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CHINA WIND ENERGY OUTLOOK

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Editorial board

Executive Summary

Current Development Status and Outlook of the Chinese Wind Power Industry

In 2011, the annual newly installed wind power capacity in China (excluding Hong Kong, Macao and Taiwan) was 17.63GW, with the Chinese wind power market beginning to enter a steady development stage after having undergone many years of rapid growth. The cumulative installed capacity nationwide was 62.36GW, allowing China to continue to maintain its leading position in the world in terms of installed wind power capacity. By the end of 2011, 30 Chinese provinces, cities and autonomous regions (excluding Hong Kong, Macao and Taiwan) had their own wind farms. More than 10 provinces had a cumulative installed wind power capacity of over 1GW, including 9 provinces with a capacity over 2GW each. The Inner Mongolia Autonomous Region remained the leader of China's wind power development, having a cumulative installed capacity of 17.59GW, followed by Hebei, Gansu and Liaoning, each having a cumulative installed capacity of over 5GW.

China's offshore wind power construction advanced successfully, with the offshore wind power planning process of Shanghai, Jiangsu, Shandong, Hebei, Zhejiang and Guangdong already completed. The offshore wind power planning process of Dalian in Liaoning Province, as well as Fujian, Guangxi and Hainan provinces were improved and further developed. The completed programs have preliminarily identified an offshore wind energy resources development potential of 43GW. Currently, there are already 38 projects, totaling 16.5GW that are undergoing early stage development. By the end of 2011, a total of 242.5MW installed capacity of offshore wind power had been completed nationwide.

In 2011, the newly added grid-connected wind power was nearly 17GW, which was basically equivalent to the installed capacity during the whole year, while the difficulty with getting grid connections had been essentially mitigated. According to China Electricity Council, the nationwide grid-connected wind power capacity reached 47.84GW. Even though the speed of getting wind power projects connected to the increased, problems remain.

Moreover, as the power grid enterprises raised their technical specifications and requirements for wind power equipment, wind power grid-connection began to transform from a "physical grid-connection difficulty" to a "technical one". Meanwhile, curtailment became a new challenge for wind power development. In 2011, more than 10 billion kWh of wind power was not generated because the grid had no capacity to absorb it.

Large-scale central government administered enterprises and local state-owned enterprises were still the major players in China's wind farm development, with close to 90% of all wind power projects invested in, constructed and completed by these corporations. By the end of 2011, a total of some 700 state-owned enterprises nationwide had participated in wind power investment and construction, which offered a cumulative grid-connected capacity of 37.98GW, accounting for 79.4% of the whole country's total grid-connected capacity. China's five major power generation groups provided a cumulative grid-connected capacity of 27.1GW, which accounted for 57% of the national grid-connected capacity. China Guodian Corporation was ranked at the No.1 position in terms of domestic wind power grid-connected capacities by offering a cumulative grid-connected capacity of 9.81GW. China Huaneng Group and Datang Group were ranked at the second and third positions, respectively. Other individual investment enterprises basically maintained a steady development status. Since the beginning of the "Twelfth Five-Year Plan" period (2011-2015), the National Energy Administration has initiated the development concept of focusing on both centralized and decentralized development, as well as corresponding administrative measures. Some inland regions began to plan their wind power development projects according to local conditions, bringing opportunities to mid- and small-sized wind power investment enterprises.

In 2011, the Top Five manufacturers in China's newly installed wind power market were Goldwind Science & Technology, Sinovel, United Power, Mingyang and Dongfang Turbine, respectively. Guodian United Power Technology Company Limited installed 2847MW in 2011 -- a growth of 73% over the previous year --

making it the business to watch during 2012. The top five enterprises in China's cumulative installed wind power market were Sinovel, Goldwind, Dongfang Turbine, United Power and Vestas, respectively. Both Goldwind's and Sinovel's installed capacities decreased relative to that of last year, but they still maintained their first and second positions in the Chinese market. Among all the newly installed wind turbine generator systems across China in 2011, the average rating was 1.545MW, which showed a continuous growth compared to 2010, while the manufacturing industry was actively researching and developing multi-MW wind turbine generator systems for offshore wind power. According to incomplete statistics, as of 2011, China had about 20 complete machine enterprises that had announced plans for R&D of multi-MW high-power wind turbine generator systems, whose power ranges were mostly 3MW-6MW.

In 2012, China's wind power market development is set to continue its growth trend of 2011. The newly added installed capacity will be in the range of 15-18GW and is expected to reach approximately 18GW. By 2015, the installed wind power capacity will reach 100GW. The percentage of decentralized wind power will further increase, but large-scale development and land-based wind power development will still be the focus, while the ratio of decentralized wind power has the potential to reach a maximum of 30%. As power grid corporations continue to improve their ultra-high voltage (UHV) power transmission lines, intelligent power grids and other infrastructure, the power grids' ability to absorb wind power electricity on a large-scale, and the scale of cross-region wind power transmission will increase, with the wind power grid-connection rate also significantly increase. The wind power manufacturing industry has entered a low-profit era; competition will intensify, the market will become more mature, and wind power manufacturers will face greater market challenges. However, the wind power industry's maturity and lowering costs have enhanced wind power's competitiveness compared to traditional energy sources. Wind power has become a high-strength emerging power supply technology and its contribution to China's electricity mix will gradually increase.

According to the "Renewable Energy Twelfth

Five-Year Plan" of the National Energy Bureau, it is expected that by 2015 China will have built 5GW offshore wind power and will have developed an offshore wind power supply chain. After 2015, China's offshore wind power will enter a large-scale development, and the target is for 30GW offshore by 2020. However, it will be very difficult to achieve this goal, and it will be difficult for offshore wind power to achieve such a significant breakthrough in so short a time.

Wind power is the new energy source that features the most mature technology, the best conditions for large-scale development and the brightest commercial future. The important role of wind power as China's strategic emerging industry will not change. The successive promulgation of a series of relevant industry adjustment policies will inevitably force the prioritization and integration of this industry. The future development space of China's wind power industry will be extensive.

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Catalogue

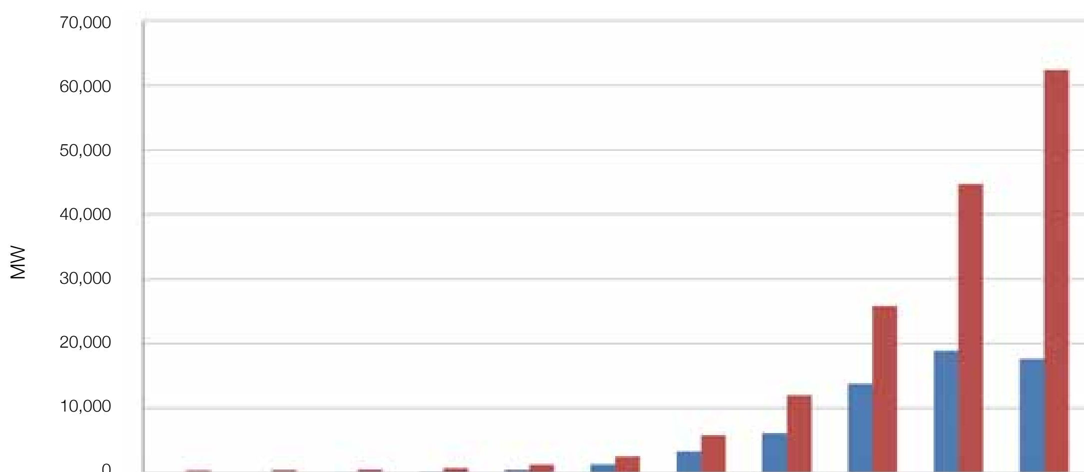
1 Current Status of China's Wind Power Development

1.1 Overview of the Wind Development in China

1.1.1 General Development of the Wind Projects in China

According to the Chinese Wind Energy Association's (CWEA), 2011 statistics, China (excluding Hong Kong, Macao and Taiwan) installed 11,409 new turbines totaling 17.63GW of new capacity during the year. This is a 6.9% decrease compared to the 18.94GW installed in 2010. The Chinese wind power market is beginning to enter a steady development stage after having undergone many years of rapid growth. As of the end of 2011, China had 45,894 wind turbines for a total capacity of 62.36GW, maintaining its position as the leading wind power market globally.

Annual wind power installation data since 2001 is shown in Figure 1-1.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Annual Installation	41.7	66.3	98.3	196.9	506.9	1,287.6	3,311.3	6,153.7	13,803.2	18,928	17,630.9
Cumulativel Installation	381.2	447.5	545.8	742.7	1,249.6	2,537.2	5,848.5	12,002.2	25,805.4	44,733.4	62,364.3

Figure 1-1 The annual newly-added and cumulative wind power installed capacities in China during 2001-2011

Source: "Wind Energy" magazine, March 2012 issue

In 2011, wind power generated 71.5 billion kWh (71.5 TWh), accounting for 1.5% of national power generation. The environmental benefits produced by wind power are apparent: assuming that 320g of standard coal is replaced by one kWh of electricity, then it is possible to replace over 22 million tons of standard coal, reducing some 360,000 tons of sulfur dioxide emission and some 70 million tons of CO_2 emission, producing significant energy-saving and emission-reducing benefits. Assuming that each household uses 1500 kWh of electricity each year, the grid-connected electricity supply of wind power in China during 2011 can meet the electricity demand of more than 4.7 million households for one year.

Data link

The statistics of the wind power installed capacity in this report primarily uses statistics published by the Chinese Wind Energy Association and are based on the actually completed installations at wind farms.

This chapter also provides the data published by the China Hydropower and Water Resources Planning and Design General Institute, including constructed capacities and grid-connected capacities. 'Constructed capacities' refer to completed projects that are registered with the government, while 'grid-connected capacities' mean the projects that have been grid-connected and for which payment of the electricity produced was made by the grid companies. The length of time project installed and grid-connected and payment made can be up to months, which make the numbers from each category of statistics greatly different from each other. Therefore, it is not appropriate to simply compare citing different data without giving source of the data or giving further explanation of the definition of the statistics.

According to the data from the China

Hydropower and Water Resources Planning and Design General Institute, in 2011, China's newly added wind power constructed capacity was 10.53GW and its newly added grid-connected capacity was 16.5GW. As of the end of 2011, the whole country's cumulative wind power constructed capacity was 52.53GW and its cumulative grid-connected capacity was 47.84GW. For details on each year's grid-connected capacities, see Table 1-1.

Table 1-1 National statistics of new/cumulative grid-connected capacities and annual growth rates for wind power during individual years

Year	Newly added grid-connected capacity for year/MW	Year-end cumulative grid-connected capacity/MW	Annual growth rate/%
Before 1994	—	9.7	57.82
1994	12.9	22.6	132.99
1995	11.1	33.7	49.12
1996	23.3	57.0	69.14
1997	84.7	141.6	148.60
1998	71.9	213.5	50.78
1999	50.3	263.8	23.56
2000	77.3	341.1	29.30
2001	41.7	382.8	12.23
2002	65.7	448.6	17.16
2003	98.3	546.9	21.91
2004	215.9	762.7	39.48
2005	506.1	1,268.8	66.36
2006	1,399.4	2,668.2	110.29
2007	3,360.8	6,029.0	125.96
2008	6,143.7	12,172.7	101.90
2009	5,497.3	17,670.0	45.16
2010	13,640.0	31,310.0	77.19
2011	16,530.0	47,840.0	52.79

Sources: Hydropower and Water Resources Planning and Design General Institute; National Wind Power Information Administration Center; China Wind Power Construction Results Statistics and Assessment Report: 2011

1.1.2 Development by Regions

As of December 31, 2011, 30 provinces, cities and autonomous regions in China (excluding Hong Kong, Macao and Taiwan) had their own wind farms. More than 10 provinces each had a cumulative installed wind power capacity of over 1GW, including 9 provinces with a capacity of over 2GW each. The Inner Mongolia Autonomous Region remained the leader of China's wind power development. In 2011, its newly added installed capacity was 3,736MW and cumulative installed capacity was 17,590MW, accounting for 21% and 28% of the entire Chinese market, respectively, followed by Hebei, Gansu and Liaoning, each having a cumulative installed capacity of over 5GW (see Table 1-2).

Among the Top 10 provinces and autonomous regions, Ningxia had the fastest installed capacity growth in 2011, showing a cumulative growth rate of 144%, followed by Shandong with 72.96%, Xinjiang with 69.85%, and then Hebei and Xinjiang with 45% each. Following 2010 when wind power was installed for the first time in the five provinces of Shaanxi, Anhui, Tianjin, Guizhou and Qinghai, Sichuan Province installed its first wind project in 2011. China's wind farm development is advancing towards more regions of different climatic and resource conditions.

Table 1-2 Wind power installed capacity status by province

S/N	Province (autonomous region, municipalities directly under the Central Government)	2010 cumulative/MW	2011 new/MW	2011 cumulative/MW
1	Inner Mongolia	13,858.01	3,736.4	17,594.4
2	Hebei	4,794	2,175.5	6,969.5
3	Gansu	4,944	465.2	5,409.2
4	Liaoning	4,066.9	1,182.5	5,249.3
5	Shandong	2,637.8	1,924.5	4,562.3
6	Jilin	2,940.9	622.5	3,563.4
7	Heilongjiang	2,370.1	1,075.8	3,445.8
8	Ningxia	1,182.7	1,703.5	2,886.2
9	Xinjiang	1,363.6	952.5	2,316.1
10	Jiangsu	1,595.3	372.3	1,967.6
11	Shanxi	947.5	933.6	1,881.1
12	Guangdong	888.8	413.6	1,302.4
13	Fujian	833.7	192	1,025.7
14	Yunnan	430.5	501.8	932.3
15	Shaanxi	177	320.5	497.5
16	Zhejiang	298.2	69	367.2
17	Shanghai	269.4	48.6	318
18	Henan	121	179	300
19	Anhui	148.5	148.5	297
20	Hainan	256.7	–	256.7
21	Tianjin	102.5	141	243.5
22	Guizhou	42	153.1	195.1
23	Hunan	97.3	88	185.3
24	Beijing	152.5	2.5	155
25	Jiangxi	84	49.5	133.5
26	Hubei	69.8	30.7	100.4
27	Guangxi	2.5	76.5	79
28	Qinghai	11	56.5	67.5
29	Chongqing	46.8	–	46.8
30	Sichuan	0	16	16
31	Hong Kong	0.8	–	0.8
Summary		44,788.8	17,630.9	62,364.6
32	Taiwan	519	45	564
Total		45,252.8	17,675.9	62,928.2

Source: "Wind Energy" magazine, March 2012 issue

Data link

According to the data from the China Hydropower and Water Resources Planning and Design General Institute, the wind power grid-connection data in China in 2011 by province (region) is shown in Table 1-3.

Table 1-3 Cumulative wind power grid-connected installed capacity of each province nationwide in 2011

S/N	Province	Cumulative grid-connected capacity/MW	S/N	Province	Cumulative grid-connected capacity/MW
1	Inner Mongolia	14,384.4	16	Shanghai	269.4
2	Gansu	5,551.6	17	Hainan	254.7
3	Hebei	4,991.3	18	Anhui	247.5
4	Liaoning	4,039.5	19	Shaanxi	245.5
5	Jilin	2,936.3	20	Henan	154
6	Shandong	2,718.6	21	Beijing	150
7	Heilongjiang	2,625.5	22	Hunan	133.8
8	Jiangsu	1,704.3	23	Jiangxi	133.5
9	Xinjiang	1,659.8	24	Tianjin	125
10	Ningxia	1,361.5	25	Hubei	115.4
11	Shanxi	1,035	26	Guizhou	60.9
12	Guangdong	933	27	Guangxi	49.5
13	Fujian	873.7	28	Chongqing	46.8
14	Yunnan	684.8	29	Sichuan	16
15	Zhejiang	320.6	30	Qinghai	14
Total					47,835.6

Sources: Hydropower and Water Resources Planning and Design General Institute; National Wind Power Information Administration Center; China Wind Power Construction Results Statistics and Assessment Report: 2011

1.1.3 Overview of the Wind Project in Pipeline

In addition to those projects already completed, there are many wind farm projects across the country that are in early stage development or have already been approved, which are building a good foundation for the long-term, stable development of China's wind power industry.

