National Action Plan

for

China's Wind Power Industry Development

June, 2005

Contents

PREFACE

Developing and utilizing wind energy represent one global trend. Following the IT industy, the wind power industry has already become a sunrise industry. Wind power is expected to meet 12% of electricity demand, create 1.8 million job opportunities and reduce more than 10 billion tones of CO2 emission globally by 2020.

China has made significant progress in developing and utilizing wind energy as a result of more than 10 years' effort. By the end of 2003, 40 wind farms had been established and 1042 units of WTG installed with total capacity of 567.02 MW, ranking the tenth largest wind power country.

Imported WTG have been dominating the domestic market, covering more than 95% of market share until 2000. To increase the domestic capability and accelerate the localization of manufacturing wind power equipments, several China's government bodies, such as National Development and Reform Commision, Ministry of Scinece and Technology and former State Economy and Trade Commision, have sponsored a series of national programs, including National Key Scientific and Technological Projects, "Ride the wind" program, National Debtfunded Wind Power" program, as well as wind power concession projects, and thus made notable achievements. At present, China has almost gained the capability of designing and manufacturing the WTG and key components, with the market share of domestic units aleady reaching 15% by the end of 2003.

However, there is only one WTG manufacturer that has gained batch production and independent intellectual property rights. What's more, the majority of loally-made WTG feature small unit capacity, and out-dated technology, far behind the international latest level. Consequently, how to promote the locally production of WTG with advanced technology and independent intellectural property rights present one challenge and the focus of this research project.

At the request of the project management office for the NDRC/World Bank "China Renewable Energy Scale-up Program", the WTG consultant group completed this research report, which analyzed the status quo and the problems, presented policy proposal encouraing the development of the wind power industry, and the national action plan for China's wind power industry development.

Volume I

Wind Power Industry Development in China

1. WIND FARMS IN CHINA

1.1 Sizes of Wind Farms

Since the first 55kW Vestas WTG system installed in Hainan Dongfang wind farm in 1985, the installed capacity of wind farms has gradually increased in China. From 1997-2002, the growth rate of installation was very high, with annual newly installed capacity of between 50,000kW and 80,000kW. During this period, 10 wind farms were built in China with capacity of more than 10,000kW, namely: Dabancheng No.2 Wind farm in Xinjiang Autonomous Region; Nanao Wind Farm in Guandong Province; Huitengxile Wind Farm in Inner Mongolia Autonomous Region; Xianrendao Wind farm in Liaoning Province; Tongyu Wind Farm in Jiling Province; Donggan Wind Farm in Dalian, Donggang Province; Dandong Wind Farm in Liaoning Province, Keseketeng Wind Farm in Inner Mongolia Autonomous Region, Kuocangshan Wind Farm in Zhejiang Province, Yumen Wind Farm in Gansu Province; Hedingshan Wind Farm in Zhengjiang Province; Huilai Wind Farm in Guangdong Province; and Dabancheng No.1 Wind Farm in Xinjiang Autonomous Region. At present, China's Wind Industry is developing steadily, with totally 40 wind farms, 1042 units of WTG, and installed capacity of 567 MW by the end of 2003. Table 1-1 and Figure 1-1 show the installed capacity of wind farms during past years. The annually average wind speeds, highest and lowest temperatures, air density as well as installed capacities are given in Table 1-2 for 40 wind farms.

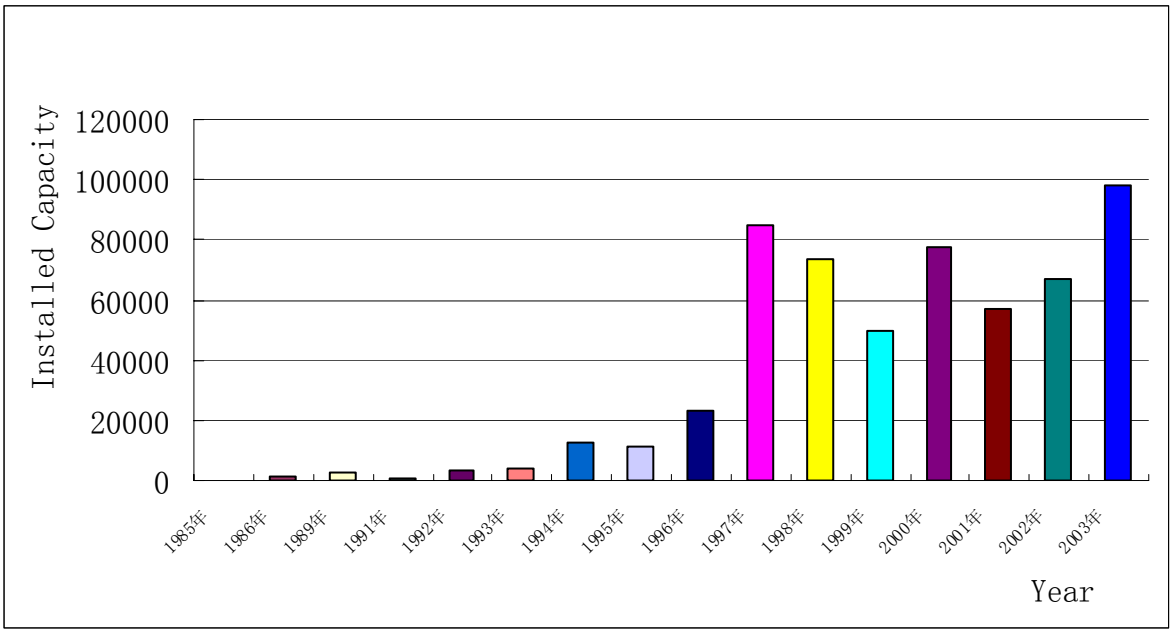


Figure 1-1 The installed capcapcity of wind power in China

Table 1-1 The list of annual installation of Chinese wind farms

Year	Newly increased capacity（kW）	Acumulated capacity (kW）	Annual growth rate (%)
1985	55	55	
1986	1065	1120	1936.36%
1989	2750	3870	245.54%
1991	690	4560	17.83%
1992	3300	7860	72.37%
1993	4000	11860	50.89%
1994	12900	24760	108.77%
1995	11100	35860	44.83%
1996	23300	59160	64.97%
1997	84650	143810	143.09%
1998	73450	217260	51.07%
1999	50000	267260	23.01%
2000	77340	344600	28.94%
2001	57210	401810	16.60%
2002	66910	468720	16.65%
2003	98300	567020	20.97%

Table 1-2 Annually average wind speed, temperatures, & air density for wind farms in 2003

(descending order in tems of capacity)

No.	Wind farm	Annual average wind speed	Highest Temperature	Lowest Temperature	air density	number of WTG	Installed capacity (kW)
1	Dabancheng No.2	8.15 m/s	37.5 ℃	-31.9 ℃	1.1 kg/m3	157	82800
2	Nanao	8.11 m/s	℃	℃	kg/m3	130	56690
3	Huitenxile	7.12 m/s	℃	℃	kg/m3	72	42700
4	Xianren Dao	6.0 m/s	34.4 ℃	-23.6 ℃	1.23 kg/m3	47	31660
5	Kesheketeng	6.2 m/s	36 ℃	-40 ℃	1.139 kg/m3	45	30360
6	Tongyu	7.02 m/s	38.9 ℃	-33.5 ℃	1.244 kg/m3	49	30060
7	Donggan	6.5 m/s	35 ℃	-25.1 ℃	1.23 kg/m3	38	22450
8	Yumen	7.1 m/s	℃	℃	1.059 kg/m3	38	21600
9	Dandong	6.1 m/s	34 ℃	-27 ℃	1.23 kg/m3	28	21000
10	Kuachang Shan	6.3 m/s	℃	℃	kg/m3	33	19800
11	Daban cheng No.1	6.3 m/s	37.5 ℃	-31.7 ℃	kg/m3	42	18400

