers must also have a yearly capacity of more than 1 GW and provide complete support facilities for their products. They must also have more than five years of experience in the sector.

2.5.4 Business Development Status

It is often stated that China has around 80 wind power manufacturers, which is essentially true, even though some of the companies included in this number are wholly owned subsidiaries of others. Still, the main group is usually divided into three tiers (Liu, 2010). At the top, the three “Tier I” wind power equipment gurus consist of Sinovel, Goldwind and Dongfang Electric Corporation (DEC). In the middle, making up the “Tier II” segment, are principal manufacturers such as Shanghai Electric Group and XEMC Windpower. The large number of small and medium-sized companies falls into the bottom or “Tier III” rung. According to statements from the Chinese Wind Energy Association, at most ten of them will be capable of meeting the new requirements. State owned enterprises are also under pressure to make sure that they reach the 8% renewable energy goals, which are a major part of the 12th 5-year plans goal of non-fossil fuels making up 15% of the total energy production in 2020. If the separate goals given to each company are not reached, they will most likely face the risk of being acquired by others.

Another area of some concern, according to renewable energy foundation, is that of the non-governmentally sanctioned wind power projects which have become very common. The problem stems from the fact that projects with a capacity below 50 MW have not required state-level approval, meaning that projects below this limit have been able to be integrated after only local level approval. The much more expedient approval procedure and grid connection process has meant that many companies have initiated 49.5 MW projects. This has unfortunately created a massive grey area in the state-level approval system with the result being a huge conflict with the wind power and power grid plans. A report from the former Administration of Water Resources and Hydropower Planning and Design, now working under the name Hydrochina Corporation, reveals that during 2009, 111 of the 187 approved wind farm projects that year had a 49.5-MW capacity. Even though the local approval system and the state-level approval are essentially similar, the flexibility involved on local level approval as well as the lack of information on a state-level has contributed to grid-problems, since the necessary grid development is usually lacking when the projects are finished. This can also be seen as a partial explanation for the problems mentioned in the previous section.

Related to this, it is relatively simple to realize that the current overcapacity in turbine manufacturing is actually an overcapacity of a very specific kind. A large part of current manufacturers are using the exact same technology, in many cases bought or licensed from the same company. The key factor here is that this is old technology, and the products, by current standards, are of low quality. Compatibility with the power grid is often an issue, as is the lack of LVRT. Price battles are already being waged and very soon a large portion of small and medium size manufacturers may find themselves out of business. China has as a target to achieve 100 GW of grid-integrated wind power by 2020. Due to the requirements mentioned above, a large part of the manufacturing capability cannot and will not be used to achieve this goal. Quality over quantity is already being pushed at the government level, with the state wanting to fix the current problems before moving forward. (SERC, 2010) With only around 5-years of working knowledge of the wind power market, cooperation with foreign companies is very important and is seen as a sign of good business strategy.

Table 6 below shows the newly installed capacity and market share of the largest Chinese wind power developers in 2009. The table does not individually list all developers since they are quite numerous, but as can be seen, more than half of the market share belonged to only 4 companies and the 20 companies in the list, all with an installed capacity of over 100 MW, account for almost 90% of the total market share. The 2010 numbers have yet to be officially reported and are unreliable, with different sources announcing different totals. Just as a comparison however, it can be said with some certainty that the market leader, Guodian, installed well over 8000 MWs of capacity. They are currently the 3rd largest developer in the world and the largest in Asia. Compared to 2009 levels, their total installed amount is more than times as high, which in itself is quite staggering.

Table 6. Market shares of Chinese Wind Power Developers.

Capacity (MW)	Developer	Newly Installed Capacity (MW)	Captured Market share in 2009(%)	
>1000	Guodian	2,600.4	18.8%	
	Datang	1,739.85	12.6%	
	Huaneng	1,644.75	11.9%	
	Huadian	1,230.05	8.9%	
500-1000	China Guangdong Nuclear Power	854.45	6.2%	
	Jingneng	797.5	5.8%	
	Guohua	590.25	4.3%	
100-500	CECEP	400.25	2.9%	
	CPI	319.67	2.3%	
	China Res Power	309.75	2.2%	
	Tianrun	309.75	2.2%	
	China Wind Power	295.5	2.1%	
	Hecic new-Energy	160.4	1.2%	
	SDIC	151.5	1.1%	
	SINODYDR	148.5	1.1%	
	Ningxia Electric power group	143.5	1.0%	
	Zhongmin	130	0.9%	
	Shenneng north	129	0.9%	
	Luneng	102.25	0.7%	
	Honiton Energy	100	0.7%	
Others		1,645.89	11.9%	
Total		**13,803.21**	**100.0%**	

When looking at the situation among turbine manufacturers, with statistics from 2010, seen below in Tables 7 and 8, the situation is much the same. Sinovel, Goldwind, and DEC together have more than a 50% share of the Chinese wind energy market, and the 20 largest turbine manufacturers account for 98% of the total market share.

Table 7. Top 20 Turbine Manufacturers in Newly Installed Capacity.

2010 China newly installed capacity: Top 20 turbine manufacturers			
No.	**Manufacturer**	**Newly Installed Capacity (MW)**	**Market Share**
1	Sinovel	4386	23,2 %
2	Goldwind	3735	19,7 %
3	DEC	2623,5	13,9 %
4	United Power	1643	8,7 %
5	Mingyang	1050	5,5 %
6	Vestas	892,1	4,7 %
7	SEC	597,85	3,2 %
8	Gamesa	595,55	3,1 %
9	XEMC	507	2,7 %
10	ChinaCreative	486	2,6 %
11	CSIC	383,15	2,0 %
12	Nanche	334,95	1,8 %
13	Envision Energy	250,5	1,3 %
14	GE	210	1,1 %
15	Suzlon	199,85	1,1 %
16	**HEAG**	161,64	0,9 %
17	Ningxia Yinxing Energy	154	0,8 %
18	Windy	129	0,7 %
19	SANY	106	0,6 %
20	WindCHN	100	0,5 %
Others		382,9	2,0 %
Total		**18927,99**	**100,0 %**

Table 8. Top 20 Turbine Manufacturers in Cumulative Capacity.

2010 China cumulative installed capacity: Top 20 turbine manufacturers			
No.	Manufacturer	Newly Installed Capacity (MW)	Market Share
1	Sinovel	10038	22,4 %
2	Goldwind	9078,85	20,3 %
3	DEC	5952	13,3 %
4	Vestas	2903,6	6,5 %
5	United Power	2435	5,4 %
6	Gamesa	2424,3	5,4 %
7	Mingyang	1945,5	4,3 %
8	GE	1167	2,6 %
9	XEMC	1089	2,4 %
10	SEC	1073,35	2,4 %
11	Suzlon	805,1	1,8 %
12	Windy	723	1,6 %
13	ChinaCreative	682,5	1,5 %
14	Nordex	524,7	1,2 %
15	CSIC	479,25	1,1 %
16	Nanche	465,3	1,0 %
17	Envision Energy	400,5	0,9 %
18	Windy	295,08	0,7 %
19	Ningxia Yinxing Energy	252	0,6 %
20	CE	249	0,6 %
Others		1750,26	3,9 %
Total		**44733,29**	**100,0 %**

As can be seen in Table 8, the total cumulative installed capacity shows more of the same picture, with the top three manufacturers being the same, showing a well established market, and the following companies keeping their overall position, only jockeying for position relative to each other. A closer comparison shows that Vestas and Gamesa have lost market share as of late, while MingYang and SEC seem to be gaining. Since we are only comparing a single year to the overall situation, the differences may simply be statistical in nature, denoting only natural fluctuations.

However, considering that the Chinese wind power market is essentially only 6 years old and knowing what we know about the currently very competitive nature of the market, the differences may be significant. The regulations and standards implemented have a huge effect on the market and only sufficiently advanced wind turbines are now being sold, meaning that the companies who are losing or gaining a high degree of market share are probably doing so due to either the current designs of their turbines or regulatory changes.

One thing that is sure to impact the future success of the manufacturers in the market is the development of offshore wind power resources. According to Liu (2011), news from the Renewable Energy Industry Market Review & Outlook, which was held in Beijing in January of this year, is that China's is expected to invest more than 25 billion RMB in offshore wind farms in the next five years. Goals for the installed offshore capacity are 10 GW, and this is planned to rise above 30 GW by 2020. The manufacturers who can keep up to date with the regulations and develop reliable, 2.5MW or higher, solutions for offshore wind farms are the ones who stand the largest chance of succeeding in the near future. Factors to take note of are then the reliability, ease of maintenance and installation of the turbines, all of which Mervento has a high degree of. Other factors that can be of significance are such things as hurricane and acidic protection features. The Chinese government has intentionally stalled the development of offshore wind power so that the knowhow and technology can mature but the wait is now over and companies are assumed to be able to develop the necessary technology or acquire it from foreign partners.

