

BOOMING WIND POWER MARKET AND INDUSTRY IN CHINA

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ABSTRACT

The year 2007 in China both newly increased and cumulative installed capacity were doubled again, this paper analyzes the driving forces of such high growth rate, the advantages and risks for future development. The possibilities of 100GW wind installation by year 2020 also discussed, including resource and land available, power grid constraint, policies needed, and new wind power system in developing.

INTRODUCTION

In China newly increased installed capacity in the year 2007 achieved new record of 3304MW, it is more than the previous 20 year's cumulative of 2600MW, resulting 5900MW by the end of the year, the central government target of 5000MW by year 2010 already reached three years ahead of schedule. Based on the detailed statistics of installed capacity, market share of foreign and domestic manufacturers, source of technologies and project feasibility studies, this paper to identify the achievements and problems of wind power development. The new target in year 2020 for wind power development should be meet the requirement of 3% electricity from non-hydro renewable energies, it is estimated to be 200TWh based on the assumption of total electric power installation by year 2020, since biomass and solar power generation will not make signefecent contribution, maybe most of the target have to be met by wind, and 100GW installed capacity is needed. Is that possible? What is the major constraint? Several issues discussed in this paper.

WIND POWER MARKET

Power industry in 2007

Along with the high growth rate of economic development, demand for electricity supply sharply increased, about 100GW new installed capacity added in 2007, the cumulative reached 714GW, however, 83% of electricity were generated by coal, contributing large amount of CO₂ emission, wind generated electricity only 0.2% of the total. The mix of power generation see Table 1.

Table 1 Source of power generation in 2007

Source	Installed capacity		Electric energy generation	
	(GW)	(%)	(TWh)	(%)
Coal	554	77.6%	2700	82.9%
Water	145	20.3%	487	15.0%
Nuclear	8.85	1.2%	62.6	1.9%
Wind	5.90	0.8%	5.2	0.2%
Biomass	?			
Total	714	100%	3255	100%

Source: China Electricity Council

Wind power installation doubled again

Both newly increased and cumulative installed capacity were doubled again in 2007, see Table 2.

Table 2 Wind power growth in 2004 to 2007

	2004	2005	2006	2007	2008 est.
Newly increased (MW)	197	502	1330	3300	5000
Newly increased Growth rate	100%	155%	166%	147%	52%
Cumulative (MW)	764	1266	2600	5900	10900
Cumulative Growth rate	35%	66%	105%	127%	85%

Real electric energy generated by wind in 2007

The data of annual energy production from 47 existing wind farms in 12 provinces has been collected, installed capacity of 1580MW in total, all of them were completed before the end of 2006, and no added installation in 2007, the average value of annual full load hours in each province were calculated, and the maximum one (3552) and minimum one (978) were deleted during the calculation, the results are listed in Table 3.

Table 3 Annual full load hours of some wind farms

Province	Number of wind farm	Annual full load hours in 2007	Capacity factor	Average power of wind turbine (kW)
Hebei	4	2373	0.27	885
Inner Mongolia	7	1933	0.22	770
Liaoning	9	1325	0.15	715
Jilin	4	1931	0.22	798
Shanghai	2	1651	0.19	1356
Zhejiang	1	1344	0.15	609
Fujian	5	2000	0.23	986
Shandong	3	1728	0.20	881
Guangdong	6	1600	0.18	566
Hainan	1	1417	0.16	483
Gansu	2	1737	0.20	786
Xinjiang	4	2401	0.27	654
12 provinces	47	1787	0.20	791

The average value for 12 provinces to be 1787, it is 10% smaller than 2000 which we expected, and most of these 47 wind farms are using wind turbines with proven type, energy production mainly depending on wind resource.

National priority policy

“Energy conservation and emission reduction” as a national policy by the Chinese government, each power generation company has to reduce the energy consumption to meet the strictly quantified requirement. Clean power development are encouraged.

Wind power concession projects

Since 2003 to 2007 there are five phases of national wind power concession projects were implemented, to stimulate large scale wind power development, the major principles are as follows:

- The provincial government call for bidding to select investor to develop wind power project at least 100MW.
- The winner of the bid signing an agreement with government and power purchase agreement with provincial power grid company, the rights of developer could be guaranteed.
- Major terms in the agreements are fixed feed-in-tariff which offered by winner, for the energy generated in terms of the first 30000 full load hours; the wind turbine used in the project at least have 70% of domestic made components; power grid company will construct transmission line to the wind farm, and fully purchase all electricity generated by wind; the incremental costs between wind and conventional power will be shared by all consumers of power.

Most of the major terms were included in national renewable energy law later in 2005.