12	Sanwei	6.1 m/s	℃	℃	1.18 kg/m3	25	16500
13	Jime					15	16400
14	Hedingshan	6.9 m/s	℃	℃	kg/m3	23	13250
15	Huilai	5.6 m/s	38.4 ℃	2.1 ℃	1.33 kg/m3	22	13200
16	Kangping					12	10200
17	Zhangwu					12	10200
18	Helan					12	10200
19	Zhangbei	7.1 m/s	35.1℃	-34.8℃	1.1.8kg/m3	24	9850
20	Faku	m/s	℃	℃	kg/m3	12	9600
21	Dongfang	7.0 m/s	35.1 ℃	5 ℃	1.17 kg/m3	19	8755
22	Changdao	6.2 m/s	16.5 ℃	-13.2 ℃	1.225 kg/m3	13	8100
23	Hengshan	5.9 m/s	35 ℃	-25 ℃	1.23 kg/m3	24	7400
24	Zhurihe	6.2m/s	39℃	-37℃	1.11kg/m3	32	6900
25	Pingtan	7.7 m/s	38 ℃	0.9 ℃	1.196 kg/m3	14	6800
26	Dongshan	6.5 m/s	30.7 ℃	-11.1 ℃	1.185 kg/m3	10	6000
27	Xilin	7.2 m/s	36 ℃	-40 ℃	1.14 kg/m3	13	4780
28	Jinzhou	6.5 m/s	39.7 ℃	-23.6 ℃	1.25 kg/m3	5	3750
29	Chengde	9 m/s	℃	-42 ℃	1.09 kg/m3	6	3600
30	Shandu	6.8m/s	30.3℃	-28.6℃	1.07kg/m3	12	3600
31	Xiaochangshan	m/s	℃	℃	kg/m3	6	3600
32	Dachangshan					6	3600
33	Mulan					6	3600
34	Fengxia					4	3400
35	Zhangzidao	m/s	℃	℃	kg/m3	12	3000
36	Alashankou	m/s	℃	℃	kg/m3	2	1200
37	Buerjin	m/s	37 ℃	-37.5 ℃	kg/m3	7	1050
38	xixia					2	500
39	Sijiao	m/s	℃	℃	kg/m3	10	300
40	Rongcheng	m/s	℃	℃	kg/m3	3	165
	nationwide（excluding Taiwan Province）					1042	567020

1.2 Models of WTG

With the continuous improvement of technology of wind turbines, there is a notable trend that the unit capacity is developing for the larger scale. In May 2001, in Liaoning (Yingkou Xianrendao wind farm) 4 large 1300kW N60 WTG systems were installed and in 2003, in Shandong (Jimo wind farm) 12 large N60 WTG systems were installed which are the largest WTG installed in China so far.

The most common turbines used in Chinese wind farms are 600kW size, the number of unit for these size is 483, representing 46.35% of the total. The second most common is 750 kW size with total installed number of 99, the total number of 250kW wind turbines is 82 and the total number of 300kW wind

turbines is 70. For the end of 2003, the installed number of all kinds of WTG system in Chinese wind farms is shown in Table 1-3.

Table 1-3 Numbers of WTG of different size in China's wind farms in 2003

Unit capacity(kW)	1300	850	800	750	660	600	550	500	450	350	330	300
Number Installed	16	40	12	99	53	483	30	53	3	1	16	70
Unit capacity(kW)	275	250	200	150	130	120	100	55	30	Sum		
Number Installed	2	82	21	28	3	10	6	4	10	1042		

1.3 The Wind Farms in different Provinces

Xinjiang Autonomous Region, Inner Mongolia Autonomous Region, Liaoning Province, Zhejiang Province, Guangdong Province and Fujian Province are relatively rich in wind resource.

Liaoning Province is the leader across the country in terms of installed capacity, with 11 wind farms, 202 units of WTG and accumulated installed capacity of 126.5 MW by the end of 2003. Next is Xinjiang with 208 units of installed WTG and cumulative installed capacity of 103.5 MW. The third is Inner Mongolia with 174 installed WTG and cumulative installed capacity of 88.3MW. Table 1-4 shows the installed WTG by the end of 2003.

Table 1-4 Accumulated installed capacities in different provinces in 2003

No.	Province	Number of Units	Installed Capacity （kW）	Percentage （%）
1	Liaoning Province	202	126460	
2	Xinjiang Autonomous Region	208	103450	
3	Inner Mongolia Autonomous Region	174	88340	
4	Guangdong Province	177	86390	
5	Zhejiang Province	66	33350	
6	Jilin Province	49	30060	
7	Shandong Province	33	25165	
8	Gansu Province	38	21600	
9	Hebei Province	30	13450	
10	Fujian Province	24	12800	
11	Ningxia	12	10200	
12	Hainan Province	19	8755	
13	Heilongjiang Province	6	3600	
14	Shanghai	4	3400	
	Nationwide (excluding Taiwan province)	1042	567020	100