By the end of 2011, the whole country had some 1500 wind power projects in early stage development, totaling approximately 90GW. There are more than 20 provinces where the early stage development pipeline exceeds 1GW, including such provinces and regions as Yunnan, Guizhou, Hunan, Henan and Guangxi, which have more than 1.5GW each

Large wind power bases have been approved by the Central Government and are in early stage development, including the Jiuquan Phase-II GW base in Gansu (3GW), the Urad Middle Banner GW base in Bayannur, Inner Mongolia (1.8GW) and the Kumul GW base in Xinjiang (2GW), for a total of 6.8GW.

1.2 Characteristics of the Wind Development

1.2.1 The "Three Northern Area[1]"Still the Major Region of China's Wind Power Development

The "Three Northern Area" of China features very abundant wind energy resources. In most areas, the wind power density level is Class 3 and higher (with the US wind measuring system). In some particular areas such as Huitengliang in Inner Mongolia, Urad Middle Banner in Bayannur Inner Mongolia, Saihanba in Chifeng Hebei and Dabancheng in Xinjiang, the wind power density level is close to or over Class 5 by American System of wind measurement. Following the promulgation of the wind power Feed-in tariff, these areas will have significant advantages in wind power development (without considering curtailment of wind). Therefore, for a long time, the "Three Northern Area" has been the key region of China's wind power development.

[1] The “Three Northern Area” refers to the northeast, north and northwest areas in China. The region includes 14 provinces/cities: Hei Longjiang, Jilin, Liaoning, Beijing, Tianjin, Hebei, Henan, Shanxi, Inner Mongolia, Shannxi, Gansu, Qinghai, Ningxia, and Xinjiang.

1.2.2 Wind Power Development in Inland Regions Beginning to Accelerate

In 2011, 30 provinces (regions, cities) across the country had completed wind power projects. Compared to 2010, provinces, with which there is no wind in the past or limited wind development, now with salient wind development included Guizhou, Guangxi, Sichuan and Qinghai. Meanwhile, the installed capacities in such provinces and cities as Anhui, Tianjin, etc., also experienced significant growth. This can be seen as a signal, i.e. wind power development has quietly started in those inland regions where there has been little interest previously (see Tables 1-2 and 1-3).

During the startup and rapid development stages of wind power development in China, wind farm projects had been mainly concentrated in the "Three Northern" regions and southeast coastal regions. These places have abundant wind energy resources. The "Three Northern" regions, in particular, have further advantages, such as simple construction conditions, with whole tracts of lands able to be developed together, etc. Therefore, they have always been the major regions that development enterprises compete for. Provinces in inland regions typically have ordinary wind energy resources and are mostly located in areas where construction conditions are complex and the development costs are high, such as mountains, hills and lake fronts, etc., therefore they have not attracted the attention of development enterprises.

As the effort of developing wind farms on a large-scale and centralized basis intensifies, the competition for acquiring project development rights becomes increasingly fierce. At the same time, continuously increasing wind curtailment occurrences are also dramatically reducing the profits of wind farms in these areas. The advantages of wind farms in inland provinces are gradually becoming increasingly apparent. First of all, these areas feature a dense population, a high electrical demand and good wind farm grid-connection conditions, basically without electricity-limiting. Secondly, the continuously improving wind energy conversion efficiency of wind turbine generator systems and their continuously improving adaptability to various construction conditions has allowed wind farm construction projects in these areas to not only become feasible but also provide significant economic benefits.

In 2011, the National Energy Administration had initiated the development concept of focusing on both centralized and decentralized development and promulgated corresponding administrative measures. It is foreseeable that the dispersed development of wind farms in inland regions will account for an increasingly larger share of the market.

1.2.3 Significant Progress with the Large-scale Wind Power Base Construction

Since 2008, nine 10GW wind power bases have been planned in Gansu, Xinjiang, Hebei, East Inner Mongolia, West Inner Mongolia, Jilin, Shandong, Jiangsu and Heilongjiang on the basis of the results of wind energy resource assessment across individual provinces/regions nationwide and early stage development. Not all of these projects in the planning have been approved by the National Energy Administration through its formal permitting documents. With the current scale of projects permitted, this report will focus on the part that has been finished construction, which are GW size wind bases as part of the 10 GW size bases.

Currently, the main equipment tendering work for the wind turbine generator systems of the 10 projects has been completed. They have been listed in the first group of approved wind power projects of the "Twelfth Five-Year Plan" program of Xinjiang Autonomous Region, and approval is expected to be completed in 2012. (See Table 1-4).

Table 1-4 Summaries of construction situations of individual bases

Name of base	Category of Wind Base	Planned/MW	Approved/MW	Grid-connected/MW	Under construction/MW
Jiuquan Phase-I	Gansu	3,800	3,800	3,600	200
Kailu, Tongliao	Inner Mongolia	1,500	1,500	700.5	799.5
Urad Middle Banner	Inner Mongolia	2,100	300	300	0
Damao, Baotou	Inner Mongolia	1,600	200	200	0
Zhangbei Phase-I	Hebei	1,350	1,350	1,350	0
Zhangbei Phase-II	Hebei	1,500	500	400	100
Chengde	Hebei	1,000	450	336	114
Southeast Kumul	XinJiang	2,000	0	0	0
Total		14,850	8,100	6,886.5	1,213.5

Sources: Hydropower and Water Resources Planning and Design General Institute; National Wind Power Information Administration Center; China Wind Power Construction Results Statistics and Assessment Report: 2011

In the meantime, there are another 6 GW-scale wind power bases across the country for which early stage construction tasks are being organized and conducted, including the Helanshan GW base in Ningxia, the Wuwei GW base in Gansu, the Daheishan GW-scale wind power base in Siping of Jilin Province, the wind base in Xilin Gol League, the Taohemu GW base in Xingan League and the Hulunbuir GW wind power base. Preliminary examination of the planning reports for the above mentioned bases is basically complete, with a total preliminary planned capacity of 14.7GW. It is still necessary to determine the final planned scale and construction schedule based on electricity market consumption studies.

1.2.4 Severe "Curtailment" in Some Areas

The wind power grid-connection and consumption issue is gradually becoming a major challenge restricting wind power development. China's wind resources are mainly distributed in the “Three Northern Area”, but electrical loads are mainly distributed in coastal regions. In general, the geographical distribution of wind energy resources is mismatched with the electrical load. Over the last two or three years, the wind power's grid-connecting bottleneck and market consumption issues began to surface and the wind curtailment phenomenon became quite severe due to the fact that wind power development is highly concentrated in the “Three Northern Area”, wind power and power grid construction paces are not synchronous, local load levels are low, the number of flexibly adjustable power supplies is limited, and the cross-provincial/cross-regional market is not mature. Although the “Three Northern Area” has abundant wind energy resources and provides the largest amount of annual grid-connected electricity nationwide, it is also the place where the wind curtailment phenomenon is the most severe. In March 2011, the State Electricity Regulatory Commission issued the "Wind Power and Photovoltaic Power Generation Regulatory Report", which provided statistics regarding non-purchased wind power electricity during January-June 2010. Regionally, the amount wind electricity curtailed in the north and northeast were the largest, accounting for 57.20% and 38.33% of the total wind electricity curtailed nationwide, respectively. Provincially, the amount of curtailed wind power electricity in Inner Mongolia was the largest, accounting for 75.68% of the total curtailed wind power electricity nationwide.

The "China Wind Power Construction Results Statistics and Assessment Report: 2011" provided statistics and analysis of the "curtailment" situation in 2011. According to the statistics and analysis of 584 wind farms in the “Three Northern Area”, east Inner Mongolia and Jilin were the areas in which "curtailment" was the most severe, with a "curtailment" rate of more than 20%. The "curtailment" issues in west Inner Mongolia, Gansu and Heilongjiang were also quite severe, with a rate of more than 10%.

The issue of curtailment of the wind has started to surface in the past two years, along with the progress of the Wind Base program. The issue became most salient in 2011, when the central government started to take different measures to address it. On the one hand, the government was looking into different options to increase the consumption of the wind in these regions, as well as to increase the transmissions to the neighboring regions with higher electricity demand. On the other hand, the government also realized that before the problem of electricity consumption or transmission can be solved overnight, it would be good to slow down the process of Wind Bases while starting to develop wind in the central and east area, where wind resources may not be prominent but electricity load is higher and transmission infrastructure is robust.

Table 1-5 Statistics of "curtailment" situations in the wind power sector of China's major provinces (regions) in 2011

S/N	Region	Wind-abandoning rate/%	Number of wind farms in statistics
1	East Inner Mongolia	22.99	98
2	Jilin	20.49	44
3	West Inner Mongolia	17.51	129
4	Gansu	16.99	39
5	Heilongjiang	14.49	59
6	Liaoning	10.34	74
7	Xinjiang	3.21	32
8	Hebei	3.09	74
9	Shandong	1.46	57
10	Ningxia	0.64	33
Total		11.12	639

1.3 Offshore Wind Power

1.3.1 General Situation: Offshore Potentials, Plans and Early Stage Works

China's coastline is more than 18000km long, and China has more than 6000 islands. Offshore wind energy resources are mainly concentrated along the southeast coast and on its nearby islands, with an average wind energy density of over 300W/m^2. The offshore wind power development potential at 5~25m water depth and 50m height is approximately 200GW. The offshore wind power development potential at 5~50m water depth and 70m height is approximately 500GW.

In addition to abundant offshore wind energy resources, China's eastern coastal regions also feature a developed economy, a high energy demand, a robust power grid structure, and good wind power grid-connecting conditions. Therefore, China has unique advantages for developing offshore wind power.

In January 2009, the National Energy Administration organized and held the National Offshore Wind Power Working Conference, officially launching the offshore wind power planning work, and starting investigations into offshore wind energy resources and offshore wind farm project planning. As of the end of 2011, the offshore wind power planning for Shanghai, Jiangsu, Shandong, Hebei, Zhejiang and Guangdong had already been completed. The offshore wind power planning for Dalian in Liaoning Province as well as provinces such as Fujian, Guangxi and Hainan are still in development.

The completed plans preliminarily identified an offshore wind development potential of 43GW. Currently, there are already 38 projects of 16.5GW that are in early stage development.

Offshore wind power as a competing user of maritime areas has always been a major issue of concern to the National Energy Administration and State Oceanic Administration. As the coastal provinces' offshore wind power programs are completed successively and pass inspections by the National Energy Administration, and the Oceanic Administration have combined sea area use management as an important part of their administration, often making the offshore programs examined and approved by the National Energy Administration hard to be implemented effectively. In order to promote offshore wind power programs, in 2011, relevant authorities and the State Oceanic Administration completed the work of interfacing the offshore wind power projects in Shandong, Jiangsu and Fujian with such province's Marine Function Divisions (2011-2020) and with the National Marine Function Divisions (2011-2020), effectively promoting the successful execution of offshore wind power programs.

1.3.2 Current Offshore Development

In 2011, China's offshore wind power construction progressed in an orderly way: installation of 100MW wind turbine of the Rudong 150MW offshore wind farm pilot project in Jiangsu was completed; in Shanghai, two experimental wind turbine - one with capacity of 3.6MW and the other of 5MW - were installed; by the end of 2011, China's cumulative installed capacity of off offshore wind was 242.5MW.

The four projects from the first round of the offshore concession tendering, totaling 1GW, were undergoing a new round of environmental evaluation and cable routing along the coastal and intertidal areas in Binhai, Sheyang, Dongtai and Dafeng cities (counties), Jiangsu Province. These projects were granted project permission in the tender in 2010, but were consequently told that the site of the projects has to be changed. The early stage work for the new projects sites has basically been completed.

The Shanghai Donghai Bridge Phase-I offshore wind farm project is Shanghai City's pilot project and China's first large offshore wind farm with a total installed capacity of 102MW. With the 240h pre-acceptance examination of all 34 wind turbine generator systems completed on August 31, 2010, the project has been running for more than a year so far. The project post-evaluation work has been completed, and the following conclusions have been reached: the project was constructed according to the design; the project investment has been effectively controlled; the project's power generation output is moderately lower than projected. The Donghai Bridge offshore wind farm is China's first large offshore wind power project, and the experiences gained during its construction and operation offer important learning opportunities for China to better develop its offshore wind energy resources in the future. In the meantime, the project feasibility study examination and main equipment tendering for the Donghai Bridge Phase-II project has also been completed.

1.3.3 Future Development: Challenges and Opportunities

According to the wind power development "Twelfth Five-Year" plan, the offshore wind power installed capacity should reach 5GW by the end of 2015. By the end of 2020, the offshore wind power installed capacity should reach 30GW. However, development has been slower than planned, and those targets, particularly 5GW in 2015, will be difficult to reach. In addition to the nearly 250MW already completed, there are also some 2.3GW offshore wind projects in early stage development. Compared to the target, half of the capacity is not yet verified. In consideration of the construction cycle of offshore wind farms, the wind farms of these capacities should be able to be determined and verified in 2012. Therefore, in 2012, development of China's offshore wind farms will face tremendous opportunities.

However, the major challenge for China’s offshore development lies in the lack of coordination between different government agencies on exploration of the marine areas. This challenges remains even with the current policies and regulations published. A better coordination between government agencies may involvement of a higher government to step into the process, which is not really happening so far.

Undeniably, China's offshore wind power development is currently still in the early stages. Mature experience is lacking in several areas, including planning and standards, equipment manufacturing, engineering design, construction & installation, cost control, operation & maintenance, policies and management, etc. The existing challenges cover the entire industrial chain.

During the "Twelfth Five-Year Plan" period, "being active and sound" will be the basic philosophy for China to drive its offshore wind power development. All participants in offshore wind power development should actively reinforce capacity building, improve their own construction and management abilities, and ensure successful fulfillment of their offshore wind power development goals.

1.4 Relevant Policies and Measures Promoting the Development of China's Wind Power Industry

1.4.1 Policies and Measures on Industry Development and Management

2011 was the first year of China's "Twelfth Five-Year Plan". In order to regulate the wind power industry towards stable and rapid development, the National Energy Administration issued a series of industry management standards and technical requirements intended to strengthen wind farm construction planning and management.

1) The National Energy Administration issued the "Interim Measures for the Management of Wind Power Development and Construction", further strengthening and improving wind power construction management systems and mechanisms, reinforcing management of all elements of wind power projects ranging from planning to project early stage tasks, development rights, project approval, engineering construction, completion and operation, regulating and guiding nationwide wind power projects to advance on a healthy and orderly basis.

2) Implementing annual approval and planning management for wind power development. In order to control the wind power development pace and effectively realize wind power generation benefits, the National Energy Administration started to implement approval and planning management for wind power projects in 2011, issuing the "Notice on the Planning and Arrangement of the First Group of Tentatively Approved Wind Power Projects for the 'Twelfth Five-Year Plan' Period" in July 2011, which will implemented in the period of 2011-2015,contains a total scale of 26.83 million kW for tentatively approved wind power projects nationwide, including 12.75 million kW for state-approved

projects and 14.08 million kW for locally approved projects. The "Notice" required that those projects not listed in the approved programs must not be approved. For the four provinces and regions of Hebei, Heilongjiang, Jilin and Inner Mongolia, the Notice had specifically raised requirements that the study of regional wind power electricity planning and consumption plans must be accelerated, the electricity outgoing transmission projects must be completed, and coordinated development of wind power and power grids must be maintained. Last April, the "Plan for Second Group of Approved Wind Power Projects for the 'Twelfth Five-Year Plan' Period" was also issued, including a total of 14.92GW.

3) The "Implementation Rules of the Interim Measures for the Management of Development and Construction of Offshore Wind Power" (Guo Neng Xin Neng #[2011] 210) was issued in July 2011.