2.6 Chinese Business Culture

2.6.1 Marketing your Country

It is necessary at this stage to deviate somewhat from the current topics in order to address some serious lacks in marketing strategy which goes largely unnoticed when it comes to China and indeed the world. To illustrate the problems and explain why it is so important when looking at the choices of partner companies, we can use a couple of well-known brands as examples.

Nokia, as one of the most successful international companies in Finland and largest mobile phone companies in the world, is often seen as representing Finland and will easily demonstrate the first point to be made. Nokia has always had a very big responsibility for representing Finland abroad. The company employs many both locally and abroad as is sometimes seen as a natural asset. The truth is however that when it comes to Finland being Nokia's country of origin, it is practically an unknown factor in China and many other countries. A lot of people mistake Nokia as being an American or Japanese brand. A lot of Finns find this amusing, but do not pay much attention to why this is. The simple explanation is that when Nokia marketed itself in Asia, it forgot to market Finland as well. Not only has this probably cost Nokia when they tried to expand but it can also be seen as one reasons for Nokia's recent problems in Asia, where the company has lost market share at an alarming rate.

At the point of peak brand popularity, Nokia did not take the opportunity to build the proper brand loyalty. In Chinese culture, with its long documented history stretching back thousands of years, where you come from and what you have done previously is very important. Nokia failed to make this distinction and for this reason, did not manage to build any personal attachment to the brand among its customers.

As an opposing view, one can look at Apple which has been hugely successful. Apple markets their brand not only with quality, like Nokia does, but also using American culture. To illustrate this point clearly, when foreign companies market their products in China, they hire famous Chinese actors or local talents to star in the commercials. This is not the right way to go about building brand loyalty in China. The Chinese will see this for what it is; marketing and nothing else. If a company uses its own people, its own country and culture, to market its products, this will build interest in the brand. This is especially true in the case of Finland. Due to the lack of Finnish brands on the Chinese market and Nokia not emphasizing their origins, many Chinese know nothing about Finland. The few who know Nokia is Finnish might be able to mention that it is a European country.

2.6.2 Marketing your Strengths

The lack of knowledge shown to exist above can probably be explained with the traditional Finnish way of doing business, meaning winning with quality alone. Focusing on quality is definitely the right choice, but in intensive global competitions, naked quality is not enough. Due to the Finnish mindset, many Finns seem to think that Finland as a country and culture doesn't have much to introduce. This may be due to the humble nature of Finns, but from a foreigner's point of view however, Finland has a lot of potential which it has not yet shown to the world. Unfortunately, as shown above, Chinese people seem to think that Finland is just another distant mysterious country, and even Americans, more attuned to frequent international business, seem to have this opinion.

Germany has a very successful marketing position in China and rest of Asia and can be used as an example here. The image Germany has built for itself in Asia is of a culture taking things very seriously, ensuring good quality and having a good attitude in life: a nation of honest people who keep their promises and are always on time. The German educational system is well known in China while the Finnish educational system, although it often receives international praise, is practically unknown. German products are among the most strongly trusted in China simply because they are German that one can almost say that Germany itself has become a brand in China. The pervasive belief in Germany as a stamp of quality is so high that many Chinese now regard products from German as always being good. In the marketing of the products this is used effectively by proudly mentioning that the product is German as often as possible.

In the field of wind power, this can at least partly explain why the most successful wind turbine technology licensing company in China is Aerodyn. Windtec is also doing very well in China, with Chinese people seeing Austria as being very similar to Germany.

Due to the Finnish mentality, Finnish companies like to be humble in their achievements, but while being humble is something that is seen as reasonable within Chinese society, the same does not apply to foreigners, who are expected to be more outspoken about themselves. A Chinese wind turbine manufacturer might be seen as bragging if they were to talk about their successful products while a Finnish company might be seen as unsuccessful if they fail to do the same. In the eyes of a Chinese company representative, a failure to mention success signifies that something is wrong.

2.6.3 Innovation in China

If you ask other students at an international school or line, Chinese student are usually some of the most hardworking students around. Some have it as a goal to finish 3-year degrees in half them time and many do. The Chinese educational system is hard and disciplinary but it works. Where it fails however, is in innovativeness.

The same innovative spirit which is so well-known in American R&D is usually absent in China. It is often stated that the American educational culture of a pioneering spirit is what enables the American educational system, despite its many flaws, to produce so many new ideas among its populace. If this is true, then the opposite must be true of China. While innovativeness and individual achievements are highly praised in the US, they are seen as nuisances and unnecessary in China. The goal is instead the good of the community as a whole and not the individual. This mindset is partially to blame for the lack of innovation in China which in turn makes foreign technology licensing such a necessary part of the current Chinese wind power market.

Another related reason for the lack of innovation can be found when one looks at the competition within the Chinese educational system. With so many applicants for position at both educational entities as well as employers, the competition is necessarily fierce. Interviewing is not feasible until the very end of the application process if one is faced with thousands of applicants. For this reason, grades are everything in the Chinese educational system. The interview is what might get you the job but you will never get close to landing an interview without flawless grades. This both explains the previously mentioned hardworking attitude of Chinese students as well as the lack of innovativeness in China. If you have to focus your entire attention on getting a perfect score in every test, how can you be expected to understand everything you have to remember? It is unrealistic to believe you can memorize every book you have read in during your studies and without the needed practical understanding of the theoretical knowledge, there can be no innovation. Chinese students are learning how to remember, not how to understand. The point might be made that this also explains why China is so good at producing copies of foreign products. The end result is in any case, a severe lack of innovativeness.

2.6.4 The Future of Wind Power in China

China has clean energy targets of total installed capacity of 150GW by the year 2020. The actual forecasted amount actually expected to be available at that time is a massive 230GW according to GWEC (2010). This might seem too optimistic, but as can be seen below in Figure 3, the development so far seems almost exponential in nature.

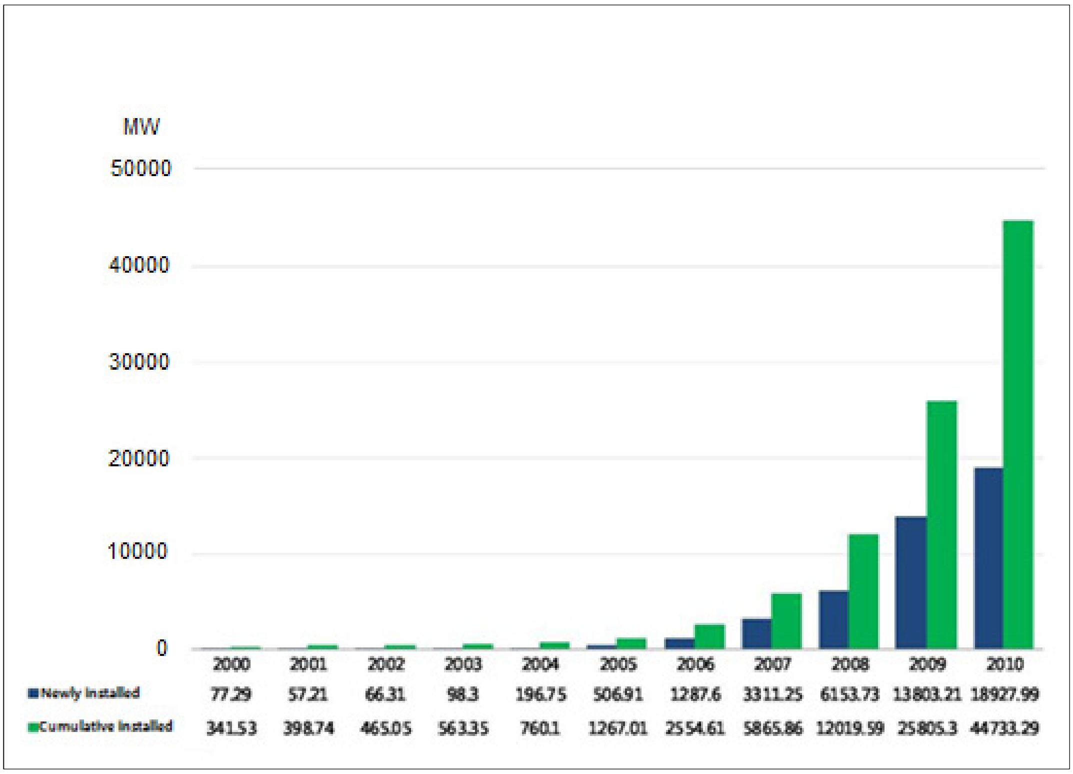


Figure 3. China Wind Power Development in terms of Capacity.