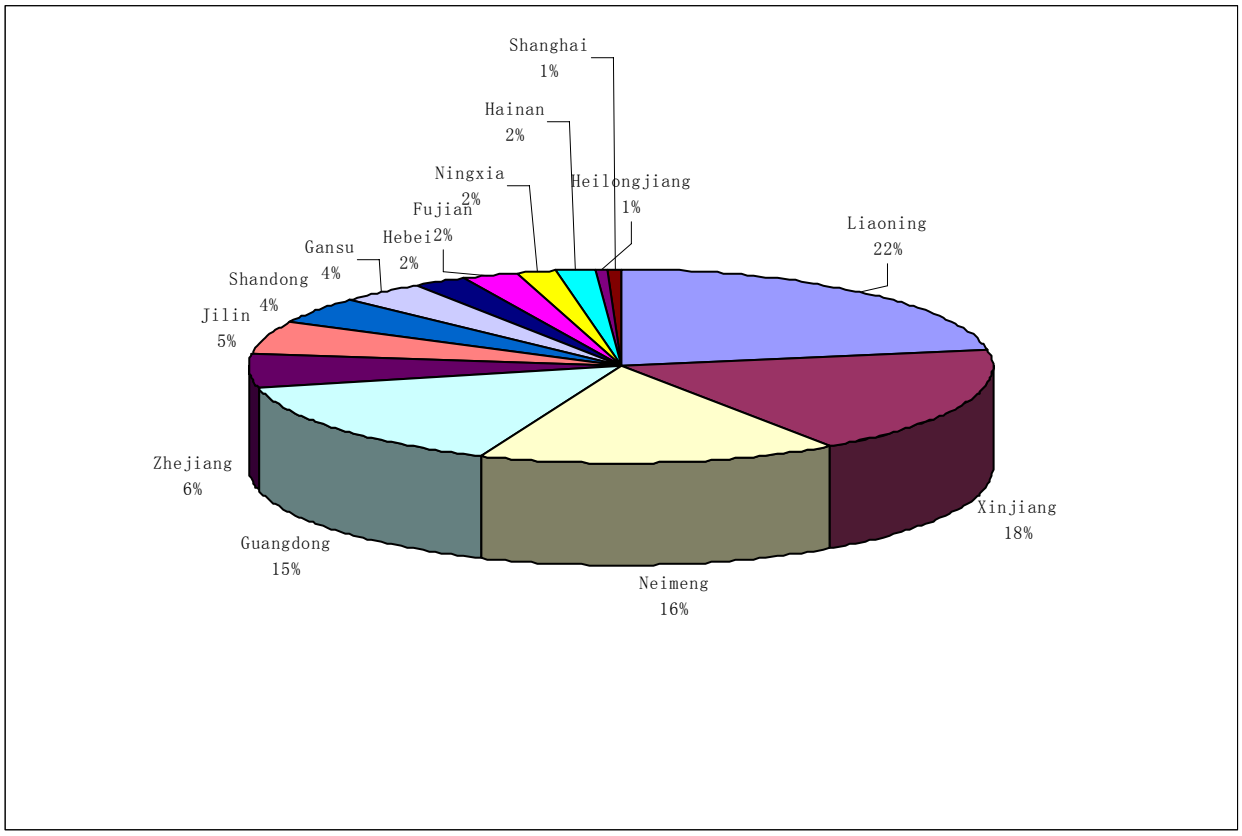


Figure 1-2 Installed wind turbines in China by province

1.4 Manufacturer's Share in the Wind Farm Market

By the end of 2003, foreign wind turbines still dominate the local wind power market. The market share for the imported units was 84.65%, while the share of the locally made WTG was 15.35% (see Figure 1-3). Among these companies, NEG Micon company's sale amount is the highest with market share of the total of 30.06%. Vestas has 16.92% and Nordex 15.62%. The grand total of Chinese market share for foreign manufacturers in 2003 is listed in Table 1-5.

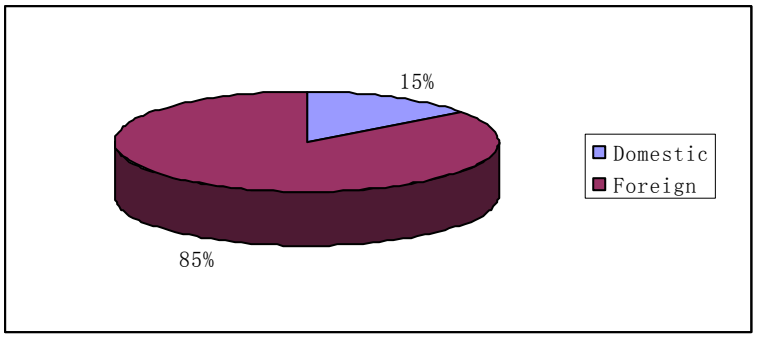


Figure1-3 The market share of Chinese manufacturers by the end of 2003

Table 1-5 The cumulative market share of foreign manufacturer by 2003

（excluding Taiwan province）

Manufacturer	Capacity(kW)	Share among the Total Imported Units	Share among the China's Total Installed Capacity
NEG Micon	170390	35.52%	30.06%
Vestas	95920	20.00%	16.92%
Nordex	88550	18.46%	15.62%
Gamesa	20800	4.34%	3.67%
MADE	18480	3.85%	3.26%
Nedwind	17500	3.65%	3.09%
Zond	16500	3.44%	2.91%
Bonus	13550	2.82%	2.39%
Bazan-Bonus	12000	2.50%	2.12%
AN Bonus	9600	2.00%	1.69%
HSM-250T	4500	0.94%	0.79%
Tacke	4500	0.94%	0.79%
Dewind	3000	0.63%	0.53%
Jacobs	1500	0.31%	0.26%
Windmaster	800	0.17%	0.14%
AWT-275	550	0.11%	0.10%
US Windpower	500	0.10%	0.09%
Darrious	350	0.07%	0.06%
Newind	300	0.06%	0.05%
Aeroman	300	0.06%	0.05%
Wincon	100	0.02%	0.02%
Total	479690	100.00%	84.65%

Table 1-6 The market share of Chinese WTG manufacturers by the end of 2003

Manufacturer	**Capacity (MW)**	Share among the Total Domestic Units	Share among the China's Total Installed Capacity
Xinjiang Goldwind	50.1	57.57%	8.84%
Xian Nordex	210	24.13%	3.70%
Zhejiang Windey	6.15	7.07%	1.08%
Yituo-MADE(Luoyang)	5.28	6.07%	0.93%
Beijing Wandian Co.,Ltd	2.4	2.76%	0.42%
Shanghai Shenxing	1.2	1.38%	0.21%
FD28-300	0.6	0.69%	0.11%
FD31-300	0.3	0.34%	0.05%
Total	87.03	100.00%	15.35%

2. CURRENT SITUATION OF CHINESE WTG MANUFACTURERS

Based on the great progress in National Key Scientific and Technological Projects in the past sequential Five-Year-Plans directed by the Ministry of Scicence and Technology and Ride the Wind Program by former State Planning Commission as well as National Debt Wind Power Program by former State Economic and Trade Commission, remarkable progress has been made in terms of the domestic capability of designing and manufacturing of large-scale WTG and components. A manufacturing team has been established which is led by WTG manufacturers followed by components-manufacturing enterprises. The localization of manufacturing has been gained for 600 kW WTG, whose localization ratio had reached 96% by 2003. Locally-made units have occupied 15.35% of the domestic wind power market in terms of accumulated installed capacity. The domestic manufacturer won 33.46% of the newly increased market in 2003. During the tenth FYP period, the Ministry of Science and Technology had again sponsored the R&D for WTG of MW size to meet the international level.

2.1. The overview of Chinese WTG manufacturers

The major manufacturers for WTGin China includes: Xinjiang Goldwind Scientific and Technological Limited Liability Company, Zhejiang Windey Wind Turbines Generator Engineering Limited Company, Xi'an Nordex Wind Electric Equipment Limited Company, Yituo-MADE (Luoyang) Wind Electric Equipment Limited Company, Shanghai Shenxing Wind Turbines Generator Equipment Limited Company, and Beijing Wandian Company. Table 2-1 gives an overview of the general manufacturers for WTG systems in China by the end of 2003.

Three companies, Dongfang Turbine Factory, Dalian DHI & DCW, and Baoding Propeller Factory, signed the technology transfer contract with foreign companies to get the MW size WTG production licenses and began to enter wind power industry. All of these three companies plan to product their first ptototype WTG in 2005.

Both of Xinjiang Tebian Electricity Shenyang Wind Power Co. and Jiangxi Zhonghang Wind Power Science & Technology Co. are new wind energy companies established in 2004, and plan to develop their first sample WTG in 2005 based on their own technology. The technology support for these two companies are two domestic wind energy research institutes, Shenyang Industry University and Chinese Helicopter Design Research Institute respectively, which undertook the national key research and development on MW size WTG.