The National Energy Administration studied and formulated the "Implementation Rules of the Interim Measures for the Management of Development and Construction of Offshore Wind Power", with regard to the "Interim Measures for the Management of Development and Construction of Offshore Wind Power" issued in 2010, which was enacted through a joint document with the State Oceanic Administration. The document provided specific provisions regarding the work contents and requirements during offshore wind farm planning, a pre-feasibility study and feasibility study stages and clearly defined the duties of individual management departments. Moreover, it also raised requirements regarding the construction and operation of offshore wind farms. The Rules expressly specified that offshore wind farms must, in principle, be deployed in sea areas that are no less than 10km from the coast and where the seawater depth is no less than 10m when the tidal flat width is over 10km and that such locations must be suitable for avoiding sea-use conflicts between different industries and reducing development enterprises' investment risks. The implementation of these policies increased the difficulty of developing offshore wind power and forced all 4 offshore wind power concession tendering projects of 2010 to re-determine their locations, a very expensive undertaking which underscores the need for planning coordination between different government agencies.

4) The "Notice on Decentralized Access Wind Power Development" and the "Guidance on

Development and Construction of Decentralized Access Wind Power Projects".

In July 2011, the National Energy Administration issued the "Notice on Decentralized Access Wind Power Development" (Guo Neng Xin Neng #[2011] 226), requiring the competent energy department of each province (region, city) to investigate and study the wind energy resources required for decentralized wind power, proposing a preliminary plan for near-term decentralized wind power development, and actively exploring the rules and experiences of management in development and construction of decentralized wind power projects. The document had for the first time proposed boundary conditions for decentralized wind power development.

In November 2011, the National Energy Administration issued the "Guidance on Development and Construction of Decentralized Access Wind Power Projects" (Guo Neng Xin Neng #[2011] 374), providing provisions regarding conditions, project site selection, early stage tasks and approval, access system technical requirements and operation management, engineering construction and acceptance of decentralized access wind power projects.

The issuance of the above documents indicated that China's future wind power development would focus on both decentralized and centralized models to mitigate power grid access pressure.

5) The "Interim Measures for the Management of Power Prediction and Forecast at Wind Farms" (Guo Neng Xin Neng #[2011] 177), was issued in June 2011.

In order to strengthen and regulate wind farm operation management, it proposed that all wind farms must have wind power prediction and forecasting capabilities and that wind power prediction and forecasting must be conducted as required. Each wind farm's prediction and forecasting system shall be formally up and running starting from July 1, 2012. The document also raised requirements regarding such aspects as operation management, supervision, and examination, etc.

6) The "Notice on Strengthening Grid-Connected Wind Power Operation Management" (Guo Neng Xin Neng #[2011] 182) was issued in June 2011.

With regard to the multiple occurrences of large-scale wind turbine generator system grid disconnection accidents since 2011, this document proposed such requirements as strengthening wind farm construction management, strengthening wind farm grid-connecting operation management, enhancing the low-voltage ride-through ability of grid-connected operational wind turbine generator systems, and strengthening safe operation management of electrical systems. It also included the deployment of such work as monitoring of the low-voltage ride through, wind power grid-connection operation design specifications, etc.

7) The "Notice on Strengthening Wind Farm Safety Management" (Guo Neng Xin Neng #[2011] 373) was issued in November 2011.

In consideration of issues such as the frequent occurrence of safety incidents during wind farm construction and operation as well as weak safety management in the wind power industry, this document proposed requirements that each wind power development enterprise must strengthen safety management in all elements of wind farm construction, as well as strengthening incident information reporting and management, that each equipment manufacturer must enhance its equipment reliability and technological level, and that qualification management in the wind power industry must be strengthened.

8) The "Notice on Issuing the Interim Measures for the Management of Wind Power Information" (Guo Neng Xin Neng #[2011] 136)

In order to improve wind power information management and regulate the work of wind power information reporting, examination, statistics and release, this Notice expressly specified that the National Energy Administration authorize the National Wind Power Information Administration Center, a center established under the Hydropower and Water Resources Planning and Design Institute, to be responsible for wind power information management and each province (region, city) to be responsible for supervising and coordinating its wind power information submission work. This Notice made provisions regarding information collection and submission as well as information application, analysis and evaluation, and further made clear systems for information personnel. Currently, the National Wind Power Information Administration Center has already organized development of the "Wind Power Generation Information Reporting System" and "Wind Power Information Person Training & Certification Management System", both of which are already formally in operation.

9) Issuance of the Wind Power "Twelfth Five-Year" Plan

As authorized by the National Energy Bureau, the Hydropower and Water Resources Planning and Design General Institute was responsible for drafting the special wind and solar power generation program for the "Twelfth Five-Year Plan" period. After more than a year, with 3 collective working meetings, and multiple consulting sessions and modifications being made, both programs have been included in the "Renewable Energy 'Twelfth Five-Year' Development Plan".

10) The Ministry of Finance, the National Development and Reform Commission and the National Energy Bureau jointly stipulated the "Interim Measures for the Management of Collection and Use of the Renewable Energy Development Fund" (Cai Zong #[2011] 115). China's renewable energy electricity price surcharge has been increased from RMB 0.4 cents/kWh today to 0.8 cents.

1.4.2 Technical Standards

In 2010, the National Energy Bureau began to develop and revise standards for the wind power industry. It organized and set up the Energy Industry Wind Power Standardization Technical Committee, initiated the China wind power standards system framework, and preliminarily planned to establish 183 standards, which mainly included 6 major system frameworks covering wind farm planning and design, construction and installation, operation & maintenance management, grid-connection management technology, wind power machinery and equipment, and wind power electrical equipment.

In early August, the National Energy Bureau issued 18 wind power technical standards drafted by the Wind Power Standardization Technical Committee that covered wind power grid-connecting, project estimates, and generator unit equipment, which further improved and supplemented Chinese technical standards in areas of wind turbine generator system manufacturing, project construction costs, quality assurance, installation and operation, and maintenance management. For details, see Table 1-6.

Moreover, multiple technical standards and administrative measures drafted by the Hydropower and Water Resources Planning and Design General Institute, including the

Land Use Indexes for Wind Farm Construction, "Code for Geologic Examination of Wind Farm Projects", "Design Specifications for Tendering of Wind Farm Projects", and design and technical specifications for planning, the pre-feasibility study, feasibility study and construction organizing of offshore wind farm projects, have been submitted to the National Energy Bureau for official written replies.

Table 1-6 Summary of 18 wind power technical standards issued in 2011

S/N	Name of standard	Standard No.
1	Technical Specifications for Grid-Connecting Design of Large-Scale Wind Farms	NB/T 31003—2011
2	Guidelines for Vibration Condition Monitoring and Diagnosis of Wind Turbine Generator Systems	NB/T 31004—2011
3	Method for Testing Quality of Electric Energy of Wind Farms	NB/T 31005—2011
4	Technical Standard for Steel Structure Corrosion Resistance of Offshore Wind Farms	NB/T 31006—2011
5	Charging Standard for Investigation and Design of Wind Farm Projects	NB/T 31007—2011
6	Quota of Budgetary Estimate for Offshore Wind Farm Project	NB/T 31008—2011
7	Compilation Rules and Charging Standard for Budgetary Estimate of Offshore Wind Farms	NB/T 31009—2011
8	Quota of Budgetary Estimate for On-land Wind Farm Project	NB/T 31010—2011
9	Compilation Rules and Charging Standard for Design Budgetary Estimate of On-land Wind Farms	NB/T 31011—2011
10	Manufacture and Technical Specifications for Permanent Magnet Type Wind Turbine Generators	NB/T 31012—2011
11	Manufacture and Technical Specifications for Doubly Fed Type Wind Turbine Generators	NB/T 31013—2011
12	Manufacture and Technical Specifications for Converters of Doubly Fed Type Wind Turbine Generators	NB/T 31014—2011
13	Manufacture and Technical Specifications for Converters of Permanent Magnet Type Wind Turbine Generators	NB/T 31015—2011
14	Technical Specifications for Battery Energy Storage Power Control Systems	NB/T 31016—2011
15	Technical Specifications for Main Control Systems of Doubly Fed Type Wind Turbine Generator Units	NB/T 31017—2011
16	Technical Specifications for Electric Pitch Control System of Wind Turbine Generator Units	NB/T 31018—2011
17	Corona-Resistant Polyimide Film-Backed Mica Paper Tapes with Glass Fabric for Coil Insulation on Wind Turbine Generators	NB/T 31019—2011
18	Corona-Resistant Polyimide Film for Turn-to-Turn Insulation on Wind Turbine Generators	NB/T 31020—2011

2 Current Status of China's Wind Power Industry

2.1 Current Status of Equipment Manufacturing Industry

2.1.1 Industry Scale and Market Structure

In 2011, there were a total of 29 original equipment manufacturers (OEMs) active OEMs in China. Compared to 43 suppliers in 2009 and 38 in 2010, the number of OEMs showed a decreasing trend, being basically equal to the number of 30 suppliers in 2008. It should be noted that the term "OEM" is used here to distinguish from "manufacturer". An "OEM" means a wind turbine manufacturer that has sold/installed one or more prototype machines in the market during the year. Currently, there are still over 70 registered wind turbine "manufacturers" in China, but they do not necessarily make a contribution to the market every year.

In 2011, the Top Five manufacturers in the Chinese market were Goldwind 3,600MW (20.4%), Sinovel 2,939MW (16.7%), United Power 2,847MW (16.1%), Mingyang 1,177.5MW (6.7%) and Dongfang Turbine 946MW (5.4%), respectively. As of 2011, the Top Five enterprises in China's cumulative installed wind power market were Sinovel 12977MW (20.8%), Goldwind

12678.9MW (20.3%), Dongfang Turbine 6898MW (11.1%), United Power 5282MW (8.5%) and Vestas 3565.5MW (5.7%), respectively. For details, see Table 2-1.

The total market share of the Top 15 suppliers in 2011 was 93.9%, a 0.6% decrease compared to 94.5% in 2010. In 2011, the total market share of the Top 10 suppliers was

Table 2-1 Installation data for China's Top 20 wind power complete-machine

	2010 new/MW	2010 cumulative/MW	2011 new/MW	2011 cumulative/MW
Goldwind	3,735	9,078.85	3,600	12,678.9
Sinovel	4,386	10,038	2,939	12,977
United Power	1,643	2,435	2,847	5,282
Guangdong Mingyang	1,050	1,945.5	1,177.5	3,123
Dongfang Turbine	2,623.5	5,952	946	6,898
XEMC Wind Power	507	1,089	712.5	1,801.5
Shanghai Electric Group	597.85	1,073.35	708.1	1,781.5
Vestas	892.1	2,903.6	661.9	3,565.5
Shenyang Huachuang	486	682.5	625.5	1308
CSR Zhuzhou	334.95	465.3	451.2	916.5
GE Wind	210	1167	408.5	1,575.5
CSIC (Chongqing) Haizhuang	383.15	479.25	396	875.3
Zhejiang Windey	129	723	375	1,098
Gamesa	595.55	2,424.3	361.6	2,785.9
Envision Energy	250.5	400.5	348	748.5
Yinxing Energy	154	252	221	473
Sany Electric	106	143.5	179.5	323
XJ Wind Power	22	26	166	192
Huayi	161.64	295.08	151	446.1
Suzlon	199.85	805.1	96.2	901.3
Others	460.9	2,354.47	259.3	2,613.7
Total	18,928	44,733.3	17,630.8	62,364.2

(Rankings based on new installation data for 2011)

Source: "Wind Energy" magazine, March 2012 issue

83.18%, a 4.07% decrease compared to 87.25% in 2010. In 2011, the total market share of the Top 5 suppliers was 65.3%, a 5.7% decrease compared to 71% in 2010, as shown in Figure 2-1.

Based on the above analysis, the following conclusions can be drawn: first, although the number of OEMs is still big, but the number has been decreasing in the past three years; secondly, the market share of the top 5 OEMs is getting smaller, while the contrast of the projects are more scatter with lower ranking OEMs.

It can be seen from Figure 2-2 that among the Top 15 enterprises in 2011, the sales volume of 10 of them increased, including United Power, Mingyang Wind, XEMC Wind Power, and Shanghai Electric Group, etc.; while the sales volume of 5 enterprises, i.e. Sinovel, Goldwind, Dongfang Turbine, Vestas and Gamesa, decreased their volume compared with 2010.

With an installed capacity of 2,847MW in 2011 - a 73.0% increase over the previous year - Guodian United Power Technology Company Limited became the enterprise to watch in 2012. With its first batch of 1.5MW wind turbine generator systems launched in 2008 and with an installed capacity of 768MW in 2009, United Power ranked the 4th in the Chinese market. It secured its 4th place again in 2010 with an installed capacity of 1643MW, and then entered the Top 3 ranking list in 2011 with significant advantages. Also, United Power was very fast in new product R&D, producing its 3MW turbine in 2010, and its 6 MW turbine was completed in late 2011.

Another notable enterprise is CSR Zhuzhou Electric Locomotive Research Institute. Since 2008, when its first 1.65MW generator unit was manufactured and installed, this company has maintained stable, constant growth. In 2011, CSR Zhuzhou Institute installed 451MW and entered the Top 10 ranking list for the first time, becoming a rising star in the industry. Nor was CSR Zhuzhou Institute left behind in the field of new product R&D. The prototype machine of the 2.5MW generator unit that it developed was already installed, and its 5MW generator unit will be available soon.

The installed capacities of both Goldwind and Sinovel decreased somewhat in 2011, although they maintained their first and second positions in the Chinese market.. Moreover, Goldwind and Sinovel were also active in fields such as new product R&D, and the exploration of international markets. Goldwind, Sinovel, United Power and Mingyang were all ranked in the 2011

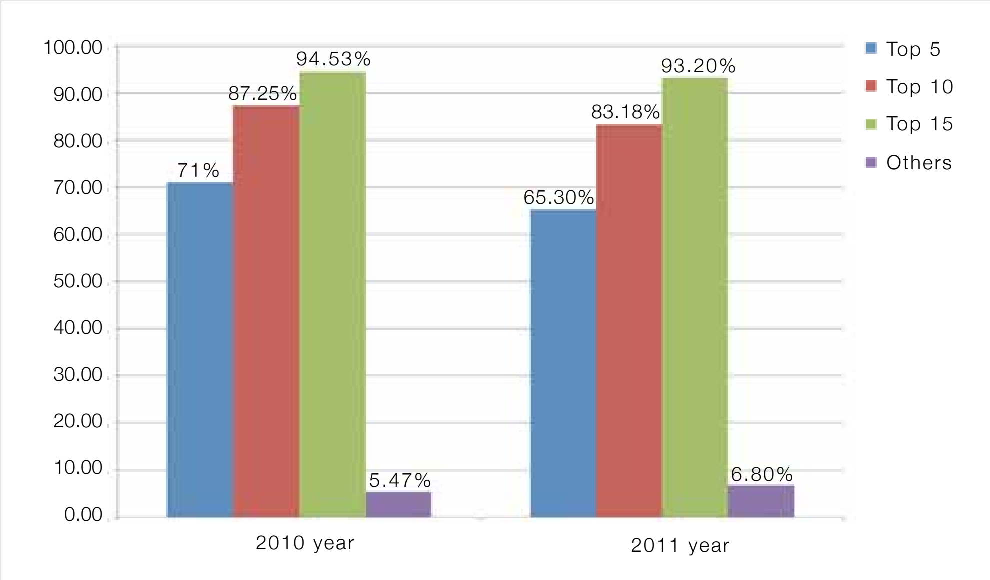


Figure 2-1 Market shares of Top 15 suppliers in China's wind power market during 2010-2011

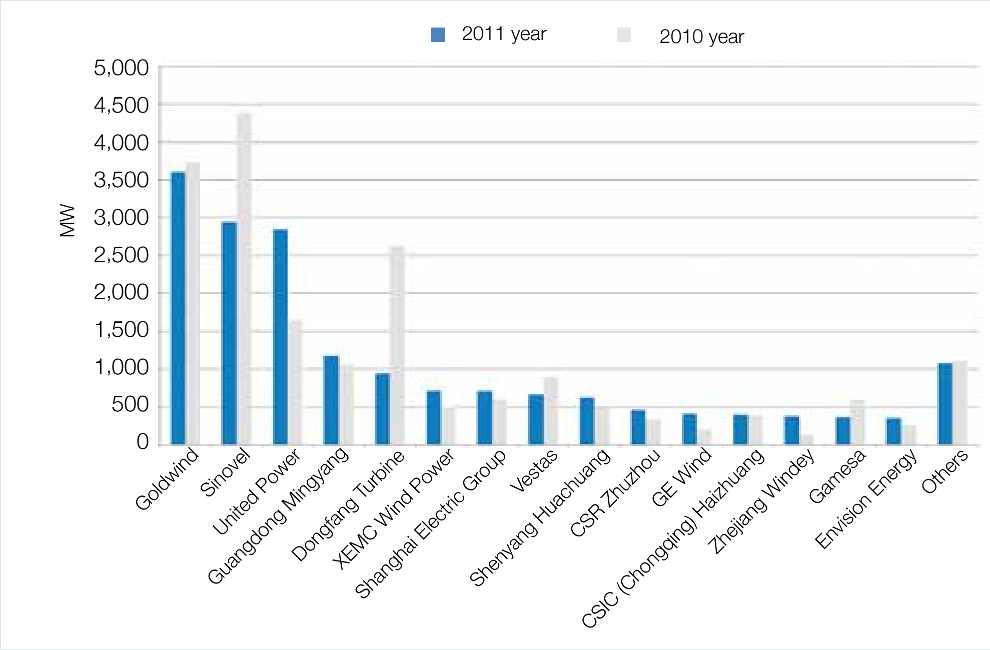


Figure 2-2 Installations of Top 15 suppliers in China's wind power market in 2011

Global Top 10 Manufacturers list.