There are discrepancies between different Chinese institutions in their evaluation of the wind power resources. This is due to differences in methodology, but most evaluations seem to agree that there is a theoretical reserve of onshore resources of around 3,200 to 4,000 GW. Where the different surveys differ is in their estimates of the technically exploitable amount.

Professor Li Junfeng, the Deputy Director General of the Energy Research Institute, Secretary General of China Renewable Energy Industries Association and Vice-Chairman of the

Global Wind Energy Council, among other positions, has been quoted several times in lectures, giving the following calculation to estimate the total potential: The practical development area in China is approximately 200,000 km^2, and based on current technology, over 50m of elevation requires 3-5 MW wind turbines to cover 1km^2. With 200,000 km^2 of development land area available in China, the total installed onshore wind capacity is probably around 600 to 1,000 GW. According to the China Coastal Zone and Tideland Resource Investigation Report (GWEC, 2010) the total sea area with a depth of 0-20 meters off the coast is approximately 157,000 km^2. Assuming usage of 10% to 20% of the total amount of sea surface, the total offshore wind capacity can easily reach 100~200GW. These numbers fit very well with later studies such as the one by the Chinese Academy of Engineering (2009) which estimates the total currently exploitable capacity of both land-based and offshore wind at between 700 to 1200 GW. Even with slight discrepancies in other studies, the conclusion has to be that there are abundant wind power resources in China with the potential for wind power looking good indeed. Another factor to realize is that due to advances in technology, the total amount of exploitable wind power increases by around 10GW per year.

Compared to the current top-five wind powers, the extent of wind resources in China is close to that of the US and greatly exceeds India, Germany and Spain. According to GWEC (2010), wind energy resources are particularly abundant in the southeast coastal regions, the islands off the coast and in the northern part (northeast, north and northwest) of the country. There are also some places rich in wind energy in the inland regions. With a long coastline, offshore wind energy resources in China are also abundant.

The newest global forecast for 2011-2015 from GWEC indicates that Asia, between 2011 and 2013, will achieve a new installed capacity of 116GW, with the 2015 capacity reaching 26 GW, compared to 19 GW in 2010. China is expected to achieve a 2015 new installed capacity of 20 GW, compared to 16.5 in 2010.

In 2009, the Chinese government made a political commitment, stating as a goal that non-fossil energy would satisfy 15% of the country’s energy demand by 2020. At current development speeds it certainly looks like this goal will be easily attained.

In Asia, the potential markets for wind energy are China, Taiwan, Singapore, Malaysia, Korea and Japan. All these countries have the economies to support major wind power projects. So why choose China over the other potential markets? As it turns out, China is the only real choice, because not only is it developing fast but it also has true potential for growth in the future and not only the short term. The main factor is of course that China has the biggest wind power reserves in the whole of Asia, but the second most important factor is that government support already exists to make use of this potential. The other potential countries all have the wind power resources and economic fundamentals to handle wind power projects but more often than not planning is lagging behind either due to regulatory reasons or lack of willingness to invest more aggressively in renewable energy.

China’s ambitions for developing and implementing wind energy acts as a catalyst for other Asian nations to do the same. China is serious about its wind power development goals and as such wants to ensure that everything goes as planned. So far, the results have topped every goal with the result being revised plans with new targets developed every other year. Because the Chinese government fairly considers itself to be an economic superpower, and with the current economic situation one could even go so far as to say that it is the only current one, the government is willing to take responsibility and strive to be an example for the world in matters such as clean energy. This makes it very likely that China will keep the promise of 15% renewable energy by 2020. Most likely, the end result will not be a “reaching of the goal” but a considerably higher number.

The energy production targets used in the 12th five-year plan, devised by the National Energy Bureau and Research Network, include such targets as non-fossil energy accounting for 15% of the primary energy consumption target in 2020, and having more than 90% of non-fossil energy converted into electricity at that time. Nuclear power, hydropower, wind power, solar power and other non-fossil energy power generation capacity’s share of the total power generation capacity will reach about 35%, meaning that by 2020 the proportion of China's non-fossil energy generating capacity will be around 25% of the total generating capacity. According to plans prepared by the coastal provinces as part of the 12th 5-year plan, the installed capacity of offshore wind power is planned to reach 32,800 MW by 2020 (SERC, 2010). This is again something to take into account in the latter stages of candidate screenings. Related to this, with the development of wind power in China shifting towards off-shore application, the need for hurricane protection and acidic protection is an area where there is an R&D focus since the government is emphasizing quality and reliability of future wind power installations.

2.7 Mervento

2.7.1 Current Technology

Mervento Ltd is the leading global provider of multi-megawatt direct drive wind turbine power plant solutions for onshore, near shore and offshore applications (www.mervento.fi). As stated by the company, their turbines are developed with superior energy production and reliability as the foremost aim. Energy production has been successfully increased by designing the rotor with top-class blades and thereby ensuring a very low rated wind speed. A tall tower guarantees higher energy production, but is usually also more prone to vibrations due to resonance with excitation frequencies. Using a new development process, Mervento designers have found a way to increase the height of the tower and increase the natural frequency. The risks of resonance are therefore reduced along with the manufacturing costs.

Better reliability has been achieved through using direct drive technology. The traditional wind turbine design has been simplified using through novel solutions. A medium voltage direct drive permanent magnet generator is for example used to transform mechanical energy into electric power. The wind turbine rotor and the generator have the same rotational speed, with the turbine hub and generator structure being integrated. This makes it possible to exclude the gearbox from the design totally. Current Mervento turbines therefore have a low noise level, low vibration level and high total efficiency. Mervento turbines also feature highly integrated components, which makes it possible to achieve a lower weight and shorter manufacturing and assembly times. Low operating and maintenance costs and a long turbine lifetime are some of the key strengths as well as selling points of Mervento's turbines.

2.7.2 China Project

As a part of Mervento Ltd's growth, the Chinese wind energy market has become one area of interest. It has become clear to Mervento Ltd that in order to succeed in China, the company needs a Chinese partner. Mervento has always considered China to be an important market, and has since the beginning of 2011 made an effort to find a suitable partner company in China. The timing for this "China Project" has been dependent on the testing of Mervento's new turbine, the MERVENTO 3.6-118, as well as the development of the Chinese wind power market, which is currently in the process of switching from quantity in quality, in their wind farm and turbine development projects. Mervento Ltd is looking to find a licensee for the permanent magnet technology and related solutions.

3 RESEARCH METHOD

3.1 Source of Data

Regarding the sources used in the data tables presented, most figures, where available, stem from official government reports that have been made available online. Most government reports can be sourced to the relevant agency concerned. However, since most data released online is either specific or limited to a certain area of interest, compilation from different sources is the largest obstacle in getting the necessary larger overview. It seems that due to unclear labelling of the original data, the numbers in some official reports have been misquoted to mean something else than what is intended. Such is for example the case with installed versus integrated capacity. In these cases, either the original source or the more widely used number has been quoted. More often than not, these inconsistencies exist between the English documents and the original Chinese ones, in which case the Chinese original figures have been used. In some cases this meant that older data had to be uses, since the newer data only exists for a subset of the older one. Since the time-difference (a matter of a month or two in most cases) is so small, it should not have any direct effect on this thesis. In all cases except one, the data used in the final analysis is current as of the end of 2010. The exception being the table of wind energy developers (Table 6), where there is not yet any official reliable data for 2010. In relevant instances where newer data has been used, this is noted.

The original sources of the data, some of which in indirectly referenced at times, are the China Electricity Council (CEC), State Grid Corporation (SGC), State Electrical Regulatory Commission (SERC) and in some cases the Global Wind Energy Council, (GWEC) who has collated data from the previous sources but often without direct references.

3.2 Screening Criteria

The necessary criteria used in order to find a suitable partner company can be divided into several different categories dependent on their necessity as well as their application. Some are easily quantifiable while others are not. Some can be applied directly to the available selection of companies while others are applied to geographical areas of development, either of wind farms themselves or the power grid. These criteria serve only as guideline when it comes to selecting a candidate for partnership, but can if necessary also be used as screening criteria if needed. Their main use is meant to be as an indicator of market development.

The criteria presented below are grouped according to whether they are region or screening criteria. Selection criteria, meaning those that are hard to define mathematically or cannot be used to exclude a company, are presented in a separate group since they should be applied late in the selection process. Each group also has its criteria sorted according to their necessity to ensure that application of them is as easy as possible and is done in the correct order. Although the list of selection criteria are stipulated by Mervento Ltd, and are mentioned below, the screening criteria exist due to simple necessity or lack of options.