Harbin Power Plant Equipment Gourp Corporation is developing 600 kW variable speed constant frequency WTG and plans to develop and install first sample WTG in 2005, and will also begin

to develop 1.2 MW WTG in 2005.

Additional, some companies also think to enter wind turbine manufacturing, and began to do some preparation works, including technology development, market investigation and nigotionate.

At present, the products of the wind power equipment manufacturing enterprises in China are stall regulated WTG, with capacities of 200kW, 250kW, 600kW, 660kW, and 750kW. Only the 600kW WTG system produced by Beijing Wandian Company features variable pitch propellers. Table 2-2 gives the main technical parameters and technological characteristics of the domestic WTG. The variety is not wide-ranging and give limited choice for the domestic owner, compared with the case in some foreign products.

The majority of the six factories of WTG have been established in the last 3 to 5 years. Through introducing and assimilating mature foreign wind turbine technologies, they have already gained the capability of designning and manufacturing WTG, especially for capacity of 600 kW. However, one problem still remains of the lack of local capability to develop WTG designs with proper independent intellectual property rights.

Table 2-1 The general situation on manufacturer for Chinese WTG systems by the end of 2003

	Enterprise Name	**Character**	**Time of founding**	**Amount of capital**	**No. of staff**	**Annual Prod-uction**	**Main products**	**Sales end of 2002**
1	Xinjiang Goldwind	Limited Liability Company	1998.2	RMB 32,300,000	105	200	S43－600	81
							750 kW	2
2	Xian Nordex	Chinese-foreign joint venture	1998.6	USD 2,100,000	15	100	N43/600	35
3	Yituo-MADE (Luoyang)	Chinese-foreign joint venture	1999.1.15	USD 6,000,000	29	140	MADE －660kW	8
4	Zhejiang Windey	Limited Company	2001.12	RMB 22,500,000	23		FD25-250	17
						10	WINDEY 48-750	2
5	Beijing Wandian	Limited Company	1994	RMB 17,000,000	55	30	WD646	4
6	Shanghai	Limited	1999.9	RMB	15	50	SDEC-JA	2

	Shenxing	Company		5,600,000			COBS 43/600	

Table 2-2 Main technical character and technical parameters of domestic WTG

Manufacturer	**Xinjiang Goldwind**	**Xian Nordex**	**Yituo MADE**	**Zhejiang Windey**	**Shanghai Shenxing**	**Beijing Wandian**
Model	Goldwind S43/600	N-43	AE-46/1	FD25-250	SDEC-JACO BS43/600	WD646
Rated Power（kW）	600	600	660	250	600	600
Power Control	Stall control	Stall control	Stall control	Stall control	Stall control	Variable pitch
Number of blade	3	3	3	3	3	3
Rotor diameter（m）	43	43	46	25	43	46
Rotor rotational speed (rpm)	26.8/17.9	27.2/18.1	25.5/17	43	26.8/17.9	22.43/33.67
Swept area (m^2)	1452	1452	1662	491	1452	1652
Rated wind speed (m/s）	15	13.5	15	15	15	13
Cut-in wind speed（m/s）	3.2	2.5	3.5	4	3.2	3.5
Cut-out wind speed（m/s）	24	25	25	25	24	30
Survival wind speed（m/s）	70	70	70	60	70	60
Total weight (kg)	65000	72000	77000	27000	65000	62000
Temperature range	-30 ℃ ～ +45 ℃	-30 ℃ ～ +45℃	-30℃～+45 ℃	-30℃～+45 ℃	-30 ℃ ～ +45 ℃	-30 ℃ ～ +45℃
Tower height（m）	38.5/48.5	46	43.5	30	38.5/48.5	42
Tower weight（kg）	33000/45800	40000	40000	17000	33000/45800	36000
Generator						
Power（kW）	600/125	600/125	660	250	600/125	600/160
Rated（rpm）	1517/1013	1513/1013/	1500/1000	1000	1517/1013	1516/1011/
Gear Box						
Model	1 grade planet 2 grade parallel axle	3 grade planet	3 grade parallel axle	2grade cylinder	1grade planet 2 grade parallel axle	2 grade planet
Speed ratio	1：56.6	1:55.8	1：59.5	1:23.6	1：56.6	1:45.03
Rated Power（kW）	645	630	715	280	645	600
Input rotational	26.8	27/17		43	26.8	33.67

speed（rpm）						
Output rotational speed（rpm）	1517	1513/1013/	1500/1000	1023	1517	1516/1011/
Efficiency	0.97	0.97	0.97	0.97	0.97	0.97
Yawing system						
Type	Active	Active	Active	Active	Active	Active
Yawing speed	0.2°/s	0.9°/s		0.47°/s		0.7°/s

Xinjiang Goldwind Scientific and Technological Limited Liability Company, founded in February 1998, is a new high-tech enterprise set up by Xinjiang WindEnergy Company, China Water Conservancy Investment Company, Xinjiang Wind Power Institute, etc and several individuals who provided funds together. It is the first joint-stock enterprise that has an ability to produce WTG systems in batch process at home. By the end of 2003, it had produced and sold 81 units of of 600 kW wind turbine. The company has the longest experience of commercial operation of WTG systems already exceeding three years. The company has introduced foreign manufacturing technologies for 750 kW WTG systems and has already produced 2 units and put them into operation by 2003. At present it is developing a new type of 1.2 MW WTG system without gear box within the framework of National 863 R&D Program.

Xi'an Nordex Wind Power Equipment Limited Company, a joint venture enterprise producing wind power generators, was set up by Xi'an Aero-Engine (Group) Corporation and the German Ende Company. The company was established in June of 1998 and its registered capital is US$ 2.1 million with the Chinese side accounting for 60% and the German side accounting for 40%. The limited time of joint venture is 30 years. This company has introduced the production manufacturing technologies of 600 kW WTG systems from the German Nordex Company and it has already produced and sold 35 wind turbines of 600 kW by the end of 2003.

Yituo-MADE (Luoyang) Wind Power Equipment Co., Ltd. is a Chinese-foreign joint venture enterprise mainly producing large-scale wind power generators. It was co-funded by China Yituo group Co., Ltd. and MADE Renewable Technological Company of Spain National Utilities Electric Co. in Jan. 1999, and its total investment funds is US$ 6 million and has a production capacity of 140 WTG systems per year. The company has introduced the technology for manufacturing 660kW WTG systems from the Spanish MADE Company and it has produced and sold 8 units of WTG systems of 660 kW by the end of 2003.

Zhejiang Windey Wind Turbines Generator Engineer Co., Ltd is set up by Zhejiang Electromechanical Group Co., Ltd, Zhejiang Electromechanical Design & Research Institute Co., Ltd, and some natural persons. Its registered capital is RMB 25.51 million Yuan. The main

products of the company are 250 kW, 600 kW and 750 kW WTG systems and among them, 250 kW and 600 kW size have already realized local manufacturing. At present, it is developing 750 kW WTG systems and this is the subject of the national “Tenth Five-Year Plan” scientific & technical tackling plan undertaken by the company. By cooperation with German REpower Company, it was introduced to and has absorbed advanced foreign technology. The first batch of 2 units of with 750kW were installed in Changdao in Shandong and started to generate electricity at the end of September 2003. Based on this, it is carrying on the development of megawatt size large-scale wind power generator in the Naitonal 863 R&D Project.