The Chinese operations of foreign-funded enterprises have been dramatically challenged by Chinese companies during the past two years. The primary reasons for this are that over the past several years Chinese-made wind power equipment has achieved batch supply capability, and due to intense competition and an oversupply in the market, prices have decreased year after year. The products of foreign funded enterprises scored badly during the equipment tendering process, due to their comparatively higher price. Nevertheless, their products were still more trusted by the market in areas such as reliability, which is the major reason why international companies such as Vestas and Gamesa possess such a large global market share. The early Chinese wind power market was characterized by a lack of competition due to insufficient supply of equipment. During the past several years, however, as products from a large number of Chinese enterprises have become available, market competition has exploded, and price competition has become increasingly important. As rationality returns to market competition, core values such as product quality and post-sales services will definitely regain market emphasis, as competition between Chinese enterprises and foreign companies return to the same starting point. It is expected that both Chinese enterprises

Figure 2-3 Trend of the average turbine size in the Chinese market

and foreign companies will show excellent market performances and work together to drive advances in wind power technology, ensuring the stable and healthy development of the industry.

In 2011, 11409 wind turbine generator systems were installed in China with an average power of 1545.4kW, showing a continuous growth compared to 2010, as shown in Figure 2-3. Among all the wind turbine generator systems installed last year, the 1.5MW models dominated, with a 74.1% market share. 2MW models accounted for 14.7%, models with a power of over 2.5MW accounted for 3.5%, other models with a power, for example, of 1MW, 1.25MW, 1.6MW, 1.65MW, 2.1MW and 2.3MW accounted cumulatively for 5.3%, while wind turbine generator systems with a power less than 1MW only accounted for 2.4%.

As far as the technical characteristics of wind turbine generator systems are concerned, the market supply of pitch variable-speed wind turbine generator systems using gearboxes and doubly fed induction generators was greater, owing to the maturity of the technology. Direct-drive wind turbine generator systems using synchronous generators and full-power converters instead of speed-increasing gearboxes became increasingly attractive, however, with more and more enterprises beginning to participate in the R&D, design and manufacture of such generator units.

It is worth noting that full-power current conversion technology has become gradually more mature over recent years. The application of full-power converters gradually increased and they were no longer limited to direct-drive systems. A combination of technologies using synchronous generators, full-power converters and was flexibly applied to both 100kW-scale and multi-MW-scale wind turbine generator systems.

Since 2008, the supply of wind power parts and components in China has mostly satisfied the market demand. These parts and component enterprises included both Chinese enterprises and foreign-owned factories set up in China. The number of wind power blade enterprises was the largest. Excluding the in-house blade factories of complete-machine enterprises, there were over 30 blade manufacturers in China. Among these blade enterprises, however, some had never started batch production, and some had already expressly indicated they would exit this market. Currently, the independent blade manufacturers with large market shares are still China Composites Group Corporation, Sinoma, Zhonghang Huiteng, and LM. The change in market structure of parts (gearboxes, generators, etc.) manufacturers was insignificant. It is worth noting that those components previously most difficult to obtain in China, such as main shaft bearings, gearbox bearings and converters, have now entered the localized batch production stage.

As mentioned above, the current trend among Chinese OEMs is to make their own parts and components in-house, leaving scant market space for enterprises specializing in components.

By making their own parts and components in-house, the wind power OEM's main aim is to ensure market supply, guarantee product quality, and maintain minimum costs. As the wind power parts and components supply system increasingly improves, enterprises specialized in the production of wind power parts and components must, in addition to meeting the above mentioned requirements of complete-machine enterprises, also maintain their advantages in areas such as innovative R&D, quality control, and cost control. Only in this way can they win back a larger share of the market.

2.1.2 Development Characteristics and Trends

Based on the evaluation of the development of China's wind power equipment manufacturing industry over recent years and the status of industry development in 2011, this report summarizes the following characteristics and trends: industry administration, capacity building, business strategy, and product R&D:

1) Operational reliability of wind power equipment gained increasing attention

During 2010 and 2011, the National Energy Bureau authorized the Chinese Wind Energy Association (CWEA) to conduct a survey of the quality of wind power equipment, which attracted both industry and media attention. In addition to submitting the survey results to the National Energy Bureau, CWEA also recommended safety measures based on the problems discovered during the survey, which in turn provide an early warning to the industry.

In November 2011, the National Energy Bureau issued the "Notice on Relevant Requirements for Strengthening Wind Farm Safety Management", requiring wind farm owners to improve wind farm quality and safety management and promptly report possible wind power equipment quality problems, requiring wind power equipment manufacturers to strengthen process control and quality management and continue to enhance the reliability and technological level of their generator units, and authorized CWEA to periodically conduct quality surveys on operational wind turbine generator systems, announce the survey results and quality evaluation results to the general public, and publish corresponding safety measures and industry early-warning information regarding similar problems or typical accidents.

Moreover, at the China Wind Power Conference 2011 in Beijing, press conferences were held for the "China Wind Power Generation Evaluation System Research Report" jointly researched and written by CWEA, Vestas and industry experts; as well as the "China Wind Power Development Road Map 2050" jointly published by the Energy Research Institute of the National Development and Reform Commission and organizations such as the International Energy Agency. These research reports, which had considered foreign development experiences, provided valuable insight into all relevant issues, including wind power equipment quality evaluation, wind power equipment operation management, and the development trends of wind turbine generator system technology.

Government departments, industry associations, research institutes and the industrial community all considered the healthy, stable development of the wind power industry to be of utmost importance, using different approaches to promote the improvement of wind power equipment operational reliability. As the industry continues to develop and mature with guidance from government departments, a more healthy, orderly and sustainable wind power industry chain will develop.

2) Further improvements in enterprise-backed wind power technology R&D systems

In 2010, the Ministry of Science and Technology and the National Energy Bureau established multiple R&D centers and key laboratories for the wind power industry to carry out fundamental research and promote technological advances as supported by major Chinese scientific research institutions and leading enterprises.

In November 2011, the National Energy Bureau authorized the establishment of the "National Energy Key Laboratory for Wind Energy & Solar Energy Emulation and Inspection Certification Technology", based at the China General Certification Center. This signified the initiation of a public technical service platform for China's wind and solar energy industries, integrating technical standards research, inspection certification technology research and inspection certification practices, in order that technological advancement and the internationalization of China's wind and solar energy industries would continue to accelerate.

The China General Certification Center is a scientific research and technical service agency specialized in the inspection and certification of renewable energy products such as wind and solar energy. It has an inspection and certification team equipped with advanced technology in the wind and solar energy field and has set up a blade inspection and testing center in Baoding, as shown in Figure 2-4. The establishment of the National Energy Key Laboratory for Wind Energy & Solar Energy Emulation and Inspection Certification Technology will further enhance China's capabilities in the field of wind and solar energy inspection and certification.

The state-level R&D centers, engineering technology centers or key laboratories that China's wind energy industry has set up at superior enterprises, including the engineering

Figure 2-4 Baoding Blade Inspection and Testing Center of the National Energy Key Laboratory for Wind Energy & Solar Energy Emulation and Inspection Technology Certification

technology centers or laboratories established with the approval of the Ministry of Science and Technology, already cover most relevant technical elements, including wind power blades, generators, wind power systems, control systems, offshore technical equipment, offshore wind power projects, wind farm operation, wind power grid-connecting, emulation, and inspection and certification. China's wind energy scientific R&D system continues to improve, as shown in Table 2-2 below.

3) R&D of onshore wind turbine generator systems suitable for different operating environment characteristics gained increasing attention

The distribution characteristics of China's wind energy resources determine that China's wind farms are mostly distributed in remote areas far from central cities and are formed in accordance with the "large-scale, high-concentration" wind power development model. With the grid connection and power consumption issues faced by major wind power bases becoming increasingly significant, China has proposed a new concept, focusing on both large-scale bases and distributed development,

Table 2-2 Research Institutions approved by the Ministry of Science and Technology and the National Energy Bureau and established during 2010-2011

Name of research institution		Backing unit
Institutions approved by the Ministry of Science and Technology include	State Key Laboratory of Wind Power Equipment and Control	Guodian United Power Technology Company Limited
	National Engineering Research Center of Offshore Wind Power	CSIC (Chongqing) Haizhuang Wind Power Equipment Co. Ltd.
	State Key Laboratory of Wind Power Generation Systems	Zhejiang Windey Co., Ltd.
	State Key Laboratory of Offshore Wind Power Generation Technologies and Inspection	XIANGTAN ELECTRIC MANUFACTURING GROUP (XEMC)
Institutions established with approval of the National Energy Bureau include	National Energy Wind Power Blades R&D (Experimental) Center	Institute of Engineering Thermophysics, Chinese Academy of Sciences
	National Energy Offshore Wind Power Technical Equipment R&D Center	Sinovel, Shanghai Jiao Tong University
	National Energy Large-Scale Wind Power Grid-Connecting System R&D (Experimental) Center	State Grid Corporation of China
	National Energy Wind Power Generator R&D Center	XEMC Xiangtan Electric Research Institute of Traction Equipment, etc.
	National Energy Wind Power Operation Technology R&D Center	China Guodian Corporation, China Longyuan Power Group Corporation Limited
	National Energy Key Laboratory of Wind Energy & Solar Energy Emulation and Inspection Certification Technology	China General Certification Center

providing the momentum needed to drive stable development of this industry.

In 2011, while steadily promoting construction of large-scale wind power bases, China was also actively studying how to develop distributed wind power access technology and decentralized wind power project development planning. Many of the wind power projects of over several GW tentatively approved by the National Energy Bureau for the "Twelfth Five-Year Plan" period were also located in areas outside the planned, large-scale inland bases.

The areas where such projects are located typically feature low average annual wind speeds or high altitudes, being significantly different from the environmental characteristics of those areas where large-scale bases are planned. To meet the developmental requirements of these projects, equipment manufacturers are, when developing their wind turbine generator systems, introducing "low wind speed" or "high altitude" models to ensure higher developmental potential for these projects.

Regarding China's distributed wind power development, the goal for installations by 2015 is 30GW (including both completed and projects under construction). This means that tailor-made wind turbine generator systems will not only have a very large share of the market in the future but will also become an increasing part of China's wind power development as it continues to mature.

4) Acceleration of multi-MW-scale offshore wind turbine generator systems suitable for coastal wind farms R&D

During the "Eleventh Five-Year Plan" period, China acquired MW-scale wind turbine generator system R&D technology and realized batch production capability through various modes, providing strong support to the large-scale development of China's wind power market. By the end of the "Eleventh Five-Year Plan" period, multiple Chinese enterprises had successively and successfully developed wind turbine generator systems with a power of 3MW and higher, and had become powerful bidders for China's first group of offshore wind power concession tendering projects.

Offshore wind power is an important direction for wind power development, both inside and outside China. According to unofficial statistics, as of 2011, about 20 Chinese OEMs had announced plans for the R&D of multi-MW high-power wind turbine, with power ranges mostly concentrated between 3MW-6MW, as shown in Table 2-3. Sinovel's 6MW turbine was completed in May, 2011, and Guodian United Power Technology Company Limited's 6MW wind turbine generator system in December, 2011, signifying that China's large-scale wind turbine generator system R&D capabilities had stepped up to the next level.

The manufacturing industry is actively researching and developing multi-MW-scale wind turbine generator systems for offshore wind power, which will provide more model selections for China to develop offshore wind power equipment in the future. However, the development of offshore wind turbine generator systems will face more challenges in areas such

Table 2-3 R&D advances of some Chinese enterprises in high-power offshore wind turbine generator systems

Abbreviated name of enterprise	Model of generator unit	Single-machine power/MW	R&D advances
Sinovel	SL3000	3,000	Batch installations
	SL5000	5,000	Prototype machine
	SL6000	6,000	Prototype machine
Goldwind	GW3000	3,000	Prototype machine
	GW6000	6,000	Under development
Dongfang Turbine	DF3000	3,000	Under development
	DF5500	5,500	Under development
United Power	UP100	3,000	Prototype machine
	UP100-DD	3,000	Prototype machine
		6,000	Prototype machine
Mingyang Wind	SCD3.0	3,000	Prototype machine
	SCD6.0	6,000	Under development
Shanghai Electric Group	SE3600	3,600	Prototype machine
	SE6000	6,000	Under development
XEMC Wind Power	XE115-5000	5,000	Prototype machine
CSIC (Chongqing) Haizhuang	H5000	5,000	Under development
Sany Electric		6,000	Under development
Shenyang Huachuang	CCWE3000	3,000	Prototype machine
CSR Zhuzhou Institute	WT2500	2,500	Prototype machine
	WT5000	5,000	Under development
Zhejiang Windey	WD2500	2,500	Prototype machine
	WD5000	5,000	Under development
Zhejiang Huayi	HY3000	3,000	Prototype machine
	HY5000	5,000	Under development
Envision Energy	E6000	6,000	Under development

Source: "Wind Energy" magazine, December 2011 issue as technology, experience, and marketability, requiring that extra attention be given to R&D organizations as early as possible.