Region criteria

- I1: Regions which are promoted by the government
  (To ensure that the necessary permits are granted without problems.)
- I2: Regions that wind farm operators are actively pursuing
  (They have the say where to develop; we choose the company, not the place)
- I3: Regions near or on the coast
- (Minimize shipping costs, ensure future development)
- I4: Avoid regions with grid development problems
  (Otherwise they could cripple the project)
- I5: Development in an area where there is still rapid expansion
  (Not where there is already extensive planning and bidding is over)

Screening criteria

- D1: A company who is not foreign owned nor joint venture with a foreign company
  (This would make a deal very unlikely indeed.)
- D2: A company of the right size. Not too small so they cannot invest in a license, but also, for the same reason, not too big.
- D3: A company who does not already have a license or design for a turbine which is 2.5 MW or higher. (Meaning they cannot fulfil the new energy standards of 2011.)
- D4: Preferably a company which is actively engaged in the market
  (Meaning the company has sold turbines.)
- D5: Preferably a company who is not or has only recently started developing 3.6+ MW turbines (To improve the chance that they are interested)
- D6: Preferably a company who is already using the permanent magnet technology
  (So a higher capacity turbine is easier to implement in practice.)

Starting with the least significant screening criterion, PMDD technology being relatively rare in the market means that it cannot be a high priority (D6) even though it might have a big effect on the chance of finding a suitable company. This is unfortunate but, as has been discussed above, market conciliation is sure to arrive due to the wind power standards.

The main goal in this market analysis is to find a company that needs 3.6 MW turbines. As such, looking for those that do not already have plans for this capacity seems prudent (D5). Nonetheless, this cannot be the main criterion since some companies may have the means to achieve this goal or may feel they do due to their collaboration with other licensers for example.

For the same reason as in criterion D6, the active companies in the market (D4), meaning the ones who have market share, should be the ones to look at but this criterion cannot be prioritized too highly. To assume that all small companies without market share in 2010 will simply give up is too much of a generalization.

Criterion D5 and D3 are somewhat related and can in fact be considered two sides of the same coin. They may however differ in the same way as in the explanation for criterion D6, above, and should therefore be held separate. The 2.5MW limit comes from the 2011 wind power standards and marks the minimum required capacity that will be required. As such, this criterion (D3) is deemed quite important.

Criterion D2, whether or not the company is of the right size, is hard to quantify but nonetheless has to be. As the minimum limit, any company has been deemed to be small enough if they simply do not seem to have the finances necessary to consider buying a license. This may be somewhat loose a definition, but it is better to define this important criterion too loosely than too tightly, so that potential candidates aren't discounted unwontedly. This criterion also entails such factors as personnel, facilities etc., but these factors did not have to be stringently applied since later criteria were enough to limit the field sufficiently. The only other factor, too large a size, comes is very tightly coupled with the technology necessary to attain the requirements for the 2011 wind power standards. As such they may be unnecessary, with most major players already developing the turbine capacities necessary for some time. This can be confirmed after the screening.

Criterion D1 is in this list as an almost absolute factor, since any joint venture of a Chinese and a foreign wind energy company will entail licenses, therefore excluding the possibility of the company being a suitable candidate.

As for the actual selection criteria, which are unsuitable for screening yet very important factors when deciding between different companies, they are as follows.

Selection Criteria

- C1: Track record
  (Experience, in terms of turbines produced)
- C2: Financial situation
  (Important since the company will have to have financing for a license.)
- C3: Survival chance
  (A somewhat subjective opinion on whether the company will be able to fulfil the 2011 wind power standards.)
- C4: Experience with international cooperation
  (Important considering the time and money spent negotiating.)
- C5: PMDD technology usage level
  (Similar to criteria D6, here applied for selection.)
- C6: The results of the region criteria I1-I15.
  (Only if further selection is necessary.)

4 ANALYSIS

4.1 Wind Turbines and Licenses

Not counting joint ventures or fully foreign-owned companies, the current wind turbines available on the Chinese market stem from only 5 sources, these being Aerodyn, GH, Windtec, Dewind as well as designs from the ShenYang University of Technology. A breakdown of the different licensees can be seen below in Table 9.

Table 9. Wind Turbine Licensees on the Chinese Market.

Aerodyn	GH	Windtec	Dewind	ShenYang University of Technology
Mingyang	United Power	Sinovel	BZD	China Creative
SEC	Zhejiang Windey	DEC	SEC	HAFEI
CS Windpower	DEC new Energy	XJ Group	(Jiangsu Wende)	China Tianjie Group
CSIC	HAFEI	(CSR)		Baoji Oilfield Machinery
(HEAG)	(Tianwei Group)			Shenyang Tewin
				Sharpower
				GC China Turbine Corp
Foreign	**Own design**	**Unknown**		BZD
15	9	2		SANY

ShenYang University's designs are the most widely used ones, but the technology and quality is not the best, with the turbines having problems to such a high degree that they have been branded unreliable. The wind farm developers in particular have been known to completely refuse to get involved in any purchase if they hear that the turbine-technology is from SU.

The opposite, with a turbine manufacturer claiming joint design with a foreign company, seems to count as them having designed it themselves, at least in terms of getting government support. It is important to remember that regarding turbine technology and licenses, the Chinese turbine companies all have the same target in mind; to get foreign technology and localize production of it to their factories.

Aerodyn was one of the earliest turbine companies in China and the oldest one of the companies still active in the Chinese market today. They have quite a wide partnership network and because they are a German company, they have a reputation for good quality in China, as explained in Chapter 2.6.2.

While GH is well known in China for their control system design, Windtec has a good reputation in China and quite long history of relationships with Chinese companies. If a Chinese company wants to use solely domestic technology then they will choose ShenYang University. This may seem odd considering their reputation, but as has been elaborated on in section 2.6.3, most Chinese companies at this stage of wind power development still have neither the ability nor the knowhow to effectively utilize their own R&D people to develop their own technology. If they want to have their own technology then they have only one place to go, and that is SU. In the Chinese wind turbine field, many seem to be of the opinion that only Aerodyn, GH and Windtec can offer reliable, usable technology.

In the tables below, the different technology sources and turbine ratings are displayed. First in Table 10a for the whole market and then in Table 10b for the current market situation, with turbines at 1.5MW levels. Table 10c shows the 2.5MW and higher turbine technology sources, since this is the future required rated power of turbines according to the 2011 wind power standards.

Looking at table 10a, it is clear that quite many companies, 24 in total, have actually sold licenses to Chinese companies, with a total number of licenses of 85. One third of the licensing companies, 8 out of 24, have developed and sold PMDD technology and 13 out of the 85 licensees, just over 15%, hold these licenses. ShenYang University remains the most popular licenser, mainly due to lower prices. The majority of licenses are also for 1.5 MW turbines.

As can be seen in Table 10b when moving to licenses of turbines with a capacity of more than 1.5 MW, the total number of licensing companies drops from 24 to 21 and the number of licenses is reduced to 85. This is a considerable yet not massive difference, which is to be expected since 1.5 is the current norm. Almost as if to prove this point, it turns out that the three lagging companies in question are also the only ones who do not have technology for producing turbines with a capacity over even 1 MW. PMDD licensers, at this level, still make up one third, seven out of all the 21 licensers, and in terms of licensees, 13 out of the 69 licenses, just fewer than 19% are licenses for turbines using PMDD. Again, this is perhaps not significant in percentage-points, but still non-trivial.

When moving to a capacity of 2.5 MW or more, the minimum capacity as required by the new wind energy standards introduced in 2011, the gap is pretty distinct. Only 11 licensing companies and 25 licenses remain, which illustrates the current situation very well and underlines the need for development of higher capacity turbine technology in China. This is one of the main reasons for why this is a good time to try to find a licensee in China. Out of the 11 companies, 4 have sold PMDD licenses, making it around 36%. The situation in terms of the number of licenses however, is quite telling. Seven out of the 25 licenses, 28%, are for PMDD turbines. This is quite a large increase as compared to the 19% and 15% of the previous charts, and again goes to prove that finding a license for a PMDD design should be considerably easier than for a DFIG turbine. Clearly, as we go up in capacity, the PMDD technology seems to get more desirable among Chinese companies. Again, looking at turbines with a 5MW capacity, only Darwind and Windtec have existing designs, with Darwind's being PMDD.

Table 10a. Wind Turbine Licensers on the Chinese Market, all capacities.