Beijing Wandian Co., Ltd. established in 1994, belongs to China Academy of Launch Vehicle Technology and is the unique domestic specialized company engaged in developing, designning and manufacturing large-scale WTG systems with variable pitch. Wandian Company, taking advantage of experience of hi-tech space science, designed and produced the variable－pitch WD 646 WTG system by itself and put them into operation in the Inner Mongolia Huitengxile Wind Farm. In recent years, Wandian Company has produced and installed 3 units of WD 646 WTG systems for Inner Mongolia Xilinhaote wind farm. Meanwhile, it has developed blades for 600kW variable-pitch WTG system and the hydraulic pressure service system. The rate of local manufacturing for this complete machine reaches nearly 95%. Wandian Company has also produced complete 250kW WTG blades for German HSW 250T WTG systems in the Inner Mongolia Zhurihe Wind Farm and finished the repairing and restructuring project of American Zond wind turbines in Inner Mongoial Huitengxile wind farm. Wandian Company also undertakes R&D of blades for MW size WTG systems under the National 863 R&D Project in the “Tenth Five-Year Plan” of the nation, and the R&D of 750kW and MW size WTG systems.

Shanghai Shenxin Wind Power Equipment Co, Ltd was established with the support of Shanghai Electric Group Company to develop wind power generation unit in 1999. The company, in collaboration with Xinjiang Wind Energy Company, has produced and installed 2 units of 600 kW WTG system.

Xinjiang Tebian Electricity Shenyang Wind Power Co., Ltd is established by Xinjiang Tebian Electricity Company and Shenyang Industry University in December 2004. The registration capital is 25 million Yuan. Shenyang Industry University is the technical support for this company, which is undertaking National 863 R&D Project titled “1 MW variable pitch and variable speed wind turbine generator”. Xinjiang Tebian Electricity is the largest enterprise on producing transformer, electrical wire and cable in China, and it has advantage on capital, electrical technology and marketing. It is planned to install first 1MW wind turbine generator system in Xianrendao wind farm, Yingkou, Liaoning province. Xinjiang Tebiedain plans to invest their wind farm to install, test and improve their WTGs

Dongfang Turbine Factory is one of the largest steam turbine manufactories in China and has more than 7000 staffs. The production capacity reached 14 GW in 2004, the largest record in its history. The main products include 300 MW, 600 MW and 1000 MW large-scale steam turbines. Dongfang Turbine Factory began to enter wind turbine genarator manufacturing, it signed the contract with German Repower on 1.5 MW wind turbine generator system technology transfer on October 1, 2004 to get the production licenses. Dongfeng began to take part in wind power equipment bidding since 2005.

Dalian DHI & DCW Group Company Ltd established in December 2001 based on Dalian Heavy Group and Dalian Crane Group. It began to enter wind turbine genarator manufacturing, and signed the contract with German Fuhrlaender on 1.5 MW wind turbine generator manufacturing technology transfer from Fuhrlaender on October 1, 2004. FM1500 wind turbine generator system will be authorized to be produce in DHI & DCW. As plan, the first 1.5MW wind turbine generator system will be produced in June 2005. And, it has got a construct contract to establish 12MW wind farm in Tuojidao.

Harbin Power Plant Equipment Gourp Corporation is one of the biggest generator equipment manufacturing bases in China. The producing capacity exceeds 10 GW generators. It began wind business at the end of 1990s. The main research program focus on variable speed and constant frequecy 600kW WTG. The first prototype WTG is under assembling period and plans to install in Mulan wind farm. It plans to research and develop 1.2MW WTG in 2005.

Baoding Propeller Factory, founded in 1960 and belonged to Chinese Aviation Industry Second Group, is only one research and manufacturing enterprise on aviation airscrew and energy components of helicopter. There is about 2800 staff including more than 800 technical persons. It’s the stockholder company of Zhonghang (Baoding) Huiteng Wind Energy Equipment Company. It signed technical transfer contract with German Fuhrlander Company to get the production license of 1 MW WTG and enter WTG assembling industry. A new subsidiary is being registered to manufacturing the WTG. The sample WTG will be assembled in late of 2005, and will be installed and operated by 2005.

Jiangxi Zhonghang Wind Power Science & Technology Co., Ltd founded in December of 2003 by China Helicopter Design & Research Institute (602 Institute), Beijing Shuguang Electric Machine Factory, and Zhonghuan Textile Industry (Hangzhou) Group. China Helicopter Design & Research Institute (602 Institute) is the technical support for Jiangxi Zhonghang. 602 Institute, which is the only institute doing helicopter design, experiment and relevant research, and have 2100 employees and 1480 technical staffs, is involved in wind energy equipment research, design and development sind since Sixth Five-year Peirod, and major research results include 100W, 200W, 500W and 3kW wind turbine generator system. It produced 13 units of 3kW system. In

Ninth Five-year plan period, 602 Institute finished research program of 600kW wind turbine generator system development. Since 2002, 602 Institute undertook the National 863 R&D project on research of MW size stall regulated wind turbine generator system. Zhejiang Zhonghang plans to produce, install and operate the first prototype WTG in June 2005.

2.2. Chinese WTG component manufactuers

Table 2-2 gives overview of the Chinese WTG component manufactuers.

The main components of WTG such as blade, gear-box, generator, yawing device, electric controlling system, tower has realized locally mass production.

The blade manufactuers include Zhonghang (Baoding) Huiteng wind power equipment Co., Ltd and Shanghai Glass Fibre Reinforced Plastic Research Institute. Zhonghang (Baoding) Huiteng wind power equipment Co., Ltd, a professional Chinese-foreign joint venture, produces blades for wind turbines and to date it has produced and sold 156 sets of blades for 600 kW WTG systems and is developing blades for 750kW, 900kW and 1.3 MW WTG.

Gear-box manufactuers include Chongqing Gear-Box Co. Ltd, Nanjing High Speed Gear-Box Factory, and Hangzhou Qianjing Gear-Box Group Co. Ltd. Chongqing Gear-Box Factory has realized the localization of designning and manufacturing gear-box for WTG systems.

The generator manufactuers include Shanghai Electrical Machinery Plant Co., Ltd; Lanzhou Electrical Machinery Plant Co., Ltd; Xiangtan Electrical Machinery Group Co., Ltd; Yongji Electrical Machinery Plant. The latter three have realized the localization of designning and manufacturing generators for WTG system.

The tower manufactuers include Qingdao Electrical Station Complement Factory, Shenyang Heavy-Duty Machine Factory, and Shanghai Taishen Electric Power Engineer Machinery Limited Company.

The electrical control equipment manufactuers include Beijing Corona Science & Technology Co,. Ltd., Xinjiang Industry Institute, Xinjiang Goldwind Scientific & Technological Limited Liability Company. The Electrical Research Institute of China Sciences Academy has realized the localization of designning and manufacturing electrical control equipment for WTG system.