The feed-in-tariff offered by winners were extremely low during the first four phase of wind power concession projects, make them not profitable, further more to identify the feed-in-tariff for other projects based on bidding low price, it is the negative impact of such concession projects.

By the end of 2007 there are five wind power concession projects completed, installed capacity up to 550MW, among them Huilai wind farm in Guangdong online before the end 2006, real energy production in 2007 in terms of full load hours is 1478, much lower than 1990 in feasibility study, also the feed-in-tariff is 7.27 Euro/MWh lower than feasible price, make the project definitely not profitable.

Fortunately in the fifth phase the criteria was changed, who offered the price close to the average value of all bidding price (delete the highest and the lowest one), who will has more possibility to win, the results of feed-in-tariff getting more reasonable. See Table 4.

Table 4 Feed-in-tariff of some wind power concession projects

Year-phase-project	Annual full load hours In feasibility studies	Average price In feasibility studies (Euro/MWh)	Price offered By winner (Euro/MWh)
2003 – 1 – Huilai	1990	57.40	50.13
2004 – 2 – Rudong 2	2273	54.25	51.90
2005 – 3 – Dongtai	2126	50.42	48.77
2006 – 4 – Danjinghe	2369	53.61	50.06
2007 – 5 – Beiqinghe	2338	53.55	52.16

“Mandated Market Share (MMS)”

In September 2007, the announcement of medium and long term plan of renewable energy development, by the Chinese government, it is the first time mentioned the quantified obligation for non-hydro renewable energy investors, called “Mandated Market Share (MMS)”, both on the installed capacity and electric energy generated.

The driving force of such booming market has been political consideration, or mandated market share obligation of installed capacity, less attention paid to future energy production. Nation owned energy or power generation group corporations, all of them with profit from coal, oil and conventional power industry, wind power only a tiny parts of their business, but have good reputations politically, they do not care the wind power projects will suffer a loss.

The problem is no statistics on real electricity production from wind, nation owned developers and local government officials only want to have more installed capacity, but not care whether the wind resource is enough or not.

Advantages

More attention had been paid by local governments to develop wind power, create a huge market for manufacturers, beneficial to the growth of domestic component and wind turbine industry.

Risks

The achievements of local government officials and high level managers of developer from nation owned enterprise, are only measured by the installed capacity instead of energy production, make so many projects are not located at good wind sites; Usually the electric load centers are far from good wind sites make difficulties in grid connection; Some of the domestic made wind turbines developed in short time from prototype to mass production, the reliability has not proved on wind sites. Such high growth rate resulting in low energy production, make projects not profitable and constrained by power grid, finally it will not really benefit to the industry in the long term.

WIND TURBINE INDUSTRY

Domestic wind turbine manufacturers growth

Since 2006 a new term of wind power concession project is implemented, the investors are required to join the bidding with a wind turbine manufacturer, and the winner has to use the product in the project, this so called “bounding” term providing firm market to manufacturers for mass production.

Driving by strong market demand, in 2007 the new increased market share are 55.9% for domestic manufacturers, 1.6% for joint venture manufacturers and 42.5% for foreign manufacturers. It is the first year for domestic manufacturers as the majority, See Table 5.

Table 5 Increased market share of Domestic owned manufacturers in 2007

Manufacturer	Increased capacity (kW)	Percentage of Domestic manufacturers	Percentage of total increased capacity
Goldwind	829950	44.93%	25.12%
Sinovel	679500	36.79%	20.57%
DEC	222000	12.02%	6.72%
Windey	65250	3.53%	1.98%
Sewind	22500	1.22%	0.68%
New Unite	9000	0.49%	0.27%
XEMC	8000	0.43%	0.24%
CSIC	3700	0.20%	0.11%
Huachuang	3000	0.16%	0.09%
CSR	1650	0.09%	0.05%
Mingyang	1500	0.08%	0.05%
Huide	1000	0.05%	0.03%
∑ Total	1847050	100%	55.91%

Source: Shi Pengfei, 2007 Wind power installation in China

The huge demand at market side make serious short supply of wind turbines, it stimulates the entrance of wind turbine manufacturing by other conventional machine building industry, such as:

- Heavy equipment – Sinovel, etc.
- Power equipment – DEC, Shanghai Electric, etc.
- Aeronautic and Aerospace – Huide, etc.
- Electric locomotive – New Unite, CSR, etc.
- Ship building – Haizhuang, etc.
- Construction machine – SANY, etc.

The new comers introduce the technology by following ways:

- Production licensing from abroad;
- Joint design by hire foreign engineering firms;
- Using the technology from the result of national R&D projects provided by research institutes

Most of the domestic made MW size wind turbines are prototypes, time is needed to show the performance and quality of components during operation, then to improve them.