	Windtec	Aerodyn	GH	EU Energy Wind (Dewind)	Vensys	Darwind	SU	University of Saarland	Windrad	SETEC	HRS-Swiss (Jingneng)	Zephyros	W2E	MECAL	GL	EDAG	KK-electric	DWD	Catum	Furhländer	Repower	Jacobs	Frisia	Mita (Control system)
600 kW																					I	I		
750 kW																					IIII	I	II I	
800 Kw																								I
1 MW		I					II													I				
1.25 MW				I																				
1.5 MW	II	IIIIII	IIII		I		11 2								I					I	I			
2 MW	II	II		II			I	I	I	I		I	I			I		I	I					
2.5 MW	I		I		I																			
3 MW	I	I	I s		I		I i i s	i			I				i									
5 MW	I	i	i		i	I									i		i							
6 MW											i			i										

I	=	License to one company
i	=	In development
s	=	Semi-direct drive license
s	=	Semi-direct drive in development
	=	DFIG technology
	=	PMDD Technology license

Table 10b. Wind Turbine Licensers on the Chinese Market, >1,5MW.

	Windtec	Aerodyn	GH	EU Energy Wind (Dewind)	Vensys	Darwind	SU	University of Saarland	Windrad	SETEC	HRS-Swiss (Jingneng)	Zephyros	W2E	MECAL	GL	EDAG	KK-electric	DWD	Catum	Furhländer	Repower	Jacobs	Frisia	Mita
1.5 MW	II	IIIIII	IIII		I		11 2								I					I	I			
2 MW	II	II		II			I	I	I	I		I	I			I		I	I					
2.5 MW	I		I		I																			
3 MW	I	I	Is		I		Iiis	i			I				i									
5 MW	I	i	i		i	I	s								i		i							
6 MW											i			i										

Table 10c. Wind Turbine Licensers on the Chinese Market, >2,5MW.

	Windtec	Aerodyn	GH	EU Energy Wind (Dewind)	Vensys	Darwind	SU	University of Saarland	Windrad	SETEC	HRS-Swiss (Jingneng)	Zephyros	W2E	MECAL	GL	EDAG	KK-electric	DWD	Catum	Furhländer	Repower	Jacobs	Frisia	Mita
2.5 MW	I		I		I																			
3 MW	I	I	Is		I		Iiis	i			I				i									
5 MW	I	i	i		i	I	s								i		i							
6 MW											i			i										

Since the price of turbines in China has dropped by around 1000 RMB per year since 2008, with the current price around 4000 RMB/kW, Chinese wind power companies have a price advantage when competing with foreign companies. This is especially true in China for companies like Sinovel, Goldwind, DEC and SNYI who already have well developed supply-chains. Due to the new wind power standards being released however, future wind-farms will be using multi-MW turbines. This is a huge opportunity since it will limit the competition and open the market. It will however also mean that the potential number of partners is severely decreased and continues to decrease since companies are already looking and in many cases have already found partners, entering into joint ventures.

4.2 Wind Power Sites

To facilitate the assimilation of this section, with numerous references to different provinces, a map of the provinces in question, can be found in the end of this thesis as Appendix 2.

According to the 12th 5-year plan, in 2011 China will continue to build large turbine generator bases, and promote the areas of Shandong, Hebei, Zhejiang and Fujian (Criteria I1).

According to SERC and the SGC however, at least this year, the wind-power operators have most of their new projects in Central and East China, such as in the provinces of Hubei, Anhui, Hunan, and Jiangxi (Criteria I2).

Due to the large scale development of Chinese offshore wind power which is set to start soon, and considering the coastal region plans mentioned before, a suitable wind power base should be one which is close to the sea, minimizing shipping costs when compared to having to transport across large distances (Criteria I3). Similarities to Finland will then probably also exist, which will be useful both in making sure that existing methods are appropriate as well as developing new ones suitable for China.

All of the provinces competing for inclusion as power bases are coastal regions, as is Jiangsu, one of the power bases.

Wind farms are usually installed in vast tracts of empty land where the wind is the strongest, and until now, for those exact reasons, that has mostly been deserted land where no one has wanted to settle. Any villages nearby will not have grown into cities due to the lack of population so the grid connections are nonexistent or lacking. Transmission lines are developed where population is concentrated, not where the wind is the strongest (Criteria I4). The Chinese government has already reacted to this development by promoting wind power in areas where the grid is already well developed, which is still rare, or being developed to a sufficiently high enough degree. For this reason, Criteria 1 and 4 are closely related. These areas were developed later than the others, meaning that they may not be fully developed, but neither are they prone to the early development problems which plague other areas.

In the Inner Mongolia region, development has already outstripped the power-grids capability to handle the energy produced and plans are already so far along the way that it is not feasible to expect any new actors to enter the market. The same is true for Gansu. (Criteria I5).

The Shandong and Jiangsu areas are the two areas which fulfil all the criteria. Shandong has been fighting to be included as a Power base development area and it looks like this will happen. Wind farm operators are already actively entering the area in anticipation of the positive decision. The province is a coastal region and does not suffer from crippled power-grid development. Jiangsu is already a power base development area but development is still not finished, meaning the potential still exists for new actors.

Among the other areas, none of the current power bases are near the coastline. The new areas fighting for inclusion as power base all look promising, but Hebei is also not near the coastline, while Zhejiang and Fujian have only limited onshore wind capacity with their potential stemming almost entirely from offshore wind power.

Due to the Chinese off-shore essentially meaning “near shore”, as explained in Section 2.5.3, Zhejiang and Fujian should not be fully discounted as possible development areas.

Another interesting development region is Guangdong. Guangdong is a highly developed coastal city in China, meaning that if offshore wind farms are developed here, the wind farm will directly serve a high load centre. Guangdong Province also has the longest coast line in China with a length of more than 4300 km. Within 10 km from the shore there is 400GW of potential. Guangdong is sure to be big part of the Chinese offshore wind project in the near future with the potential partners in Guangdong being Ming Yang. Unfortunately, MingYang already has a working 3 MW so the potential for a partnership is not so high (Criteria D3 and D5).

At this point in this thesis it is important to note that while Mervento Ltd is looking for a partner, and the partner is the one who chooses the area, not Mervento, knowing the most suitable region for development is important for several reasons. Without a shared view on the Chinese market, collaboration will be hard. The locations of factories are also of significance as related to the area of wind farm development. When Mervento is trying to choose a partner company in China, they need someone with clearly shared goals. The multitude of failed wind power companies in existence in the Chinese market goes to show that without a clear goal, a single licensee agreement might limit the use of turbines to much less of its full potential.

4.3 Wind Turbine Manufacturers

At the present time, Chinese companies are very interested in gaining a foothold in the foreign market since selling turbines abroad is seen as an essential part of a good track record for any Chinese company. Several Chinese wind developers are seriously considering export strategies (GWEC, 2010) and the enthusiasm is easily understood when one factors in the government subsidies given to successful export strategies, but without the needed quality, success is limited. However, as can be seen below in Tables 11a and 11b, displaying the sales of Chinese Manufacturers in 2010, exports of wind turbines are still not the norm among Chinese manufacturers. Goldwind takes the number one spot in both numbers of exported turbines as well as total MWs even though this means only 6 turbines with a total capacity of only 4.5 MW. Apart from the available government support, the developers' lack of experience in the long-term operation and maintenance of wind power plants is also one of the reasons why so many Chinese companies are actively seeking foreign partnership opportunities abroad. High quality and reliability which could lead to real export opportunities is a very important sales point.

Table 11a. Chinese Turbine Manufacturer Sales in 2010.

No	Manufacturer	Domestic		Export			Total	
		pc	Capacity	pc	Capacity	Country	pc	Capacity
1	Sinovel	2903	4386		4.5		2903	4386
2	Goldwind	2648	3735	6	4.5	Cuba	2654	3739.5
3	DEC	1749	2623.5				1749	2623.5
4	United Power	1095	1643				1095	1643
5	Mingyang	700	1050	1	1.5	USA	701	1051.5
6	Vestas	601	892.1				601	892.1
7	SEC	384	597.85				384	597.85
8	Gamesa	564	595.55				564	595.55
9	XEMC	253	507				253	507
10	ChinaCreative	324	486				324	486
11	CSIC	214	383.15				214	383.15
12	Nanche	201	334.95				201	334.95
13	Envision Energy	167	250.5				167	250.5
14	GE	140	210				140	210
15	Suzlon	129	199.85				129	199.85
16	HEAG	138	161.64	3	4.5	Chile, White Russia	141	166.14
17	Ningxia Yingxing Energy	154	154				154	154
18	Windy	139	129				139	129
19	SANY	70	106				70	106
20	WindCHN	50	100				50	100

Table 11b. Chinese Turbine Manufacturer Sales in 2010, Continued.