Table 2-3 Situation outline of Chinese components-manufacturing enterprises of WTG in 2003

	Enterprise name	Character	Founding time	Amount of capital (million RMB)	No. of Staff	Product	Annual production	Sales
1	Zhonghang (Baoding) Huiteng	Chinese-foreign joint venture	2001.1	35	83	600kW blade	200	156
						750kW blade	100	3
						MW blade	50	
2	Shanghai Glass Fibre Reinforced Plastic Research Institute	State-owned	1960	130	250	250 ～ 300kW blade	100	30
						660kW blade	50	
						750kW blade	50	
						1MW blade	50	
3	Chongqing Gear-Box Co. Ltd	State-owned individual proprietorship	May 18, 1966	Fixed assets 460	1400	Gear box	240	
4	Nanjing High Speed Gear-Box Factory	State-owned	1969	400	1400	FD250,300,600, 645,645J,660,660M	300	30
						FD1390	100	1
						FDP1.5,FDB1.5	4500	12
5	Hangzhou Qianjing Gear-Box Group Co. Ltd	State-owned pluralism investment	1960.12	50	3700	FZ250	100	30
						FZ600	100	20
						FZ646	20	2
7	Lanzhou Electrical Machinery Plant Co. Ltd	State-operated	1958.10		240	YF335-4	500	19
						YF450-4/6	500	
						1MW-2.5MW	300	2
8	Xiangtan Electrical Machinery Group Co. Ltd	Limited Liability Company	1999.12	49.4	241	600/125 bifilar winding	500	21
						1300/250 bifilar winding		
						1500 Double feed A	200	

	Enterprise name	Character	Founding time	Amount of capital (million RMB)	No. of Staff	Product	Annual production	Sales
						1500 Double feed B	200	
9	Yongji Electrical Machinery Plant	State-owned individual proprietorship				600/125 bifilar winding	240	

2.3. Sales of Domestic WTG in China

In 2003, China WTG system manufacturers installed 55 units of locally-made WTG system with total capacity of 32.9 MW across the country, accounting for 33.46% of newly-increased capacity of the domestic wind power market in that year. And in 2002, they installed 55 units of locally-made WTG with total capacity of 28.51 MW, accounting for 42.6% of newly-increased capacity of wind power market in that year. In 2001, 26 units of locally-made WTG were installed with capacity of 15.96 MW, accounting for 47.6% of the total. The detail of the installed locally-made WTG over the years in China is given in Table 2-4.

As Table 2-4 shows, from 2001 to 2003, the annual growth rate of newly installed WTG capacity were 119.46%, 97.24% and 56.89% respectively. The growth rates for 2001 and 2002 were rather higher, which is attributed to the fact that the percentage of localization installation has been increased as a result of the support of “Riding the Wind Program” under the former SPC and "National Debt Wind Power Program” under the former SETC, both of which encouraged the use of locally-made WTG systems.

The sales volume of Xinjiang Goldwind accounts for 25.94% of newly increased capacity of China wind power market in 2003. The newly increased domestic market share of Chinese manufacturers of WTG in 2003 is listed in Table 2-5. It works out that the domestic WTG system accounted for 15.35% of the China market by the end of 2003.

Table 2-4 Installation situation of locally-made Chinese WTG

Date	Unit Capa-city (kW)	No.	Total (kW)	Company	Wind farm	Annual installed capacity (kW)	Cumulative installation （kW）	Annual growth rate (%)
1994	120	10	1200	Bonus- HEEW	Zhurihe	1200	1200	
1995	250	4	1000	HSM — LuoTuo	Xilin wind farm	2500	3700	208.33
	250	6	1500	HSM — LuoTuo	Hainan Dongfang			
1997	200	2	400	Zhejiang Electro-mechanical Institute	Nanao	400	4100	10.81
1998	300	2	600	Shanghai Nantian	Nanao Zhenneng	3900	8000	95.12
	300	1	300	FD31-300	Dabancheng No.2			
	600	5	3000	XWEC-Jacobs	Dabancheng No.1			
1999	250	2	500	Zhejiang Electro-mechanical Institute	Nanao Zhenneng	2900	10900	36.25
	600	4	2400	XWEC-Jacobs	Dabancheng No.1			
2000	660	1	660	Yituo- MADE	Liaoning Yingkou	2460	13360	22.57
	600	1	600	Beijing Wanan	Huitenxile			
	600	1	600	Xian- Nordex	Liaoning-Yingkou			
	600	1	600	XWEC-Jacobs	Dabancheng No.1			
2001	660	6	3960	Yituo- MADE	Kesheketeng	15960	29320	119.46
	600	10	6000	Xian- Nordex	Liaoning-Yingkou			
	600	6	3600	Xinjiang-Jingfeng	Hebei Chengde			
	600	2	1200	Shanghai-Shenxing	Liaoning Yingkou			
	600	2	1200	XWEC-Jacobs	Alashankou			

Date	Unit Capa-city (kW)	No.	Total (kW)	Company	Wind farm	Annual installed capacity (kW)	Cumulative installation （kW）	Annual growth rate (%)
2002	600	4	2400	Xinjiang Goldwind	Dalian Hengshan	28510	57830	97.24
	600	18	10800	Xian Nordex	Liaoning-Yingkou			
	660	1	660	Yituo MADE	Liaoning-Yingkou			
	250	12	3000	Zhejiang-Windey	Zhangzi Dao			
	600	6	3600	Xinjiang Goldwind	Dalian Xiaochangshan			
	250	1	250	Zhejiang Windey	Zhejiang Hedingshan			
	600	13	7800	Xinjiang Goldwind	Ganshu Yumen			
2003	600	3	1800	Wandian	Xilin	32900	90730	56.89
	600	17	10200	Goldwind	Keseketeng			
	600	6	3600	Goldwind	Dalian Dachangshan			
	750	2	1500	Windey	Chang Dao			
	250	2	500	Windey	Xixia			
	600	9	5400	Goldwind	Yumen			
	600	6	3600	Xi’an Nordex	Mulan			
	600	8	4800	Goldwind	Dabancheng No.1			
	750	2	1500	Goldwind	Dabancheng No.1			

Table 2-5 Newly-increased localized market share of manufacturers of Chinese wind turbines generators system in 2003

Manufacturer	Unit power (kW)	Amount	Total power （MW）	Percentage increase of locally-made WTG	Percentage of increased total capacity in 2003
Xinjiang Goldwind	600/750	40/2	25.5	76.60%	25.94%
Xian Nordex	600	6	3.6	10.94%	3.66%
Zhejiang Windey	250/750	2/2	2	6.09%	2.03%
Beijing Wandian	600	3	1.8	5.47%	1.83%
Total		***55***	***32.9***	***100%***	***33.46%***

2.4. The Sales of imported WTG in China

Acitve foreign company in China's wind power market include Denmark-based Vestas Company (including NEG Micon), Bonus Company, US based GE Company, Germany-based Nordex Company，Spain-based Gamesa Company，MADE （already merged into Gamesa），EHN Company，Netherlands-based Nedwind Company，Inida-based Suzlon Company，German-based REpower Company，Dewind Company，Fuhrlaender Company and Japan-based Mitrubishi Company, etc. Among them, Nordex Company jointly with Xi'an Aero-Engine (Group) Corporation founded Xi'an Nordex Company, and MADE Company jointly with China Yituo group Co., Ltd funded Yituo-MADE Company, which, however, has stopped WTG production.

These foreign manufacturers, coupled with domestic ones, made great effort to develop China's wind power market, having made positive contribution to and gained important position in the China's wind power market. They still dominate the Chinese market in 2003, accounting for 66.54% of the newly increased installed capacity.