According to the status by the end of 2007, there are more than 40 domestic wind turbine manufacturers, maybe divided into four echelon: The first one is already in batch production, the second one is the prototypes had been installed, the third one would be those to install the prototypes in 2008, the fourth one for others, see Table 6.

Table 6 Chinese domestic wind turbine manufacturers

Company (ownership)	Background industry	Rated power/ Rotor dia.	Installed within 2007 (MW)
The first echelon (In batch production)			
Goldwind (Stock company)		750kW/48m/50m 1500kW/70m/77m	830
Sinovel (Nation owned)	Heavy equipment industry	1500kW/70m/77m	680
DEC (Nation owned)	Power equipment industry	1500kW/70m/77m	222
Windey (Nation owned)		750kW/49m	65
Sewind (Stock company)	Power equipment industry	1250 kW/	23
The second echelon (Prototypes had been installed)			
New Unite (Private owned)	Locomotive motor industry	1500kW/70m	9
XEMC (Stock company)	Electric motor industry	2000kW/72m	8
CSIC (Nation owned)	Ship building industry	2000kW/82m 850kW/5m	4
Huachuang (Private owned)		1500kW/70m	3
CSR (Stock company)	Locomotive motor industry	1650 kW/77m	2
Mingyang (Private owned)	Power equipment industry	1500 kW/70m	2
Hui De (Nation owned)	Aeronautic industry	1000kW/55m	1
The third echelon (Prototypes will be installed in 2008)			
HEAG (Stock company)	Power equipment industry	780kW/50m	
Envision (Private owned)		1500kW/77m	
Kailian (Private owned)	Steel Structure	2000kW/82m	
Baonan (Private owned)	Printing machine	2000kW/82m	
SANY (Private owned)	Construction machine	1500kW/77m	
Unitd Power (Nation owned)		1500kW/82m	
TIANWEI (Nation owned)	Power equipment industry	1500kW/77m	
MAIDE (Private owned)		1500 kW/70m	
.....			
The fourth echelon (Prototypes will be installed after 2008)			
XCMG	Construction machine	?	
.....			

The cumulative market share in 2007 are 44.8% for domestic manufacturers, 2.3% for joint venture manufacturers and 52.8% for foreign manufacturers. Several foreign owned wind turbine manufacturers established their factories in China, to meet the government requirement of 70% of domestic made components and the turbine assembled within China Solely owned such as GE Energy, Gamesa, Suzlon and Vestas, producing blade and generator, assembling the nacelle. Acciona and REpower established joint venture companies supply their domestic made turbines to the market. Both foreign owned and joint ventures with the advantages of proven technology high quality products, however, the price is much higher.

Major component manufacturers of blade, hub, gearbox, generator and tower maybe satisfy the market demand, however, bearings, converter and control system still in serious shortage.

POSSIBILITIES OF 100GW IN CHINA IN 2020

Background

In September 2007 the National Medium and Long Term Renewable Energy Development Plan, was open to the global public by the Chinese government, within this plan a quantified targets are announced at the first time in terms of percentage, referred as "Mandated market share (hydropower not included)".

Capacity of non-hydro Renewable Energy for each power generation investor with more than 5GW:
2010 – 3%, (my estimation to be 24GW)

2020 – 8%, (my estimation to be 96GW)

Electricity from non-hydro Renewable Energy in power grid:

2010 – 1%, (my estimation to be 40TWh, from wind need 20GW)

2020 – 3%, (my estimation to be 210TWh, from wind need 100GW)

Considering more proportion of wind power in the fast growing power industry in China, the above mentioned figures in GW or TWh are based on my own assumptions for the total power industry, see Table 7.

Table 7 Assumptions for the total power industry and wind power

	Total power in 2010	Total power in 2020	Wind power in 2010	Wind power in 2020
Capacity	900 GW	1500 GW	20GW (2.2%)	100GW (6.7%)
Electricity	4000 TWh	7500 TWh	40TWh (1.0%)	200TWh (2.7%)

Wind energy resource

It was estimated by Center for Wind and Solar Energy Resource Assessment, China Meteorological Administration (CMA), based on the results of numerical modeling, at 50m height with wind power density more than 300W/m², and take 5MW per square km as assumption, that wind potential technical available to be explore to be estimated as 2680 GW on land and 180GW for offshore. Considering the land available and many other factors, maybe 30% available for wind power projects, in the order of 800GW.

In China the distribution of wind energy resource and electric load are not well matched, the best areas with rich wind energy potential and plenty available land are in north and west China, but almost no electric load centers close to wind sites, wind farms usually located at the end of weak power grid. Along the coastal areas and offshore, load centers are close to wind site, but due to high density of population, available land for wind project is limited.

Land and offshore area

In the north and west China there are huge areas of hungeriness grassland of Gobi desert available for supper size wind farm development, however, there is no electric load center nearby.