5) Significant upstream/downstream integration development trend in the wind power complete-machine manufacturing industry

The precedent that wind power complete-machine manufacturers should get engaged in wind farm development has already existed overseas for a very long time. For example, Suzlon Energy Ltd. of India, and Gamesa of Spain, have all been involved in wind farm development. Gamesa had already introduced this model into China, improving its wind turbine generator system sales performance through cooperation with development enterprises such as China Guangdong Nuclear Power, and China Huadian Corporation. Among all Chinese complete-machine enterprises, Goldwind was the first to adopt this model. Through its subsidiary Beijing Tianrun, Goldwind now boasts successful projects both inside and outside China. Recently, enterprises such as Zhejiang Huayi, Baoding Tianwei, XEMC Wind Power, Changxing Wind

Table 2-4 Descriptions of some Chinese complete-machine enterprises in making their own parts and components

Name of enterprise	Self-made key parts and components
Goldwind	Generators, converters, control systems
Haizhuang Wind Power	Blades, generators, gearboxes, converters, control systems
XEMC Wind Power	Blades, generators, bearings, converters
New United Group	Blades, generators, control systems, towers, gearboxes
United Power	Blades, generators, converters, control systems, gearboxes
Dongfang Electric	Blades, generators, converters, control systems, towers, hubs
Mingyang Wind	Blades, converters, control systems
Sany Electric	Blades, generators, converters, control systems, gearboxes
Sinovel	Converters, control systems, gearboxes, yawing gear rings
Zhejiang Windey	Control systems
Shanghai Electric Group	Generators, converters, control systems
CSR Wind Power	Blades, generators, converters, control systems, nacelle covers, gearboxes
Huachuang Wind Energy	Generators, control systems
Baoding Tianwei	Blades, generators, control systems, towers
Vestas	Blades, generators, control systems, gearboxes
Gamesa	Blades, generators, converters, control systems, gearboxes

Source: "Wind Energy" magazine, February 2012 issue

Power, and Tiandi Wind Power, have also started to operate their own wind power projects.

Another current trend is that many Chinese OEMs make their own auxiliary parts and components. Many companies such as Goldwind, Sinovel, United Power, Mingyang Wind, and Sany Electric, are all developing and producing parts and components based on their own capabilities. Among them, the group of OEMs making their own blades, generators, converters and control systems is the largest, while some other enterprises are engaged in the production of other parts and components of their own, such as gearboxes.

Although OEMs do have many advantages in integrating the wind power industry chain, they must ensure that this is kept in moderation. For R&D and the production of parts and components, it is necessary to invest a lot of capital, organize professional R&D and production teams, and buy expensive processing, production and inspection equipment. When the market is rising rapidly, industry chain integration will bring about a decrease in costs. However, in difficult times, an excessively integrated industry chain would instead become a non-performing asset, and may encumber the continued development of the enterprise.

6) Significant acceleration in the deployment of Chinese wind power enterprises in overseas markets

As China's wind power industry continues to mature and develop, Chinese enterprises continue to strengthen their strategic approach to overseas markets. Since the end of 2007, multiple Chinese enterprises have successively realized the export of wind power equipment. Although the quantity is limited, this was still a strategically important event in the process of merging into the international market.

By 2011, the pace of Chinese enterprises' overseas investment accelerated significantly. Many wind power equipment manufacturers established overseas marketing divisions in order to actively expand into the international market. According to the information published by such enterprises, in 2011, Sinovel acquired a wind turbine purchase order in Brazil and South Africa; United Power, Sany Electric, and Chongqing Haizhuang won orders in the USA; Shanghai Electric acquired an order in India; and Goldwind acquired orders in the USA, Australia, Chile, Ecuador and Ethiopia. For the achievements of other enterprises, see Table 2-5.

In addition, some other enterprises such as China Development Bank, HydroChina

Table 2-5 Descriptions of participation of some Chinese enterprises in foreign markets in 2011

Name of enterprise	Partner	Mode	Countries involved	Relevant information
Goldwind		Investment	Australia	Construction of Mortons Lane wind farm in Australia, including 13 sets of 1.5MW generator units
Goldwind	Illinois State	Investment	USA	Construction of a wind farm project at the Shady Oaks Wind Farm with a total investment of nearly $200 million US dollars and of a scale more than 100 MW
Goldwind	HydroChina Corporation	Cooperation	Ethiopia	Providing 34 sets of 1.5MW complete machines for the Adama Wind Farm
Goldwind	CELEC EP	Cooperation	Ecuador	Providing 11 sets of 1.5MW direct-drive permanent-magnet high-altitude type generator units
Goldwind		Sales	Chile	Providing 23 sets of 1.5MW generator units for Negrete Wind Farm
Sinovel	PPC of Greece	Cooperation	Greece	Developing a land wind farm and an offshore wind farm, and building a production base in Greece. (but given the current situation in Greece, the projects is on hold)
Sinovel	Desenvix	Cooperation	Brazil	Will provide 23 sets of wind turbine generator systems for the wind farm located in Sergipe region, Brazil
Sinovel	Mainstream	Cooperation	Ireland	In the next 5 years, both parties will jointly develop and construct a 1000MW wind power project in Ireland
Xiangtan Electric	Fisher Energy of USA	Cooperation	USA	Exporting 6 sets of 5MW offshore wind power complete machines
Zhongneng Wind Power		Cooperation	South Korea	Exporting 1.65MW blades
NGC	Alstom of France	Cooperation	Spain	Exporting gearboxes complementing 1.67MW generator units
NGC	Suzlon	Cooperation	India	Exporting gearboxes complementing 1.5MW generator units
Sany Electric	AVIC International Renewable Energy	Bidding	USA	Developing a 10MW wind power project in Texas and supplying 5 sets of 2MW generator units
XEMC Wind Power	Gaelectric Holdings Plc	Cooperation	Ireland	A sales contract on 6 sets of XV90 wind turbine generator system complete machines
XEMC Wind Power		Sales	Argentina	Exporting a total of 300MW of wind turbine generator systems
XEMC Wind Power		Sales	Maldives	Exporting a total of 50MW of wind turbine generator systems
Longyuan Power	Gamesa	Cooperation		Global wind farm development
Longyuan Power	Melanchthon	Cooperation	Canada	Equity acquisition agreement on a 100MW wind power project
Haizhuang Wind Power		Sales	USA	Exporting 2 sets of 2MW wind turbine generator systems
Shanghai Electric Group	KSK Energy	Cooperation	India	Exporting 125 sets of 2MW wind turbine generator systems
United Power		Investment	Brazil	Investing the possibility of building a factory
United Power		Sales	USA	Supplying 6 sets of 1.5MW generator units for the Corpus Christi project in Texas

Source: "Wind Energy" magazine, November 2011 issue

Corporation, China Datang Corporation, and CECEP Investment Company, also actively explored overseas wind farm investment and construction projects, boosting the export of Chinese-made wind power equipment while acquiring the construction and operation rights in a variety of overseas wind power projects. As a Chinese wind power equipment inspection and certification agency, the China General Certification Center actively promoted international recognition of Chinese wind power equipment inspection and certification and has already obtained recognition by some countries in Africa, Latin America and Southeast Asia, eliminating trade barriers in export of Chinese wind power equipment.

As Chinese wind power enterprises become increasingly important in the international market, the industrial community should also work hard to study foreign economic/trade policies and patent protection knowledge to avoid conflicts in areas such as intellectual property rights, employment, and economic/trade cooperation. Fair competition should also be maintained among Chinese enterprises so that the overall interests of Chinese wind power enterprises can be protected.

2.2 Current Status of Developers

2.2.1 Industry Scale

For a long time, Chinese wind farm development enterprises have mainly been large-scale state-owned electric power enterprises. Now, there are already over 60 enterprises (excluding branch companies) that are participating in wind farm investment and development in China. With the exception of the several major central government administered enterprises, the scale of the wind farm development of other enterprises is still very small. In general, Chinese wind farm development enterprises can be classified as follows:

1) Large-scale central government administered enterprises: including Guodian (Longyuan), Datang, Huaneng, Huadian, CPI, CGNPG, CNOOC, CECEP, Shenhua (Guohua), China Three Gorges Corporation, China Resources, State Grid, SinoHydro Group, and HydroChina Corporation;

2) Local state-owned enterprises: such as Beijing Jingneng, Tianjin Jinneng, Shanghai

Shenergy, Shandong Luneng, Guangdong Yudean, Ningxia Power Generation Group, Shanxi International Electricity Group, Hebei Construction & Investment Group (China Suntien Green Energy), Fujian Energy, Zhongmin Energy, Fujian Investment & Development Group Co., Ltd..

3) Private and foreign-funded enterprises: such as Heilongjiang Zhongyu Investment, Tianjin (Hebei) Bode, China WindPower Group, GCL Hong Kong, Shanxi Yunguang Wind Power, Wuhan Kaidi, Daoda Heavy Industry, Tongliao Taihe, Honiton Energy, HKC Energy, and UPC.

4) Complete-machine manufacturers participating in wind farm development: such as Goldwind (Tianrun), Gamesa, Zhejiang Huayi, Baoding Tianwei, Changxing Wind Power, Tiandi Wind Power, and XEMC Wind Power.

In 2011, the Top 10 Chinese wind farm developers implemented a total installed capacity of 13.43GW, a 660MW decrease compared to the previous year. The total market share of these ten enterprises accounted for 76.2% of the newly added installed capacity nationwide, 1.8% more than the 74.4% in 2010.

In 2011, while the new installed capacity of wind farms decreased slightly compared to 2010, China Guodian Corporation (including Longyuan Power and GD Power) added new wind power capacity of 3860MW, a 370MW increase compared to the previous year, continuing to maintain its position as the leading wind farm developer in China. Companies whose volume decreased compared to 2010 include: Huaneng, with a decrease of 942MW; CGNPG, with a decrease of 490MW; China Suntien Green Energy, with a decrease of 185MW. Datang basically kept stable and Huadian, Guohua, CPI, China Resources and Jingneng all saw slight increases.

For the installation data and market ranking information of China's Top 10 wind farm developers in 2011, see Tables 2-6 and 2-7.

2.2.2 Development Characteristics and Trends

During the "Eleventh Five-Year Plan" period (2006-2010), large-scale central government-administered enterprises and local state-owned enterprises became the major players in China's wind farm development, with close to 90% of wind power projects developed in China over the recent years invested in, constructed and completed by these corporations. Construction of large-scale wind power bases and the launch of

Table 2-6 Top 10 developers in terms of newly added wind power installed capacities in China in 2011

S/N	Developer	Newly installed capacity/MW	Market share/%
1	China Guodian Corporation★	3,860.5	21.9
2	China Datang Corporation	2,235.1	12.7
3	Huaneng Group	2,229.0	12.6
4	China Huadian Corporation	1,104.0	6.3
5	Guohua	1,094.5	6.2
6	CPI Corporation	866.3	4.9
7	China Resources	796.1	4.5
8	CGNPG	527.0	3.0
9	Jingneng	372.0	2.1
10	China Suntien Green Energy	343.6	1.9
Others		4,202.9	23.9
Total		17,630.9	100.0

★ China Guodian Corporation is composed of Longyuan Power and GD Power.

Source: "Wind Energy" magazine, March 2012 issue

Table 2-7 Top 10 developers in terms of cumulative wind power installed capacities in China in 2011

S/N	Developer	Cumulative installed capacity/MW	Market share/%
1	China Guodian Corporation★	12,861.3	20.6
2	Huaneng Group	8,578.0	13.8
3	China Datang Corporation	8,007.1	12.8
4	China Huadian Corporation	3,829.9	6.1
5	Guohua	3,440.1	5.5
6	CPI Corporation	2,944.9	4.7
7	CGNPG	2,891.5	4.6
8	China Resources	1,773.4	2.8
9	Jingneng	1,686.3	2.7
10	China Suntien Green Energy	1,278.6	2.1
Others		15,073.4	24.2
Total		62,364.2	100.0

★ China Guodian Corporation is composed of Longyuan Power and GD Power.

Source: "Wind Energy" magazine, March 2012 issue

Data Link

According to the data from the China Hydropower and Water Resources Planning and Design General Institute, by the end of 2011, all state-owned enterprises nationwide provided a cumulative wind power grid-connected capacity of 37.98GW, accounting for 79.4% of the total wind power grid-connected capacity (47.83GW) for the whole country. Private enterprises nationwide provided a cumulative grid-connected capacity of 2.18GW, accounting for 4.6% of the whole country's total grid-connected capacity. Foreign-funded enterprises nationwide provided a cumulative grid-connected capacity of approximately 630MW, accounting for 1.31% of the whole country's total grid-connected capacity. Sino-foreign joint ventures nationwide provided a cumulative grid-connected capacity of 7050MW, accounting for 14.7% of the whole country's total grid-connected capacity.

By the end of 2011, China's five major power generation groups provided a cumulative grid-connected capacity of 27.1GW, accounting for 57% of the whole country's total grid-connected capacity. The China Guodian Corporation was ranked No.1 in terms of domestic wind power grid-connected capacities, providing a cumulative grid-connected capacity of 9.81GW. The China Huaneng Group and Datang Group were ranked second and third respectively, providing 6.58GW and 5.74GW. Other individual investment enterprises basically maintained a steady development status. (See Table 2-8)

Table 2-8 Construction status of the whole country's major wind power investment enterprises in 2011

S/N	Investment enterprise	Cumulative grid-connected capacity by the end of 2011/MW
1	Guodian	9,812.9
2	Huaneng	6,581.0
3	Datang	5,743.0
4	Guohua	2,353.0
5	Huadian	2,837.1
6	CGNPG	2,200.6
7	CPI	2,124.5
8	China Resources	1,382.8
9	Three Gorges	1,340.3
10	Others	13,460.4
Total		47,835.6

Sources: Hydropower and Water Resources Planning and Design General Institute; National Wind Power Information Administration Center; 2011 China Wind Power Construction Results Statistics and Assessment Report.

offshore wind power projects, in particular, have caused an increase in the scale of wind power projects, thereby causing an increase in upfront investment, reducing investment opportunities for other mid- and small-sized wind power developers, such as private enterprises. Since the beginning of the "Twelfth Five-Year Plan" period, the central government has initiated guidelines focusing on both large base construction and the decentralized development of wind power. Some inland regions have begun to plan wind power development projects according to local conditions. The number of these projects is fairly large, but their scale is typically small, bringing opportunities to mid- and small-sized wind power investment enterprises, as small projects are involve less up-front investment and are less competitive to obtain the permits.

In 2011, the static average investment cost of construction of on-land wind farms in China[1] dropped to approximately 7000~8000 yuan/kW, while enthusiasm for wind farm investment gradually decreased. This was mainly because the central government executed a tight monetary policy, causing some banks to reduce credit limits on renewable energy sources such as wind power, making it harder for wind power development enterprises to obtain capital through bank loans. Therefore, wind power development enterprises must change the traditional single credit channel and raise their funds through other financing channels such as IPO and corporate bonds, thereby ensuring the sustainability of wind power development.

In 2011, the National Energy Bureau, based on problems that occurred during wind farm development, operation and maintenance management in China, issued the "Interim Measures for the Management of Development and Construction of Wind Power", determining wind farm project examination and approval procedures and raising specific requirements, including mandating that non-approved wind power projects cannot get electricity price subsidies, that post evaluation must be conducted 1 year after a project is completed, that wind farm operation information must be reported promptly, and that any and all quality incidents that might occur at a wind farm must be reported. These will become the code of conduct that wind power developers must follow in the future in areas such as project examination

[1] Static investment means the current value of construction costs calculated based on the unit prices of construction elements during a base year or month when developing the expected construction costs. It includes the increase of construction costs caused by errors in the engineering workload but does not include added investments during subsequent years or months caused due to risk factors such as price increases, as well as the interest on investment spending caused by the passing of time.

and approval, and operation management.

In addition, in 2011, the National Energy Bureau also issued the "Interim Measures for the Management of Power Prediction and Forecast at Wind Farms", requiring all grid-connected operating wind farms to establish their wind power prediction & forecast systems and power generation planning & declaration working mechanisms before January 1, 2012 and formally start implementing them from July 1, 2012. Power grid scheduling bodies must develop wind farm power generation plans according to the power prediction results transferred from wind farms and the principle of prioritizing wind power scheduling, as well as by comprehensively considering system operation requirements, and notify wind farms promptly. Newly built wind farms must establish wind power prediction and forecast systems and working mechanisms for power generation planning and declaration from the outset. These provisions can help improve the ability of power grid companies to plan wind power scheduling, can increase the consumption ratio of wind power to a certain extent, and can also raise requirements for wind power developers in wind farm operation and management.