NO.	Manufacturer	Domestic		Export			Total	
		pc	Capacity	pc	Capacity	Country	pc	Capacity
21	Nordex	57	86.5				57	86.5
22	AVIC HuiDe Wind (W2E)	62	63				62	63
23	Tianwei Group	40	60.5				40	60.5
24	Repower	33	49.5				33	49.5
25	New United	20	30	2	3	USA, Thailand	22	33
26	XJ	11	22				11	22
27	Geoho	21	17.85				21	17.85
28	Hanwei Canada	9	13.5				9	13.5
29	CE	8	7.2				8	7.2
30	Dongfang Energy	4	6				4	6
31	Te-win	4	6				4	6
32	Universal Wind Energy	4	6				4	6
33	Blower Works Group	2	4				2	4
34	Siemens	1	3.6				1	3.6
35	Jiangxi Maide	2	3				2	3
36	Wande Wind Power	2	2.75				2	2.75
37	JC New Energy (Windtec licencee)	1	1.5				1	1.5
38	A-power			1	2.5	USA	1	2.5
Total		**12904**	**18927.99**	**13**	**15.55**		**12917**	**18943.54**

It is also possible to note at this stage that there seems to exist a correlation between the market success of companies, mentioned in Section 2.5.4, and the average capacity of the installed turbines from said company. This confirms the theory that this is due to regulatory reasons. This does in fact seem likely since new regulations are restricting sub-50MW projects and the standards for future turbines mandate a minimum capacity of 2.5 MW.

After analysing the wind turbine technology in Section 4.1 and the different development areas in Section 4.2, it is now also possible to effectively screen the wind turbine manufacturers. Out of the 82 companies that are active in the Chinese market, 23 are wholly foreign-owned or joint ventures, meaning that they can be removed from further analysis since the chance of licensing to them are very low. They are either looking to license their own technology, have already done so, or already have partnerships. Out of the remaining 59 companies, 18 have either left the wind power market completely, terminated all their projects or have never gotten their projects further than the theoretical stage. They have no money, no sales and no working designs and will all be out of business after the new wind power standards are introduced. These companies can therefore also be discounted. The remaining 41 companies, constituting half of the total amount of companies in the market, have been analysed in terms of ownership type, turbine models, their ratings and specifications, technology type, state of development, technology source, factory location, revenue personnel and contact information. The results, divided into four tables according to ownership form and turbine capacity, is too large to display here, and is in any case the intellectual property of Mervento Ltd and will only be included in the version presented to Mervento Ltd and not in the official version of this thesis. Table 12 below shows a section of the table for illustrational purposes. The full version, only included in the version presented to Mervento Ltd, can be found as Appendix 3.

Table 12. Section of Company Main Analysis Table.

2	XJ Group Corporation 许继 (Since 1970, 2006-Wind)	SOE (State Grid)	CN2000/93	2 MW	DFIG	2009 Dec. Prototype Mass production 150 pc order this year	Onshore	2010 May, 1 turbine's the sun gear of gearbox broke 4 turbines running and connected to the grid 20,000 RMB for erection Smart grid friendly GL, CGC Design took 2 years	38 subsidiaries 1 stock listed company (electrical power equipment)	License <-- Wintech(1.5 MW)	XuChang	RMB Billion Increase 31% NO.31 4 MW 2 pc	RMB 13.11 Billion (P 1B RMB) NO. 26 22 MW 11 pc	4813	XJ Avenue No.1298, Xuchang, Henan, P. R. China	http://english.xjgc.com/?s1 http://www.xcrcsc.gov.cn/show.asp?id=764	xjiec@xjgc.com	86 374 32 12 177 (Fax: 86 374 33 15 248)
3	Tianwei Group, wind tech Co., Ltd 保定天威	SOE (China South Industry中国兵器)	TW1500	1.5 MW	DFIG	Small amount of production	Onshore	70;77;82	Registered capital: 250 million RMB	License <-- GH	Baoding	76.29 billion RMB Increase 26.96%	60 billion RMB	9000	No.2222 Tianwei West Road, Baoding City, Hebei China	http://www.btw.cn/en/ http://www.btw.cn/en/ProductsInformation/2010/7/26/c128f397-48db-42b3-8b53-1c07caa8d1e3.htm	tzb@twbb.com	86-312-3309-096
			TW2000	2-2.5 MW		Trial-Production		93	Planned to invest 3.7 billion RMB		Listed company in Shanghai and America (Solar)	NO. 23						86-312-3309-000
			-	3 MW 5 MW	Maybe develop upon the 1.5 MW	Planning	-	-	Decreased salaries; sales decrease	Plan to carry out at 2012		52.2 MW 35 pc	60.5 MW 40 pc	1683		http://www.twbb.com/web/info1.asp?id=77		

The table contains tightly spaced information which is hard to disseminate. To facilitate the compiling of data available, a simple graphical table of the screening criteria and their results is therefore included on the next page (Table 13). Through this table, it is possible to see the screening results when considering all factors. Criterion D1 has already been applied so it is not present in the table. Criterion D2, the size of the company, has been applied in such a way that too small companies (those without the necessary facilities, personnel, knowhow or funds) have received a negative checkmark. This also applies to large companies, who, in any case, already have licenses so this may be superfluous, but the point still stands. Criteria D3-D6 are applied in the same way, with the earlier criteria being used before later ones.

After application of the criteria, the results have been colour-coded into how well they have passed the screening with the companies sorted in descending order according to domestic rank of market share. The companies who fit the screening criteria best are colour-coded dark green, with light green being the second group. This is followed by grey and light-orange.

Table 13. Company Screening and Comparison Table.

COMPANY NAME	Domestic rank	Need 3.6MW	Need design for 2.5+	Active in 2010	Medium size	PMDD
Sinovel	1	✗	✗	✓	✗	✗
Goldwind	2	✗	✗	✓	✗	✓
DEC (Tianjin)	3	✓	✗	✓	✗	✓
Guodian United Power	4	✗	✗	✓	✗	✗
Mingyang	5	✗	✗	✓	✓	✗
SEC	6	✗	✗	✓	✓	✗
China Creative	7	✗	✗	✓	✓	✗
CSIC (CHONGQING)	8	✗	✗	✓	✗	✗
CSR ZHUZHOU (Nanche)	9	✓	✗	✓	✓	✓
HEAG	10	✗	✗	✓	✓	✗
Ningxia Yinxing	11	✓	✓	✓	✓	✗
Zhejiang Windey	12	✓	✗	✓	✓	✗
SANY	13	✗	✗	✓	✓	✗
Changxing Group	14	✗	✗	✓	✗	✗
AVIC Huide	15	✓	✓	✓	✓	✗
Tianwei Group	16	✓	✓	✓	✓	✗
New United Group	17	✓	✓	✓	✓	✓
XJ Group	18	✓	✓	✓	✓	✗
Geoho Energy	19	✓	✓	✓	✗	✓
CE	20	✓	✓	✓	✓	✓
DEC new Energy (subsidiary)	21	✓	✗	✓	✗	✓
CS Windpower (Beijing)	22	✓	✓	✓	✗	✗
Universal Wind Energy	23	✓	✓	✓	✗	✗
Shenyang Blower Works	24	✓	✓	✓	✗	✗
Jiangxi MAIDE	25	✓	✓	✓	✗	✗
Shanghai Wande	26	✓	✓	✓	✗	✓
BZD	27	✓	✓	✓	✓	✗
Shandong Guofeng	28	✓	✓	✗	✗	✗
HAFEI	29	✓	✓	✗	✓	✓
China Tianjie Group	30	✓	✓	✗	✓	✗
Baoji Oilfield Machinery	31	✓	✗	✗	✓	✗
Shenyang Tewin	32	✓	✓	✗	✗	✓
Sharpower	33	✓	✗	✗	✗	✗
GC China Turbine Corp	34	✓	✓	✗	✗	✗
Shanxi Diesel Engine	35	✓	✓	✗	✗	✗
CIPPE	36	✓	✓	✗	✗	✗
HQ	37	✓	✓	✗	✗	✗
TITP Wind tech	38	✓	✓	✗	✗	✗
Shenyang Yuanda Group	39	✓	✓	✗	✗	✗
Foshan Dongxing Fengying	40	✓	✓	✗	✗	✗
Jiangsu Wende	41	✗	✗	✗	✗	✗

As can be seen above, most of the companies with good screening results are clustered in the middle of the group in terms of domestic rank. Given a focus according to the company criteria listing given above, there are only two companies which fulfil all criteria, these being China Energine and New United Group. They are in the first priority group which is colour coded dark green for illustrational purposes.

Five companies, namely Ningxia Yinxing, AVIC Huide, Tianwei Group, XJ Group and BZD, fulfil all company criteria except the last one, whether or not they use PMDD. These companies make up the second priority group, colour coded light green.