Before 2015 along the coastal area all land available for large scale wind farm will be fully used, but there are many areas used by local farmers for agriculture or sea food (such as abalone) cultivation, it should be available for individual wind turbine installation. Incentive policy is needed for farmers or cooperatives to own the wind turbine, as new business to earn money and establishing some kind distributed power system, similar to the development model in Denmark and Germany.

Offshore area with big potential but constrained by the high costs of the offshore wind technology. Along the coast of east China there are enormous areas of tideland, but today no technology suitable to use this kind of land. Research and development a new technology is needed for wind turbine transportation, installation and maintenance in tideland.

Capability of wind turbine production

Before 2015 the wind turbine manufacturing industry will grow faster and stronger, with the annual production around 10GW. The major bottlenecks in supply chain today such as bearing and converter could be overcome. The key issue is the manufacturers should develop different types of wind turbine suitable for local wind regime in China, such as cold climate, tropical climate and in Typhoon areas with low annual average wind speed but extreme high gust, etc., providing high quality wind turbines, higher reliability with low cost, make the projects gain the optimal ratio of performance and price.

Constraints of power grid

In China major electric load centers are located in the east coastal areas, large scale wind power can be connected to existing grid, and consumed locally, no need long distance transmission. There are

also many hydropower pumped storage stations within the grid to satisfy the peak load and store energy during low load period.

Most of promising rich wind energy potential in the north and west China, with plenty of land available, however, due to small electric load there, the existing power grid is weak, it will be the major bottleneck for wind power development in large scale.

The concept of "Large scale non-grid wind power system" maybe a solution to this case, it has been involved in the national science and technology basic research program. The research is focused on high energy consumption industry, such as electrolytic aluminium, desalinator, etc., the large DC load how to use intermittent wind power. New direct drive wind turbine with fixed pitch rotor, controllable variable speed DC generator also under research.

If such a "Large scale non-grid wind power system" successfully developed, wind farm would not depending on power grid, on the other way round, high energy consumption electrolytic aluminium industry could be settled to the place rich in wind energy resource.

CONCLUSIONS

The national target should be in terms of energy production, not only the installed capacity. Incentive policy to power grid enterprise is necessary to convert them from constraint to more active. In the near term to create a stable market for establishing the capability of domestic component and wind turbine manufacturing industry is the priority in China.

To meet the requirement of 3% of electricity from non-hydro renewable energy in 2020, wind power installation should be 100GW, wind resource, land area and capability of wind turbine production will be available in the next decade, major barrier would be power grid issue, new incentive policies for individual wind turbine owners and power grid enterprises are needed, R&D on tideland wind farm and "Large scale non-grid wind power system" maybe provide new opportunities. To realize 100GW wind power installation and 200TWh of electricity from wind in 2020 is possible.

REFERENCES

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Biography

Shi Pengfei is a Senior Consultant for wind power, China Hydropower Planning General Institute. Since 2004 he is serve as Vice president of Chinese Wind Energy Association. He is in charge of the pre-investment works of wind power projects, including resource assessment, planning, project proposal, feasibility study, wind farm design, etc.

Attachment:

Full name of wind turbine manufacturers

Name in the paper	Full name
Baonan	Wuxi Baonan Machine Manufacturing Co., Ltd.
CSIC	CSIC (Chongqing) Haizhuang Windpower Equipment Co.,Ltd.
CSR	CSR Zhuzhou Electric Locomotive Research Institute
DEC	Dongfang Electric
Envision	Nantong CASC Wanyuan Acciona Wind Turbine Manufacture Co., Ltd
Goldwind	Goldwind Science & Technology Co., Ltd
HEAG	Huayi Electric Co. Ltd.
Huachuang	Shenyang Huachuang Wind Power Co.,Ltd.
Huide	Huide Wind Energy Engineering Co., Ltd
Kailian	Nantong Kailian Windpower Equipment Co. Ltd.
MAIDE	Jiangxi Maide Wind Wnergy Co.,Ltd.
Mingyang	Guangdong Mingyang Fengdian Power Electronics Ltd.
New Unite	New Unite Wind Turbine Generator Co.
SANY	SANY Holding Co., Ltd.
Sewind	Sewind Co., Ltd.
Sinovel	Sinovel Wind Co. Ltd
SUT	Wind Energy Research Institute, Shenyang University of Technology
TIANWEI	Baoting Tianwei Group Co., Ltd.
United Power	Guodian United Power Technology Co., Ltd.
Windey	Zhejiang Windey Engineering Co., Ltd
XEMC	Hunan Hara XEMC Windpower Co.,Ltd.
XCMG	Xuzhou Construction Machinery Group Inc.