2.3 Current Status of Wind Power Service Industry

2.3.1 Wind Energy Resources Evaluation and The Wind Forecast

To better meet the requirements for continuous, orderly and logical planning, development and utilization of China's wind energy resources, from 2008, the China Meteorological Administration, with the support of the National Development and Reform Commission, the Ministry of Finance and other relevant departments, has taken the lead in organizing and implementing the "National Wind Energy Detailed Survey and Evaluation" program. During implementation of this program, China Meteorological Administration has, according to the wind energy resources planning and wind farm site selection requirements and using normative, uniform standards, set up 400 70~120m high anemometer towers in regions of mainland China where wind energy resources were available, having preliminarily established a nationwide on-land wind energy resources professional observation network. This

professional observation network can provide fundamental support for conducting wind energy forecast services and wind farm post-evaluation due to its continuous operation.

China Meteorological Administration's Center for Wind and Solar Energy Resources Assessment improved and optimized the wind energy numerical simulation evaluation models introduced from Canada, Denmark and the USA by absorbing their successful experiences in accordance with China's geographical and climatic characteristics. Utilizing advanced geographical information system (GIS) analysis technology, it had developed a wind energy resources assessment system (WERAS/CMA) suitable for China's climatic and geographical characteristics, offering a horizontal resolution of numerical simulation up to 1km, whose wind energy parameter simulation accuracy can meet all levels of wind power planning and wind farm site selection requirements.

Moreover, while executing this program, the China Meteorological Administration developed a normative and suitable wind energy resources calculation and evaluation system, established a wind energy resource database sharing system, and compiled and improved a series of normative technical documents for the detailed survey and evaluation of wind energy resources. These achievements will all play an active role in conducting future detailed surveys of regional wind energy resources and wind power prediction.

The China Meteorological Administration established the China Meteorological Administration Wind Energy Forecast Business System by adjusting and improving the model's parameterization scheme and operation strategy based on the numerical weather forecast model BJ-RUC and according to wind farm power forecast requirements. Wind farms forecast accuracy was dramatically enhanced by advancing and improving the assimilation technique for high-density land observation data, radar data, satellite data and specialist anemometer tower data.

2.3.2 Construction of a Standard System for Wind Power

China's wind power standards include national standards and industry standards, which are centrally managed by the Standardization Administration of the People's Republic of China. National standards are developed by China's individual specialty standardization technical committees, where technical requirements are unified nationwide. For those technical standards that have no national counterparts but that must be unified within a certain industry in China, the State Council's relevant competent administrative departments or State Council authorized relevant industry associations can develop industry standards as required.

As China's wind power industry continues to develop, individual relevant specialty standardization technical committees nationwide have, through many years of hard work, established a preliminary wind power standards system covering multiple areas such as wind turbine generator system complete machines, parts and components, materials, design, and testing. Regarding standards related to large-scale grid-connected wind turbine generator systems, for example, by 2011, China had already issued and executed 40 national standards, including 10 converted from IEC standards and 1 from AWEA standards. The contents of these national standards cover wind turbine generator system safety requirements, product performance, testing methods, wind energy resources evaluation, and wind farm requirements. There are also another 26 national standards under development and other standards currently under revision.

In addition to national standards, individual relevant industries have also issued many industry standards for the wind power industry, such as the electric power industry standard "DL/T 5191-2004 Code of Construction Acceptance on Wind Power Plant Projects", and the machinery industry standard "JB/T 10427-2004 General Hydraulic Systems of Wind Turbine Generator Systems". These industry standards play an important role in guiding wind turbine generator system design, manufacture, installation, as well as wind farm construction.

At a conference in March, 2010 in Beijing, the National Energy Bureau announced the establishment of the Energy Industry Wind Power Standards Construction Leading Group, the Energy Industry Wind Power Standards Construction Experts Consulting Group, and the Energy Industry Wind Power Standardization Technical Committee (referred to as the Standardization Committee hereinafter). The Standardization Committee then set up standard development work groups according to division of duties and issued the "Wind Power Standards System Framework (discussion draft)" in the form of the Guo Neng Ke Ji # [2010] 16 document, which has drawn up seven major categories

of 173 standards and provides an outline for China to establish and improve its current wind power standards system. As a staged work announcement on the construction of the wind power standards system, on May 8, 2011, the National Energy Bureau approved and issued 17 important standards, including the "Technical Specifications for Grid-Connecting Design of Large-Scale Wind Farms", at the 2nd session of Energy Industry Wind Power Standardization Technical Committee's 1st conference and energy industry wind power standardization working conference held in Beijing, which covers the technical standards urgently needed today for the development of the wind power industry, including large-scale wind farm grid-connection, offshore wind power construction, wind turbine generator system status monitoring, quality of electric energy of wind farms, and wind power key equipment manufacturing requirements, filling in the technology gap.

2.3.3 Testing and Certification of Wind Turbine

As recognized by the China National Accreditation Service for Conformity Assessment, the third-party inspection agencies now providing wind turbine generator system inspection and testing in China include China Electric Power Research Institute's Wind Power Grid-Connection Research and Assessment Center, CGC Wind Test Center, and Northeast Electric Power Research Institute's Laboratory on Electrical Characteristics of Wind Turbine Generator Systems. In general, China already possesses the capability to conduct wind turbine generator system power characteristics testing, quality of electric energy testing, noise testing and load testing capabilities.

To satisfy the needs of wind power equipment field inspection & testing and conducting wind power equipment type certification, China has now built two wind power public testing platforms that are already operational. One is the Zhangbei Wind Power Testing Base of the National Energy Large-Scale Wind Power Grid-Connecting System R&D (Experimental) Center, and the other is Baoding Wind Power Blade & Bearing Inspection Center of the National Energy Key Laboratory of Wind Energy & Solar Energy Emulation and Inspection Certification Technology.

The Zhangbei Wind Power Testing Base is an important part of the National Energy Large-Scale Wind Power Grid-Connecting System R&D

(Experimental) Center constructed by the State Grid Corporation of China. With the financial support of the National Development and Reform Commission and Ministry of Finance, this base was completed in the Manjing area of Zhangbei County, Hebei Province, in 2010. Covering a land lot of some 24 square kilometers and with a total of 30 machine positions, this testing base features a flat terrain, convenient accessibility, good power grid access conditions, and abundant wind energy resources. The Zhangbei Wind Power Testing Base can conduct comprehensive research and testing activities such as wind turbine generator system low-voltage penetrating ability testing, power grid adaptability testing, and wind-PV-storage integrated operation testing.

Located in Baoding City, Hebei Province, the state-level Wind Power Blade & Bearing Inspection Center is a part of the National Energy Key Laboratory of Wind Energy & Solar Energy Emulation and Inspection Certification Technology. Covering a land lot of 35,960 square meters and mainly comprised of a Blade Raw Materials Lab, blade testing workshop, bearing inspection bench and pitch system inspection bench, this Inspection Center can accomplish structural tests, nondestructive tests and wind farm blade tracking tests on blade raw materials, blade parts and components, and full-size blades up to approximately 100m long as well as related tests on multi-MW-scale wind power bearings and pitch systems. Its testing conditions meet international advanced levels. The Phase-I project with blade and raw material testing capabilities at the Inspection Center is already operational. The Phase-II project involves the bearing and pitch system testing benches, and is expected to become operational in 2013.

There are two agencies in China that have been approved by the Certification and Accreditation Administration of the People's Republic of China to conduct wind power equipment certification activities. One is the China General Certification Center, a third party certification agency in China specialized in standards research and quality certification of renewable energy products such as wind energy and solar energy, and the other is the China Classification Society Quality Assurance Ltd., which has enriched certification experiences in both this and many other fields. Chinese certification agencies can conduct wind turbine generator system design certification, type certification, wind farm project certification, and wind turbine generator system components certification.

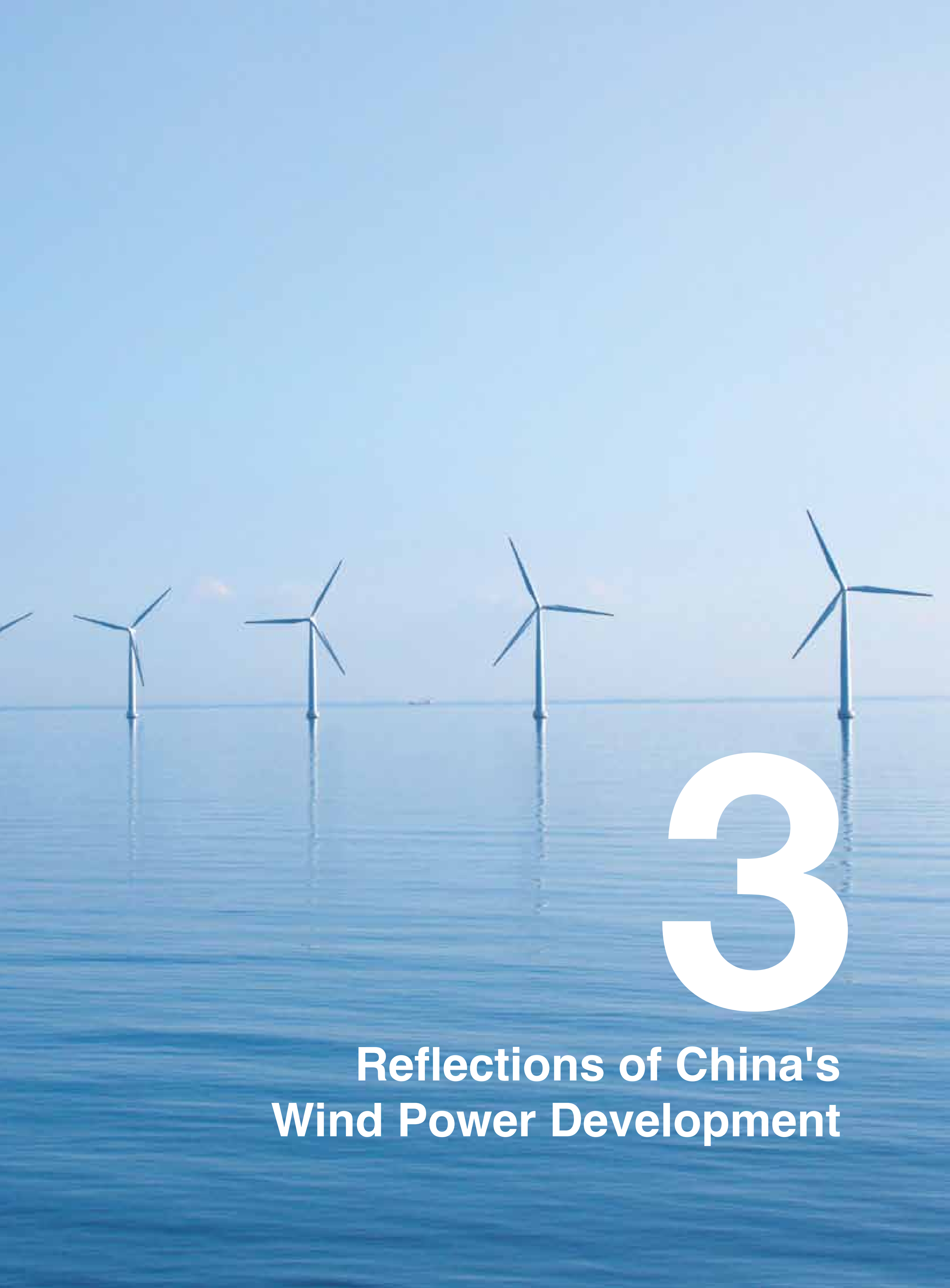
2.3.4 Insurance Service in The Wind Industry

In Europe and North America, where wind power development is mature, the insurance industry and wind power industry are already interconnected. In Europe, North America and Australia, risk management at wind power enterprises is becoming increasingly refined and professional. In addition to all-risk property insurance and machine damage insurance, more and more wind power enterprises are buying all kinds of profit loss policies, such as wind speed insurance, and non-planned operation downtime insurance. Based on actual demands, the insurance industry has also developed some innovative insurance products and services, such as weather/wind resources derivative insurance products, wind power CDM project insurance products, and all-line insurance products covering the entire process of wind power projects. Foreign wind power enterprises are active in buying their insurance policies, while the insurer and the insured also conduct effective communication and work closely together to accomplish risk prevention, aversion and management to achieve a win-win result.

The number of insurance companies providing wind power insurance services in China is not small, including Chinese insurance companies such as PICC Property and Casualty Company Limited, China Ping An Insurance Company, Alltrust Insurance Co., Ltd., and Yingda Taihe Property Insurance Co., Ltd., as well as foreign insurance companies such as Sun Alliance Insurance (China) Limited. However, the alliance between China's wind power industry and insurance industry is still in its early development stage. The scale of the wind power insurance market is still very small, and wind power insurance products are still dominated by traditional insurance products such as corporate property insurance, cargo insurance, contractors insurance, and machine damage insurance.

China's wind power insurance market is advancing slowly. On the one hand, wind enterprises are still not familiar with the insurance business and are relatively conservative in using insurance service. For example, lack of correct understanding of the role and value of insurance, and the types of insurance product that wind power enterprises buy. On the other hand, insurance companies still have a lack of trust in, and knowledge of, China's wind power equipment manufacturing industry, as it is still in its evolution stage. The number of wind power enterprises is large, and the level of their quality control varies, making insurance companies unwilling to enter this field. All these have affected development of the wind power insurance market. Furthermore, the development of third party service agencies in the Chinese wind power insurance market is not mature enough. There is a lack of interdisciplinary expertise, i.e., individuals who have both insurance and wind power knowledge. It is very hard to find authoritative third party agencies that have wind power incident inspection and loss assessment capabilities. It is hard to engage a state-level authoritative professional agency to participate in loss assessment and issue an inspection report in case of equipment claims, and the applicant and the insured can hardly reach an agreement on the loss assessment issue.

In a word, the rapidly developing wind power industry needs the insurance industry to participate more to mitigate the risks, while the large-scale development of China's wind power market will also create a huge emerging market for the insurance industry. The alliance between wind power and insurance is a mutual requirement at a certain stage in the development of these two industries. Today, however, such potential demand has not been fully realized. Therefore, both insurance companies and wind power enterprises in China must continue to deepen their mutual understanding, jointly providing risk prevention, and achieving a win-win outcome through cooperation. Industry associations and wind power inspection and certification agencies must also provide more information services and technical services for their mutual cooperation, thereby promoting steady development of China's wind power insurance market.



3

Reflections of China's Wind Power Development

After developing for nearly 20 years - and especially with the particularly rapid development over the past 6-8 years - China's wind power industry has entered a new development stage, presenting some issues that require further understanding, and raising some problems which require resolution. Over the past 6-8 years or more, ‘large scale’ and ‘high speed have been the themes of China's wind power development. The conflict between speed and efficiency has not been considered significant until now. Starting in 2011, China's wind power development began the transformation towards more concern with efficiency, with an increasing emphasis on quality than merely quantity. Here are some of the issues identified.

Intensified excess production capacity

By 2011,the production capacity of China's major wind power equipment manufacturing industry had already exceeded 30GW. Meanwhile, in 2011, the domestic market demand was just under 18GW, with development in overseas markets just entering the trial stage. This caused more than 40% of China’s production capacity to remain unused. In 2012, excess production capacity of wind power equipment has become even greater, with the total production capacities far exceeding the demands of the domestic market. The first was the need for competition. Only when the production capacity was raised could a company possibly take large orders and realize the benefits of large-scale production, thereby acquiring a definite competitive advantage. The second was the need for acquiring new development sites. Some large enterprises, pressured and attracted by the so-called "Resources-for-Industry" which requires developers to purchase locally, adopted in areas having abundant wind resources, had to build factories locally in order to acquire wind energy resources, then use such resources to acquire orders. The expansion was thus forced and often illogical. This brings the current issues into clearer perspective.

The application of new technologies and concepts without cautious planning process and guidance

China's wind power industry started relatively late compared with foreign industries. Initially most OEMs simply purchased engineering drawings and put them directly into production.