The third group is made up of CSR (Nanche) and Hafei, both fulfilling 4 criteria, with two of these being the size and the need for 3.6 MW technology criteria. They have been colour coded grey.

The fourth group, colour coded light orange, consists of companies that are only missing the correct size criteria, as is the case for Zhejiang Windey and Shanghai Wande or companies who need the 3.6MW turbine technology and are the right size, as is the case for Geoho and China Tianjie Group.

Since the selection criteria have yet to be applied, this grouping is done for screening criteria only, not for selection. Since it is now possible to see how many companies belong to each group, a suitable limit, based on the groups, can be selected and the companies who do not reach the minimum level are discarded. The selection criteria will then be applied to the remaining companies to decide which companies have the highest potential as candidates. This limit, consisting of companies who belong to the orange group or above, has been applied. For clarity, the remaining groups below the orange level have been colour coded white and are not separated. The remaining companies, 13 of them in all, now go on to the selection process.

At this stage, the companies which have already been approached by Mervento have been included in the final selection both for comparison to the already selected companies and since further analysis of them is advantageous. In fact, there are only two companies of the ones already approached which have not already been selected. DEC, due to their questionable size as well as lack of need of a 2.5 MW turbine, and SEC, who already have the 3.6 capacity and can fulfil the 2011 standards as it is. Both fell just short of being included in the final selection and are now added, growing the list of selected companies to 15.

The next phase, the application of selection criteria, has been made in the style of a selection matrix and can be seen below in Table 14. The results have again been colour-coded for clarity, this time in a slightly different colour-scheme so as not to be confused with the previous screening table groups when discussing the results further on. The main group, with results matching the selection criteria at 60% or more, have been colour coded blue. The next group, with colour-coding purple, has a result higher than 30%. The remaining group, consisting of companies with a lower score, has been colour-coded grey. In addition, any full score, signified by a filled circle, has been colour coded green for ease of interpretation.

As can be seen in the table below, there are five companies which are a good fit to the selection criteria. Both SEC and DEC, having been included for further study, show high potential. It is important to note however, that they failed to be included through the screening process. Among the top five “blue group”, CE has also already been approached, leaving Nanche and Zhejiang Windey as potential future companies to approach.

Table 14. Company Selection Matrix.

COMPANY NAME	Domestic rank	Track record	Financial Situation	Survival chance	Experience with international cooperation	PMDD Technology	Result Average
DEC (Tianjin)	3	●	●	●	●	◔	85%
SEC	6	●	●	●	●	○	80%
CE	20	◕	◑	◑	●	●	75%
CSR ZHUZHOU (Nanche)	9	●	◕	●	◕	◔	75%
Zhejiang Windey	12	●	◔	●	●	○	65%
New United Group	17	◕	◑	◑	◑	◑	55%
AVIC Huide	15	◑	◕	◕	◑	○	50%
Tianwei Group	16	◔	●	◕	◑	○	50%
Geoho Energy	19	◑	◑	◑	◑	◑	50%
XI Group	18	◔	◕	◕	◑	○	45%
HAFEI	29	◔	◔	◔	◑	●	45%
Shanghai Wande	26	◔	◔	◑	○	●	40%
BZD	27	◔	◔	◔	◑	○	25%
Ningxia Yinxing	11	◑	○	◔	◔	○	20%
China Tianjie Group	30	○	◑	◔	○	○	15%

5 PROPOSED SOLUTIONS

Mervento Ltd should consider the main selection "blue group" and secondary selection ("purple group") companies presented in Table 14 as their best match for finding a suitable partner in China. Although the 3rd (grey) group contains companies with real potential and definitely shouldn't be ignored, Mervento's goal of an exclusive licensee means that the efforts should be focused only on the companies with the highest potential before moving on. With the new wind energy standards pushing companies to develop more powerful wind turbines; this is a time of great opportunity in the Chinese wind power market, meaning that an effective approach is crucial.

A brief company analysis on each company in the "blue group" has been performed and the results will be presented to Mervento Ltd during a presentation of the findings of this thesis. This analysis will hopefully serve as a starting point for Mervento's continued search for a partner in China, making the search as fast and effective as possible. The individual analyses, in ppt format, will be presented to Mervento Ltd and are not included in the official version of this thesis.

The final analysis includes information such as ownership, history, staff, turnover of the company and assembly factory location, as well as additional information which may be of importance. Most of this information can be found in the main table, but is elaborated on further in the presentation. The analysis is done for the "blue group" companies, consisting of DEC, SEC, China Energine, Nanche and Zhejiang Windey, but may be extended at a later point if Mervento so wants. This, however, is beyond the scope of this thesis. The company analysis can be found as Appendix 4 in the version given to Mervento Ltd. This appendix is not included in the official version due to company intellectual rights. A sample page of the PPT presentation is shown in Figure 4 on the next page for illustrational purposes.

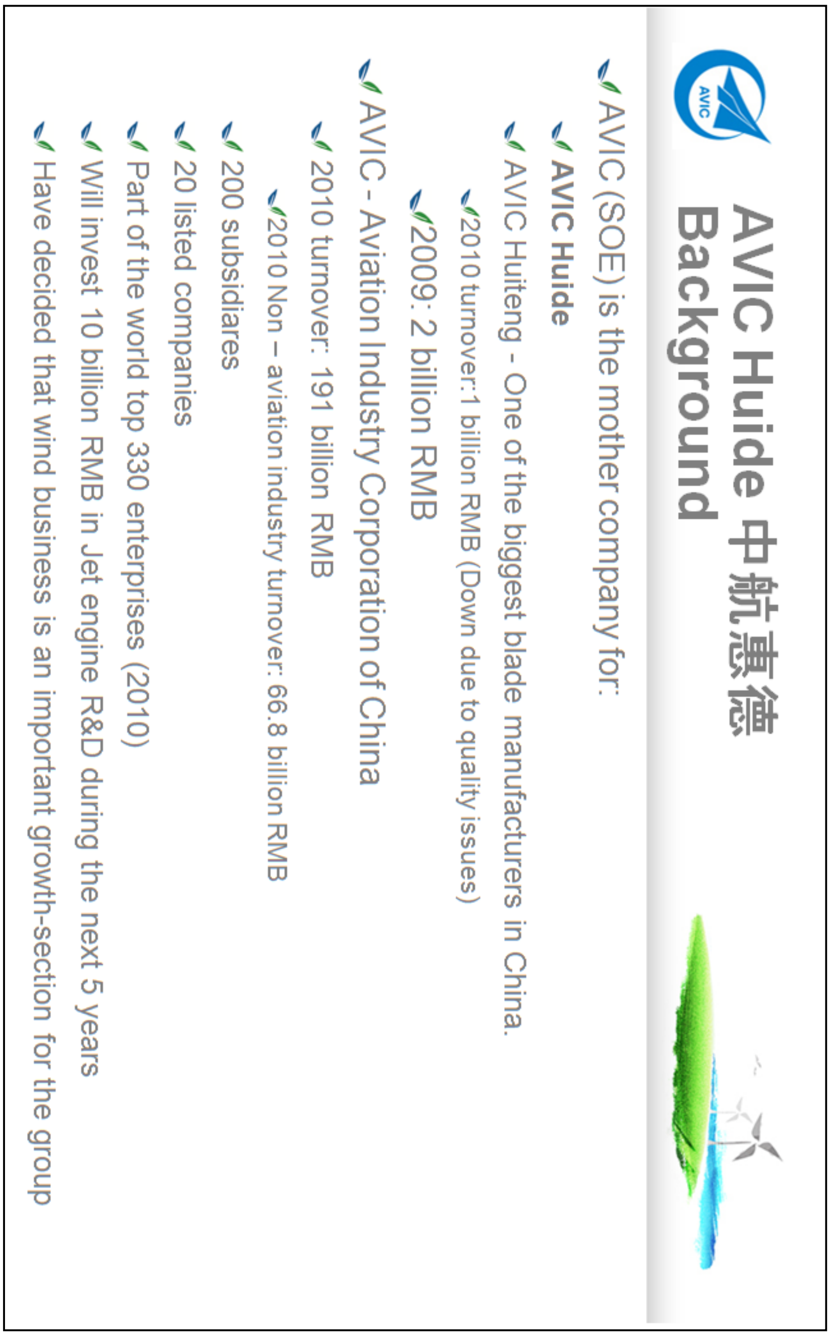


Figure 4. Company Analysis Presentation Excerpt.

6 SUMMARY AND CONCLUSION

Quality over quantity as part of wind power development is the focus set by the Chinese government through the 2011 wind energy standards. This sentiment is echoed among wind turbine developers who are now racing to develop reliable and inexpensive multi-MW technology turbines.