In terms of cumulative installed wind power capacity by the end of 2003, the top 3 manufacturers are NEG Micon, Vestas and Nordex, whose market shares were 30%, 17% and 16% respectively. Table 2-6 shows the share of foreign WTG manufacturers in Chinese market.at the end of 2003.

Table 2－6　The market share of foreign WTG manufacturers in China by the end of 2003

	Supliers	Capacity(kW)	Propotion
1	NEG Micon	170390	30.05%
2	Vestas	95920	16.92%
3	Nordex	88550	15.62%
4	Bonus	35150	6.20%
5	Gamesa	20800	3.67%
6	MADE	18480	3.26%
7	Nedwind	17500	3.09%
8	Others	49104	8.66%

In 2003，four foreign WTG manufactuers, including Vestas，Nordex，Gemesa and NEG-Micon, sold and put 76 WTG into service in China, with capacity of 65.4 MW. They accounted for totally 66.54 of the newly increased capacity in China in 2003, and 27.47, 17.60%, 13.84 and 7.63 respctively. Table 2－7 shows various manufactuers' share in the newly increased capacity in

2003.

Table 2-7 Newly-increased share of foreign manufacturers in Chinese wind turbines generators system market in 2003

Manufacturer	Unit Power (kW)	Amount	Capacity (MW)	Proportion of the foreign sets	Proportion in newly capacity
Vestas	660/850	10/24	27	41.28%	27.47%
Nordex	250/600/1300	2/2/12	17.3	26.45%	17.60%
Gamesa	850	16	13.6	20.80%	13.84%
NEG-Micon	750	10	7.5	11.47%	7.63%
Total		***76***	***65.4***	***100%***	***66.54%***

2.5. The Situation of the Investment of Foreign WTG manufacturers in China

To meet the demand of large-scale development of wind power in China, to lower the manufacturing cost of WTG, to increase their competitiveness, and to meet the specific requirements by Chinese government in the wind power concession projects as well, many foreign enterprises have been actively engaged in the localization process of WTG and gained progress to some extent. The details are given in the following parts.

Denmark-based Vestas Company（including NEG Micon）

Vestas had planned setting up factories as early as before 1998, and finally decided to establish exclusively foreign-owned enterprises and conducted compreshensive investigation and preparation. According to the introduction from Vestas, the company is now ready for factory building, which depends only on the favorable steady development of Chinese wind power market capabale of supporting one factory of certain scale. Furthermore, WTG could be put into market only 6 months after the factory building was started. Due to the low speed and uncertainty of the wind power development since 1998, the plan for building factrory had been delayed for years.

Chinese wind power maket has showed a favorable turn and Vestas Company is now reconsidering the plan for localization of WTG manufacturing. According to the new plan, it will produce V80 WTG with capacity of 2 MW WTG and other possible Models. The manufacturing site is not decided yet, but possibly neary Shanghai or Dalian city. Taking into account the difficulty and high cost related to shipping blades, the blades will be also made in China as soon as possible. The manufacturing capability for manufacturing blades and assemblying unit will be

in place in 2005.

U.S.- based GE Corporation

GE Corporation got involved in wind power industry in 2001, entered Chinese market in 2002 and has achieved rapid development, putting 10 units of 1.5 MW WTG into service in Inner Mongolia in 2004.

GE Corporation has conducted comprehensive investigation for locally producing WTG and conducted the local components purchase plan. According to this plan, GE will be capable of meeting the requirement on WTG localization rate (more than 77%) by Chinese large wind power projects, for example Wind Power Concession projects. With regard to blade, LM Corporation located in Tianjin will is priority option as component manufacturer.

GE Corporation has some mechanical plants in China, some of which could be conveniently transformed to produce WTG in view of the potential installation sites. The WTG with capacity of 1.5 MW is priority option as leading model in near-term Chinese market. A batch order for WTG is needed for GE to start its real action of establish its assembly factories in China.

Germany-based Nordex Company

In 1998, Nordex Company and Xi'an Aero-Engine (Group) Corporation jointly funded Xi'an Nordex Wind Electric Equipment Limited Company, which had already been put into operation in 2000. By the end of 2003, 52 units of 600 kW WTG have been produced and put into service. Localization has been pushed forward at high quality due the introduction of design and quality control measure from Germany. Their products showed good performance since being put into use. In response recent change in the market, Nordex is considering the localization of more WTG models.

Spain-based Gamesa Company

Gamesa plans to set up his subsidiary company in China and build factories for WTG production. The products will be 850 Model in the initial stage and expanded to MW-size ones, maintaining manufacturing capability for both models. The scale of plant will depend on the market.

Gamesa will locate their plant nearby Beijing and Tianjin, or some place near Shanghai close to harbor so as to take advantage of local complementary capability and convenience reagard to transportation. Gamesa has made surveys on the qualified WTG components manufacturing enterprise to determine partners.

Spain-based EHN Company

EHN Company entered Chinese wind power market in 2003, and bid for the Jiangsu Rudong Project in Chinese first wind power concession projects. For the purpose of locally producing WTG, EHN Company has conducted relevant survey and made plans for localization of WTG manufacturing and purchase of local components.

India- based Suzlon Company

Suzlon has chosen to set up WTG manufacturing plant in Tianjin to produce WTG with capacity of 1250 kW. Based on suvey and study, Suzlon made its strategy as: producing blade， controlling system and electrical controlling box by itself, and producing steel structure and other componets as well as assemblying system in jointly-funded enterprises or purchasing them from other enterprises. As for the concession projectss, Suzlon is going to realize the localization rate of 75.6%.

Others

Spain-based MADE Company, jointly with China Yituo group Co., Ltd , funded Yituo-MADE (Luoyang) Wind Power Equipment Limited Company, which had produced 600 kW WTG in small scale. So far, MADE Company has been purchased by Gamesa and Yituo-MADE Company stopped the production of WTG.

Germany-based REpower Company and Fuhrlaender Company have determined their partners in China and started technology transfer. Denmark-based Bonus Company has developing wind power in China for years, but so far has no plans to set plants or produce WTG locally. Some other manufacturers, such as Janpan-based Mitrubishi Corporation and Germany-based Dewind Corporation, are also seeking for market opportunity in China.

2.6. Technology and Performance Comparison between Foreign and Domestic WTG

1）The Advanced Technologies applided by foreign WTG

Rapid progress has been achieved for the imported WTG, most of which have adopted latest system designing and manufacturing technologies covering the following aspects:

Variable Pitch

This technology allow the pitch to be variable and increase theturbine power coefficient by 1－2％. Almost all the foreign WTG now apply this technology.

Variable Speed Constant Frequency

This technology allows the rotor rotation speed adjustable to maintain the most optimal tip-speed ratio so as to to notabley increase the turbine power coefficient, namely by 3%-4%. Almost all the foreign WTG now apply this technology, too.

Longer Blade and Rotor Diameter

This feature enlarge the rotor swept area per kW and thus, given the same turbine power coefficient, increase the electricity output per kW installed capacity. For instance, Spain-based Gamesa Company have increased the rotor diameter of 850 Model from 52 meters to 58 meters, and consequently the the rotor swept area per kW go up by 24%. US-based GE Company and Germany-based REpower and Fuhrlaender, as well as Spain-based EHN have all increase the rotor diameter of 1.5 MW WTG from 70.5 meters to 77 meters, and thus the rotor swept area per kW has grown by 19%. The WTG of larger wind rotor is suitable to the wind farms with lower annual average wind speed.