True innovation requires that imported technology be absorbed through fundamental research and scientific experimentation, along with the accumulation of knowledge and experience over time. Nevertheless, batch application of some newly developed, immature technologies and concepts, such as large turbines, large blades, and low wind speed and high altitude wind turbine technologies, were made rapidly without giving thorough consideration to possible risks.

Some manufacturers were only interested in results, pursuing large turbines and new models that could be rapidly produced and mass installed, without attaching sufficient importance to the digesting and absorbing of imported technologies, the ability to innovate, and product quality. Their mastery of core technologies, such as integrated design of wind turbines, load optimization calculation, control strategy optimization and grid-connection performance was insufficient, resulting in the unstable quality of some wind turbines a number of severe wind turbine quality incidents, which present a serious danger to wind power development.

Offshore wind power imposes more stringent requirements on the wind turbine's stability and technical conditions. For example, offshore turbines face more complex loads, have higher anti-corrosion requirements, may encounter floating ice in northern sea areas, typhoons in southern sea areas, and are required to be almost maintenance free. Having experimented for several years without really mastering the core technologies involved in onshore wind turbines, Chinese enterprises may very likely pay a high price by rushing hastily into the offshore wind power market.

It is expected that in 2012, the scale of the domestic market will be reduced and that international market development will be fairly slow. Meanwhile, wind power developers will focus more on the quality of wind power equipment, and the efficient output of wind farms. In 2012, the manufacturing industry needs to make continuous efforts to enhance technologies, product quality and services.

Lack of Self-Regulation in the Industry, Lack of Regulated Competition

China's wind turbine manufacturing industry lacks self-regulation and has not formed standards regulate competition in the industry. Most manufacturers use low-pricing strategies, offer low price quotes, and lack a rational attitude,

leading to over-competition. In 2011, competition among wind turbine manufacturers became more fierce and chaotic, which was directly reflected by the price competition, with price of complete wind turbines dropping from 6500 yuan/kW in 2008 to below 3700 yuan/kW in 2011.

It is generally believed within the industry that it is very difficult to maintain such low prices for wind power equipment and at the same time invest sufficiently in areas such as technology improvement and quality assurance. Price reductions have compressed profit margins and R&D investment of OEMs and component manufacturers, laying the basis for serious problems in the long-term. Such over-competition has also forced Chinese OEMs to enter the offshore wind power market - a higher-risk field - ahead of schedule.

Currently, China's efforts in developing overseas markets are very limited. The chaos resulting from domestic over-competition has not been brought to the international market, although there is oversupply of turbines in the international market as well. It is hard for developers to quantitatively assess this gap, given the complex methods for the inspection and confirmation of generator units and the lack of suitable inspection methods.

Policy loopholes in the "Renewable Energy Law"

The law and policy system related to renewable energy development is far from perfect. The main legislation for China to develop renewable energy is the "Renewable Energy Law of the People's Republic of China". The law was promulgated in 2005 and executed in 2006. It was modified again in 2009. The modified law was executed in April 2010 (referred to as the "New Law" hereinafter). In the modified New Law, the wording of some core clauses is still ambiguous and vague, and the responsibilities, rights and interests of the various parties in renewable energy development are not clearly defined, which has affected its seriousness, impartiality and scientific nature, providing an abundance of legal loopholes.

The so-called "guaranteed acquisition" of wind power by power grid companies as stipulated in the New Law is an example. "Guaranteed" as used in this context can have different interpretations, and the understanding of this word by parties on the power grid side and parties on the power generation side are very different. Since the Implementation Rules have yet to be promulgated, authoritative and lawful interpretations are not available, neither can examination and supervision be conducted. Monopolistic power grid companies are able to conduct wind power acquisitions or require wind power operators to curtail their production without any justification or legal basis. The law has lost its ability to constrain monopoly enterprises. The legitimate rights and interests of the wind power industry are not protected and it is hard to appeal.

In another example, the New Law requires wind power operators to be responsible for assisting in ensuring the safety of the power, but provides no express provisions regarding what this entails. Power grid companies can and do enable or disable connections between wind power projects and their power grids with the excuse of guaranteeing power grid safety without any justification and with no recourse. However, power grid enterprises which have tremendous responsibility on the safety of power generation facilities are neither required to be responsible for protecting power generation enterprises, nor are required to be responsible for providing assistance. As early as 2009, relevant government departments had already discovered and reported on these loopholes, but such reports unfortunately received no attention. These legal loopholes have made enforcement of the law difficult. In fact, some legal responsibilities cannot be determined on the basis of these clauses. The result has been an increasing degree of apparently arbitrary curtailment of wind power generation, and all areas of our community have requested that the Standing Committee of the National People's Congress to urgently interpret the law or revise the "Renewable Energy Law of the People's Republic of China".

Problems in wind power standards, norms and public facilities, and the technical service industry

Requirements for grid connections for wind power are more stringent than those for all other generation technologies. The wind power grid connection standard was issued in 2011. However, this law only represents the interests of the power grid companies. During the drafting of the standard there was no dialogue or consultation with the wind power operators. The grid code for wind power grid-connection is more rigorous than those for thermal power and hydro-power, and some of the requirements are unnecessary. These excessive requirements have wasted resources and restricted the effective development of wind power, as will be seen in the coming months and years.

Wind power generator inspection agencies and monitoring standards are one-sided, and not transparent.The inspection of either wind power equipment or other renewable energy equipment, especially mandatory inspections, should be conducted by independent and fair third party or public agencies. This should be true in any industry. Currently, however, the inspection agency that drafts China's low-voltage ride through inspection standard and implements inspections is a subsidiary of the State Grid Corporation of China, which is hardly impartial, and the rules that guide them are not transparent. In additiona, there are few wind power plant inspection agencies and fees are too expensive. In 2011, the central government mandated that low-voltage ride through technical inspections must be conducted on every model of wind turbine generator system equipment, but there are not enough agencies and inspectors. Currently, for LVRT inspection there is only one inspection agency, the inspection process is very tedious and time-consuming, and the waiting period for equipment to be inspected is too long - oftentimes several months. In addition, after replacing parts and components as per the inspection, further waiting is required for re-inspection and the fees are very expensive; and the machines lie idle while waiting.

Errors of the existing wind power prediction and forecast system for wind farm projects are significant. In 2011, the central government required the establishment of wind power forecast systems by June 2012, part of which has already been completed. However, the accuracy and effectiveness of these systems is is low, with errors usually around 20%.

The role of wind power related parties is not clearly defined

Local governments are highly enthusiastic, but are short-sighted in seeking political achievementsrior to July 2011, there were basically no restrictions, with all regions enthusiastically driving project approvals, and the direct result was that more than 90% of all wind farm projects were approved by local governments. Some local governments have little knowledge or understanding of the industry, and its relation to the grid companies, leading to difficulties with completing and connecting projects to the grid. Since the short-term direct contribution wind power project construction to

the local economy was not extensive, by 2011, passion for developing such projects had fallen somewhat. In order to increase the local GDP and local employment rate, local governments were instead turning their enthusiasm to bringing in related equipment manufacturing industries with the purpose of increasing local tax revenue and employment rates and attracting the equipment manufacturing industry to build local factories and requiring developers to use local equipment. This iss the so-called "Resources-for-Industry" phenomenon.ower grid and scheduling companies pursuing conomic benefits while avoiding social responsibilities. In 2011, by taking advantage of the modification of the Renewable Energy Law and utilizing the low-voltage ride through technical inspection and rigorous wind power grid-connecting technical standard,to raise the wind power grid entry thresholds. Although slowed downthe development of renewable energy, the power grid companies obtained a temporary stability, which suited their demand for economic benefits. This situation, however, does not suit the requirement that state-owned enterprises, especially large-scale monopolistic ones, should focus on social benefits as well as their profits.

Wind power equipment enterprises expand


Vestas

by establishing local manufacturing in good wind resource locations, exacerbating the problem of excess production capacity. The equipment manufacturing industry relies on the market to sell their equipment. Project development resources are the basic condition necessary for equipment manufacturers to gain their market share, and their market will be guaranteed once such resources are acquired. Therefore, to obtain resources, they must build factories locally and are forced to pursue large scale development, without considering whether or not the local area is really best suited to the building of factories. This resulted in the production capacities of China's renewable energy equipment manufacturing industry continuing to increase, despite production capacities already being in excess in 2011.

To solve the all of the issues mentioned above, it isnecessary to start by clearly defining responsibilities and providing a impartial third parties to promulgate, especially the government, to implement and enforce the rules.

Technology-enhanced, but still in urgent need of innovation

Currently, wind power operation and construction management, and the reliability of wind power equipment are still the most pressing issues facing China's wind power industry. Moreover, the percentage of directly imported high-added-value critical parts and components such as converters, main shaft bearings and control system is still more than 50%.

Wind power technologies are also seeing new changes. On the one hand, development of low-wind-speed wind turbines has emerged because of wind curtailment issues, as well as the central government's efforts to promote decentralized development. Wind turbine manufacturers are bringing out matching products in quick succession. Goldwind's low-wind-speed turbines are already in production; both Sinovel and United Power have released 1.5MW low-wind-speed turbines, and Sany Electric has launched its 2MW low-speed turbines. On the other hand, OEMs - in order to display their strength - are beginning to make large-scale wind turbines and have developed 5MW and 6MW wind turbines in quick succession. Quite a few enterprises, including Sinovel, have indicated that they have already started R&D on 10MW wind turbines.

Compared to onshore wind power, offshore wind power development is far more difficult. The foreign wind turbine technologies that most Chinese wind turbine manufacturers purchased directly had not been completely mastered, but nevertheless, the wind turbines were directly moved out to sea. In addition, the number of engineering ships and availability of construction equipment designed and developed for use in offshore wind power construction is very limited. Although China is working on relevant offshore wind power standards, only a few, such as the Premilimary Guidance for Offshore Wind Power Development and Construction, are available today. In the meantime, several strong Chinese cable manufacturers have been developing 220kV submarine cables suitable for offshore coastal wind power, but they are not yet ready for deployment. By the same token, offshore wind power requires urgent technological innovation, which is also the key to the development of the wind power industry.

Wind Power Incidents in 2011 presenting a fast increasing trend

In recent years, the disadvantages related to high-speed development began to reveal themselves. Starting from the second half of 2009, a series of incidents happened in succession, including tower collapses, blade ruptures, nacelle fires, personal electric shocks and engineering accidents, leading to more than ten casualties and damage to more than ten sets of generator equipment.

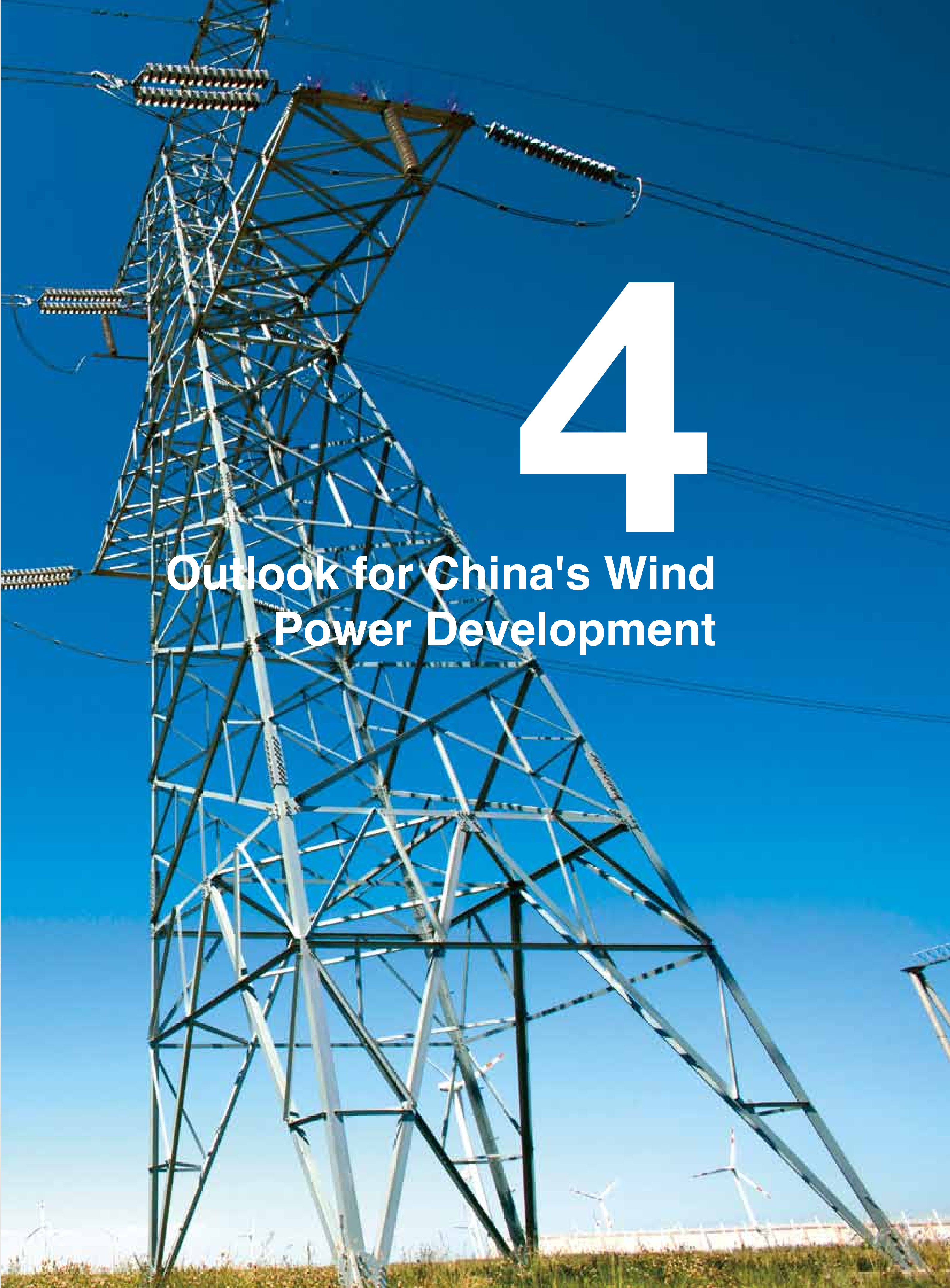
Since 2011, an increasing number of incidents of turbines tripped off the grid have occurred with wind turbine generator systems. There were 193 incidents of this kind across the whole country during January-August 2011 alone. The State Electricity Regulatory Commission has analyzed these several of these incidences and identified four major issues: a) most wind turbines have no low-voltage ride through capability; b) there are many quality problems in wind farm construction; c) connection of a large-scale wind farms could threaten the stability and safety of the power grid; d) and wind farm operation management is weak.

Relevant government agencies have attached very high importance to the phenomenon of thedramatic increase of wind power incidents in 2011. The State Electricity Regulatory Commission issued wind power safety regulations, the National Energy Bureau issued rules for low-voltage ride through inspection, and the State Grid Corporation of China released the national standard on technical requirements for wind power grid-connection. The successive promulgation of a series of policies, regulations and technical standards has imposed higher requirements on wind power grid-connection than all other power supplies. In order to guarantee power grid safety, in 2011, individual wind farms started large-scale grid-related technological upgrades, conducting low-voltage ride through technological upgrades on their generator units and adding high-standard SVG reactive power compensation devices to wind farms. Wind power enterprises have additionally invested approximately 10 billion yuan RMB for this, thus increasing their financial burden. However, merely adopting these measures rather than enhancing the quality level of conventional electric power equipment and facilities can not truly solve the wind power grid disconnection issues.