Mervento's strategy of having an exclusive licensee in China strategy will be useful since the companies in China who wish to survive in the industry will have distinction as their goal. Using different, more reliable technologies than the competition, instead of simply copying the previous success of others, will be the key factor to success. Due to regulatory demands, the necessity of included wind power maintenance is also an important factor in any future wind farm project.

China is in the enviable position of having the full support of its government when it comes to wind power development and as such will arguably be the world's most interesting market for wind power for years to come. Wind energy development will continue to be strongly supported by the Chinese government since China has to safeguard future energy needs and does not want to be reliant on energy resources controlled by other countries.

Since large state-owned energy companies have to accomplish individual energy goals by 2020 as part of the 12th 5-year plan or face the risk of being acquired by other companies, finding new areas to develop is a high priority. As such, offshore is very important market segment. Offshore is where future development will be encouraged and it is important to note that due to legal restriction to areas of development, China's offshore means the same as European near shore, at least for the near future. Due to the off shore development becoming reality, the need for features such as hurricane/typhoon and acidic protection, mainly for near shore installations, is an area of some importance and is where any company wanting to enter China should focus their R&D efforts.

REFERENCES

American Council on renewable energy, Acore (2010). US-China Quarterly Market Review. A Collaborative report. Acore. Washington, DC. Available online at: www.acore.org

Ahlstrom Capital Annual Report (2010). [Accessed 9.6.2011] Available online at: www.ahlstromcapital.com/Tiedostot/AhlstromCapital_VK2010_UK.pdf

Bergek, Anna (2002). Shaping and Exploiting Technology Opportunities: The Case of Renewable Energy Technology in Sweden. Department of Industrial Dynamics, Chalmers University of Technology.

Caprotti Federico (2009). China's cleantech landscape: the renewable energy technology paradox. Sustainable Development Law & Policy Spring 2009: 6-10

Chinese Academy of Engineering (2009). Chinese Renewable Energy Development Study. *Official report.*

China Electricity Council (2010). *Official reports.* Available online at: http://english.cec.org.cn/news.html

China Meteorological Association (2010). *Official reports.* Available online at: http://www.cma.gov.cn/english/

Doty David. February 2, 2011. Kicking Oil Addiction With Windfuels. [Accessed 9.6.2010]. Available online at: www.greentechmedia.com/articles/read/guest-post-kicking-oil-addiction-permanently-with-windfuels/

ETFChina (2008). The China Renewable Energy Program. The China Sustainable Energy Program. Fact Sheet: China Emerging as New Leader in Clean Energy Policies. Available online at: http://www.efchina.org/FNewsroom.do

EWEA and Greenpeace (2005). Wind Force 12: A Blueprint to Achieve 12% of the World's Electricity from Wind Power by 2020. Available online at: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/WF12/wf12-2005.pdf

Global Wind Energy Council (2010). Global Wind Power Report. [Accessed 9.6.2010]. Available online at: http://www.gwec.net/index.php?id=8

IEA, International Energy Agency (2010). World Energy Outlook. [Accessed 9.6.2010]. Available online at: http://www.worldenergyoutlook.org/2010.asp

Jacobsson and Johnson (2000). The diffusion of renewable energy technology: an analytical framework and key issues for research. Department of Industrial Dynamics. School of Technology Management and Economics, Chalmers University of Technology, Gothenburg, Sweden.

Johansson, McCormick, Neij and Turkenburg (2004). The Potentials of Renewable Energy. Thematic Background Papers prepared for the International Conference for Renewable Energies in Bonn

Liu Yuanyuan (2011). China Seeks Big Wind in a Push To Standardize Project Size. RenewableEnergyWorld. Available online at: http://www.renewableenergyworld.com/rea/news/article/2011/05/china-to-standardize-wind-power-projects

Martinot Eric & Junfeng Li (2007). Powering China's Development. DC. Worldwatch Institute. Washington. ISBN: 1878071831; 9781878071835

Mervento Ltd (2011). *Official homepage*. Available online at: www.mervento.fi

Nielsen Ron (2006). The Little Green Handbook: Seven Trends Shaping the Future of Our Planet. Picador. New York. ISBN 978-0312425814

Pew Charitable Trust, The (2010). Who's winning the Clean Energy Race? Growth, Competition and Opportunity in the World's Largest Economies. [Accessed

9.6.2010]. Available online at: http://www.pewtrusts.org/uploadedFiles /wwwpewtrustsorg/Reports/Global_warming/G-20%20Report.pdf

Segtrop Frank (2006). The end of cheap oil. Estiem Magazine. Issue 31 200/ll. ISSN 0874-5242.

SERC, State Electricity Regulatory Commission (2010). *Official Reports.* [Accessed 9.6.2010]. Available online at: http://www.serc.gov.cn/opencms/export/serc /english_index.html

SGC, State Grid Corporation (2011), *Official Reports.* Available online at: http://www.sgcc.com.cn/ywlm/gsyw-e/default.shtml

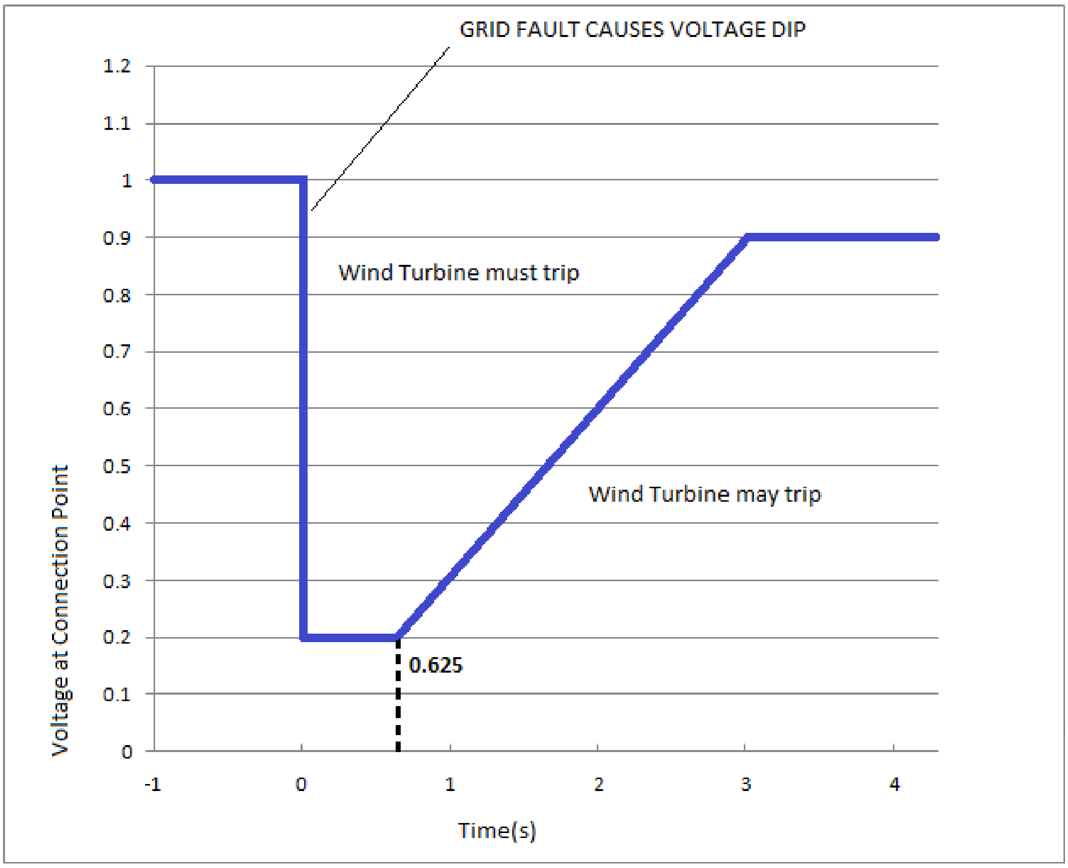
Tester, Jefferson, Drake, Elisabeth, Driscoll, Michael, Golay, Michael & Peter, William (2005). Sustainable Energy: Choosing Among Option. 1st Ed. Massachusetts. Massachusetts Institute of Technology. ISBN 0-262-20153-4.

WBCSD, World Business Council for Sustainable Development (2005). Pathways to 2050 - Energy & climate change. [Accessed 9.6.2010]. Available online at: http://www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MTcz NzA

Zijun Li (2006). China's Renewable Energy Law Takes Effect: Pricing and Fee-Sharing Rules Issued. Worldwatch institute. [Accessed 9.6.2010]. Available online at: http://www.worldwatch.org/node/3874

Appendices

Appendix 1. LVRT Voltage Requirements for Wind Turbines



Appendix 2. English map of Chinese Provinces