Occurrences of large-scale wind curtailment in 2011

The apparent occurrences of the wind curtailment in China began in 2010. In 2011, the curtailment also reached an unprecedented scale, especially in northeast and northwest regions of China, where the phenomenon became increasingly frequent. No explanation was provided for these occurrences, with grid companies carrying out curtailment in an increasingly arbitrary fashion. According to incomplete statistics, the quantity of wind generated electricity curtailment nationwide during the whole of 2011 exceeded 10 billion kWh, which is equivalent to a loss of 3.3 million tons of standard coal and the emission of 10 million tons of carbon dioxide into the atmosphere. In 2011, wind power equipment utilization hours were significantly reduced. The average utilization hours of grid-connected wind power installations nationwide dropped from 2047 hours in 2010 to 1903 hours in 2011, a reduction of 144 hours. Because of curtailment, wind power enterprises incurred a loss (excluding revenues from carbon trade) in excess of 5 billion yuan RMB, accounting approximately for 50% of the total profit of the wind power industry. In 2011, there seemed to no longer be any benefit to the development of wind power.

4 Outlook for China's Wind Power Development



4.1 Trends of China's Wind Development

Combining Centralized and Discentralized Development

In 2011, the National Energy Administration initiated the development concept of focusing on both centralized and decentralized development. It proposed strengthening power grid construction and scheduling adjustments to ensure that the power grid can better handle a diverse variety of power sources, and constructing grid-friendly wind farms and wind-power-friendly electric power systems, developing wind power prediction technology, large-scale energy storage technology, electrical power system real-time operation scheduling and control management technology, constructing ultra high voltage (UHV) intelligent power grids and realizing the optimal deployment and consumption of wind power nationwide.

The decentralized wind power development approach can also be utilized in some areas of central and eastern China, where wind energy resources are less optimal and land resources limited. But the electricity produced can be distributed to nearby power grids. It is expected that the development of decentralized wind farms in inland regions will account for an increasingly bigger percentage of wind development in China in the future.It also requires technology upgrade of turbine manufacturers to focus on turbines for low wind speed.

Combining Onshore and Offshore, and Focusing on Onshore

The focus of China's wind farm development will mainly be onshore. Nevertheless, the offshore wind power is a clear development trend for the future. In addition to the need to improve technologies, offshore wind power is restricted by conflicts with other commercial and military uses of the intertidal and coastal zone.also mainly restricted by resources. Therefore, before 2020, offshore wind power development will still serve as only a complement to onshore development, with all circles of the wind power sector still focusing their main efforts on the development of onshore wind power.

Stabilizing the Domestic Market, Actively Exploring International Market

As the Chinese wind power industry continues to mature and advance, Chinese wind power investors and manufacturers are simultaneously speeding up their pace of internationalization. When transitioning from "localization" to "internationalization", Chinese wind power companies have encountered great challenges. First, Chinese wind power equipment manufacturers must establish their own reputation for product quality and adapt to the rules of overseas markets. The biggest competitive advantage that Chinese wind turbine manufacturers have is relatively low costs. At the same time, due to lack of publicly available wind turbine operation data, Chinese wind turbines have no track record in the international market. In addition, exporting wind turbines requires tremendous capital, logistics, management and service experience. Moreover, many countries have already started to restrict overseas competition to protect their own green energy industry. Countries such as Brazil and Canada have implemented "localization" requirements on wind power projects. The United States International Trade Commission has further started "anti-dumping & anti-subsidy" investigations into Chinese-made wind towers as well as the more well known cases involving PV products. Therefore, Chinese wind power enterprises must increase their understanding of the market and overcome these multiple difficulties. Only in this way can they realize their ambition for overseas development.

4.2 Short-, Mid- and Long-Term Development Goals

The development of wind power in China has been stable since 2010. In 2012, the wind power manufacturing industry entered the high-cost meager-profit stage of development. Some enterprises will opt to exit the market. However, after such changes, the industry will become a stronger and be more competitive in China's energy structure.

The "China Wind Power Development Road Map 2050" report, jointly published by the Energy Research Institute of the National Development and Reform Commission and the IEA, proposed that the focus of future wind power layout should

be as follows:

a) Before 2020, focus should be on onshore wind power and the conducting of offshore wind power pilot projects; by 2020, wind power installed capacity should reach 200GW.

b) In 2021-2030, focus should be on the development of both onshore and coastal wind power and the conducting of open-sea wind power pilot projects; By 2030, wind power installed capacity should reach 400GW.

c) In 2031-2050, focus should be on the realization of the overall development of onshore wind power and coastal/open-sea wind power in eastern, central and western regions. It has also set wind power development goals for China based on different scenarios: By 2050, wind power installed capacity should reach 1,000GW; by 2050, wind power should meet at least 17% of the national electricity demand.

4.2.1 Short-Term Development Goals: Before 2020

The "China Wind Power Development Road Map 2050" proposed that as far as the short-term is concerned and in consideration of basic condition of the power grids and possibly existing constraints, the primary goal is to stablize the wind power market and establish a wind power industrial system leading technical standards and norms while focusing on onshore wind power assisted by coastal (including intertidal zones) wind power pilot projects. This translates into an annual market of approximately 15GW per year, and strives to increase the cumulative wind power installed capacity to 200GW by 2020.

By that time, not taking into consideration cross-province power transmission costs, the cost of wind power will reach a level equivalent to that of conventional power generation (coal-fired electricity) technologies. Wind power will become a more prominent part of the power supply structure, accounting for 10% of the total installed capacity of electric power, meeting 5% of the total electricity demand.

During the "Thirteenth Five-Year Plan" (2016-2020) period, it is generally estimated that China's economic development speed will drop to below 7%. China's economic growth pattern will be transformed, its level of energy efficiency will have improved, and its electricity demand elasicity will reduced. Due to the increase of the total installed capacity for electric power generation, however, it is expected that China's total power installations will reach at least 1800-2000GW by 2020. If wind power installation is to account for 10% of total installations nationwide, an installation scale of at least 200GW will be required. If wind power installation is to account for 15% of the total installation nationwide, the installation scale must reach 300GW. Therefore, it is expected within the industry that by 2020, the wind power installation scale will fall between 200-300GW, very likely reaching somewhere around the 250GW mark.

4.2.2 Mid- and Long-Term Development Goals

In the long run, as the wind power industry develops, the technology of wind turbine generator systems and related products will be further improved, R&D work on offshore wind turbine generator systems will also further advance, the generating capacity of wind turbine generator systems will increase, and the construction costs as well as operation and maintenance costs of wind farms will all fall. Meanwhile, the related technical problems in wind power grid-connection will gradually be solved, the power grid construction and operation mode will be improved, the consumption capacity and transmission conditions of the power grid will be improved, and the transmission cost of wind power will reduce. According to the predictions of the "China Wind Power Development Road Map 2050", by 2030 and 2050, the wind power installation scale will reach 400GW and 1000GW and meet 8.4% and 17% of the electricity demand nationwide, becoming one of the five major power supplies. Details are as follows.

- 2020~2030

Not taking into consideration cross-province transmission costs, the advantages of wind power in the electricity market in terms of economical efficiency will begin to emerge, because the cost of wind power is lower than that of coal-fired electricity. If the cross-province power transmission costs are taken into consideration, however, the full cost of wind power is still higher than that of coal-fired electricity. If the resources and environment costs of coal-fired electricity are taken into consideration, then the full cost of wind power will be lower than that of coal-fired electricity. The scale of the wind power market will further expand, both onshore and offshore development will advance, new installations each year will reach approximately 20GW, and approximately 30% of new installations nationwide will come from wind power. By 2030, the cumulative wind power installation will exceed 400GW, its ratio in the nationwide power generation will reach 8.4%, and its ratio in the power supply structure will expand to approximately 15%, providing an increasingly stronger role in meeting electricity demand, improving energy structure, and supporting the national economy and social development.

- 2030~2050

Wind power and electric power systems and energy storage technologies will continue to advance and wind power and electric power systems will be further integrated. The scale of wind power will further expand, onshore/coastal/open-sea wind power will all develop to different extents, and the new installed capacity each year will reach approximately 30GW, accounting for about half of the new installed capacity nationwide. By 2050, wind power will be able to provide about 17% of the electricity for the whole country. Wind power installation will reach 1000GW, accounting for approximately 26% of the power supply structure. Wind power will become one of the major power supplies in China and will also be widely applied in other fields such as the manufacturing industry.

4.3 Development Direction and Tasks of Wind Power

Onshore Wind Farms

Currently, onshore wind farm development and construction technology is already quite mature. In the future, the focus should be on improving micro-siting technology and continuing to enhance the quality and reliability of wind farms in terms of planning, design and operation, especially those wind farms located in complex terrains. Before 2015, pertinent in-situ system design and optimization plans will be proposed based on the planning and layout of wind power bases and the arrangement of wind turbine generator systems. By 2020, the optimized planning, design and operation plans for wind farms located in complex terrains will be basically and comprehensively realized.

Offshore Wind Farms

Prior to 2020, the depth of offshore wind farms developed in China will be mostly less than 25m. Before 2015, China will basically master the shallow-sea wind farm foundation, construction

and operation and maintenance technology. In response to the deepening understanding of the development of offshore wind power, China will start deep-sea wind farm development from 2020, with the aim of starting to build deep-sea wind farms before 2030.

After 2020, wind power projects may start in open seas where the water depth is more than 50m. At that time, it will be necessary to use large floating cranes and transport barges that have more advanced maneuverability and more powerful weather and environment adaptability.

Wind Turbine Generator Systems

According to the "China Wind Power Development Road Map 2050" released by International Energy Agency and Energy Research Institute, the wind power technology and offshore wind power continue to develop, the overall trend of wind turbine generator systems is toward the up scaling and diversification of single-machine capacities. In the meantime, the development trend can be identified as follow.

- During 2012-2015

1) The average annual wind power installed capacity in China will be 15GW, including an onshore wind power of approximately 14GW/year and offshore wind power of approximately 1GW/year.

2) 3-5MW wind turbine generator systems are mainly used for the construction of offshore and some onshore wind power bases. An annual production of 8GW is required.

- During 2015-2020

1) Offshore wind power will enter the large-scale development stage.

2) Wind turbine generator system equipment manufacturers must provide an annual supply capability of 18GW, including 13GW/year for onshore wind turbine generator systems and

73

5GW/year for offshore wind turbine generator systems.

3) Approximately 500MW must be decommissioned or upgraded technologically each year; 2500MW total capacity during the whole period.

4) Application of 5MW and higher level bigger wind turbine generatorr systems will start in offshore wind power projects, and supply capabilities of an annual average of 1,000-1,300MW must be ensured.

- During 2020-2030

1) An annual average production and supply capacity of 24GW for wind turbine generator systems will be needed, including 19GW/year for onshore wind turbine generator systems and 5GW/year for offshore wind turbine generator systems.

2) 39GW must be decommissioned or accept technological upgrading during the whole period.

3) China will enter the large-scale offshore wind power development stage. 5-10MW generator will be mainly used for meeting this market demand, and an annual production of 22GW will be required.

- During 2030-2050

1) An annual average production and supply capacity of 50GW for wind turbine generator systems will be needed, including 44GW for onshore wind turbine generator systems and 6GW for offshore wind turbine generator systems.

During the same period, wind turbine generator systems with a total capacity of 400GW must be decommissioned or accept technological upgrading. (See Figure 4-1)

2) The mass decommissioning of wind turbine generator systems of 3MW and lower will start. At that time, the demand for wind turbine generator systems will witness a new peak. 3-5MW wind turbine generator systems will gradually replace their 3MW-and-lower counterparts to become the mainstream wind turbine generator systems on the market.

3) The annual supply capability of these generators must reach 30-50GW.

4) 5-10MW generator units must reach an annual supply capability of 5-10GW, and deep-sea wind power development application requires wind turbine generator systems of 10MW and higher to reach an annual supply capability of 1-2GW. (See Figure 4-2)

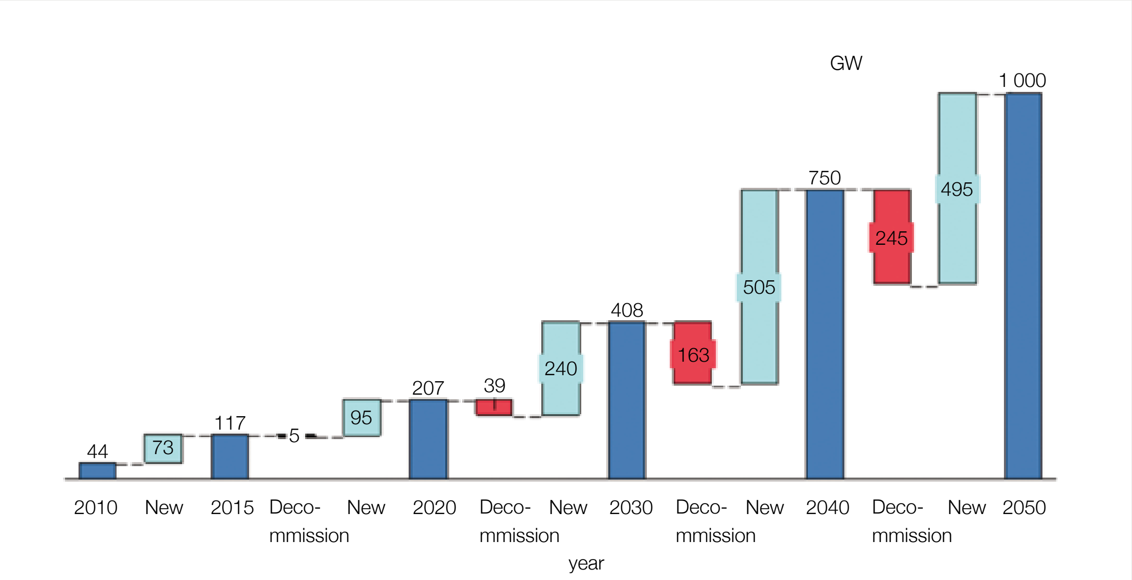


Figure 4-1 Estimate of Scale of New and Decommissioned Wind Turbine Generator Systems in China during 2010-2050

Source: "China Wind Power Development Road Map 2050", 2011, IEA, ERI

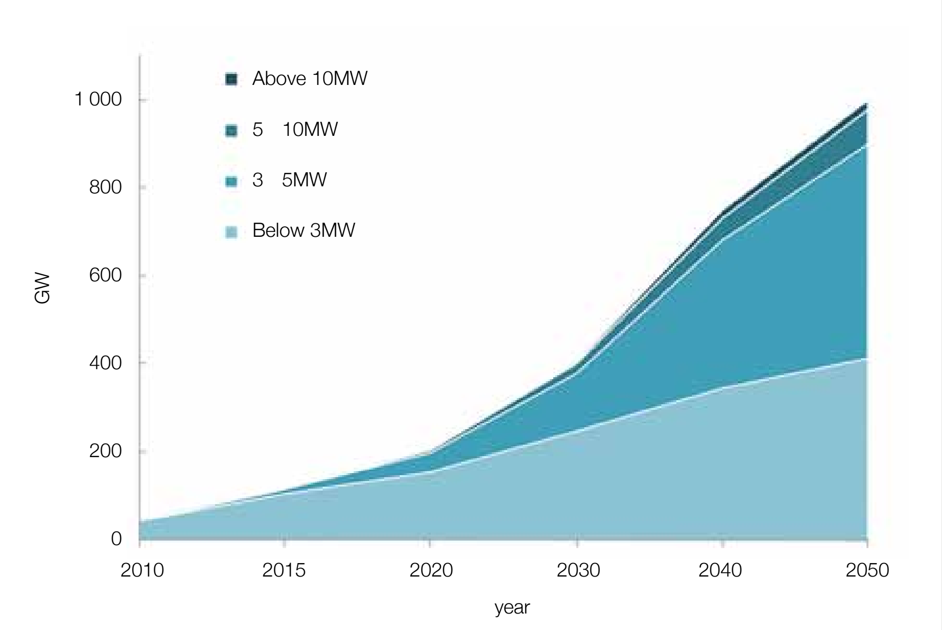


Figure 4-2 Demand for Single-Machine Capacity Wind Turbine Generator Systems in China during 2010—2050

Source: "China Wind Power Development Road Map 2050", 2011, IEA, ERI

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