Larger size WTG

Larger size WTG brings it relatively lower land cost per kW, and is suitable to employ high tower so as to enjoy relatively high wind speed at the height of hub and increase power output. Megawatt size and 2 Megawatt size WTG are already under mass-production in foreign countries, however, China is not yet able to produce one. Furthermore, WTG with capacity of 4.5MW and 5 MW are already put into operation.

Non-Gearbox direct-driving Technology

This technology could avoid the disruption due to failure of gear-box and descrease the time for repairing, and also reduce the transmission energy loss, thus increasing power output. This technology has been adopted by Germany-based Enercon Company, Netherlands-based Largway Company, and so on, 1.2MW prototype direct-drive WTG was installed in China in April 2005 by Goldwind.

Others

In addition, some manufacturers have developed WTG performance-improving techniques. For example, GE Company have developed the so-called Low-Voltage Penetration technology

capable of reducing the number and time of system failure in case of wide range vibration of grid voltage and Driving-Chain failure diagnosis technology capabale of mitigate the failure and accidents. All these technologies are to be used for the purpose of producing more electricity.

Based on the aforementioned technologies, the majority of imported WTG are showing good performance, coupled with experiences of long period regarding R&D, designing, manufacturing and on-site operation, their electricity outputes per installed capacity are relatively higher. Nevertheless, these technologies are not yet applied in China.

2）The technological level of domestic WTG

There were originally six WTG manufacturers, namely, Xinjiang Goldwind Scientific and Technological Company, Zhejiang Windey Company, Wandian Company, Beijing Wandian Company, Shanghai Shenxin Company (these four are Chinese exclusively-funded company), Xi'an Nordex Company (jointly-funded company dominated by Chinese side), and Yituo-MADE Company (jointly-funded company dominated by foreign side). However, there are now only five companies in production since Yituo-MADE had stopped production.

Under the strong national support, Goldwind Scientific and Technological Company has developed stall regulated WTG: S43/600 kW and S48/750kW. Goldwind has also gained notable market, having sold 373 units of S43/600 WTG accouting for 9% of domestic market. These two models are quite suitable to small and dencentralized wind farms but not for large ones because the fact that they are designed in early period and feature small capacity, simple structure, and high reliability but lower output per installed capacity. Comparatively, S48/750 WTG has better performance than S43/600 WTG.

Xi'an Nordex Company introduced technologies from Nordex for N43/600 WTG, which is similar to S43/600 Model of Goldwind in terms both technology and performance.

The WTG produced by the above two domestic manufacturers are of earlier design and technology, and lag behind the dominant models in the present market in terms of energy efficiency and material consumption as well as operation performance. The comparison will be conducted between foreign and domestic WTG.

3）The comparison between the energy production of foreign and domestic WTG

A. Comparison of theoretic energy production of single WTG

To compare the performance of different WTG, attention should be paid to the power curves and

theoretic power production per unit or kW at given wind situation. Take the wind power concession projects in Tongyu, Jilin Province and Rudong, Jiangsu Province as example, the theoretic energy productions of different WTG are caculated applying the same method as shown in Table 2-8.

Table 2－8 The theoretic energy production of different WTG models

Manufacturer	WTG	Hub Height (m)	Theoretic energy production per kW （kWh/kW）	
			According to Tongyu wind situation	According to Rudong wind situation
U.S. GE	GE1.5-SE	64.7	2845	2597
U.S. GE	GE1.5-SLE	70	3242	3025
Spain-based Gamesa	G52-850	65	2775	2478
Spain-based Gamesa	G58-850	65	3213	2909
Germany-based Fuhrlaender	F1570	65	2779	2529
Germany-based Fuhrlaender	F1578	70		
Spain-based EHN	IT70 CII	65	2814	2581
Spain-based EHN	IT77 CIII	70	3230	3024
India-based Suzlon	S64/1250	64	2687	2042
India-based Suzlon	S66/1250	64	2857	2187
Chinese Goldwind	S43/600		2300	2100
Chinese Goldwind	S48/750		2450	2450
Chinese Xi’an Nordex	N43/600	50	2300	2100

Although different calculation methods would lead to different result with some inevitable error, the relative difference between different WTG remain constant. So, it could be seen that the theoretic energy productions of imported WTG are 20% more than those of domestic ones.

B. Comparison of theoretic energy production of wind farms

In the same wind farm, the WTG with higher tower and hub height would enjoy higher wind speed. Given definite land area, larger WTG could be distributed more dispersely and thus mitigate the wake loss. Therefore, the notable difference exist between the energy production of the wind farms with the same total installed capacity but different WTG models, that is, the

imported WTG featuring higher tower and larger unit capacity is rather advantageous than domestic ones.

It is thus known that the domestic WTG lags behind the foreign ones in terms both technology and operation performance. In practice, given the same situation, the energy production of domestic WTG is far less than imported ones.

2.7. The cost comparison between the foreign and domestic WTG

When considering the cost difference between domestic and imported WTG, following factors should be covered:

1）Price of WTG

Big price difference exists between the domestic WTG and foreign ones, and the domestic ones are far cheaper. The preliminary quoted prices are given in Table 2-9, which shows that, the foreign WTG, except for G58 Model of Gamesa, are more expensive than domestic ones by roughly 30%.

Table 2-9 Priliminary quoted prices of WTG in Chinese Wind Concession projects

Company	Model	Quoted Price （excluding tax, USD/kW）	Quoted Price （CNY/kW）
GE	1.5sle	695	5750
Gamesa	G58	516	4270
Vestas	V80	707	5840
REpower	MM82-80		5770
Suzlon	S66	585	4840
Goldwind	S48		4540
Goldwind	S43		4150

2）Import Tariff

According the Chinese tax law and custom regulations, the import tariff rate for integrated wind power system and components are 5% and 3% respectively on the basis of contract price.

3）Import VAT

The import VAT rate is 17% on the basis of the sum of contract price minus freight and insurance charges and custom.

4）Overseas Freight and Insurance Charges

Overseas freight and insurance charges refer to the sum of the costs due to transporting equipment from producing country to importing country and the corespongding insurance premium, which amounts to 5% of the contract price.

5）Transport Cost at home

The transport cost at home dependes on the location of importing port, assembly site and wind farm site, and favourable ways and routes will be selected. Generally speaking, the costs for imported WTG are higher due to large sizes. However, this cost is negligible due to its small portion in the total cost.

6）Cost of Electricity Transmission line in wind farm

The arrangement of tramsmission lines in wind farms would differ notabley, depending on the installation of foreign WTG or domestic ones. Take a wind farm with capacity of 100 MW as example, 67 WTG of 1.5 MW or 117 ones of 850 kW would be installed if they are all foreign ones; however, 134 WTG of 750 kW or 167 ones of 600 kW would be needed in case of domestic WTG. Although relatively thin, the transmissionlines for small size model would lead high cost due the bigger length and higher complexity regarding construction as a result of larger number of installed WTG.

7）Cost of Tower

The unit cost per kW of larger size tower tends to be lower. As a result, imported WTG are usually of large scale with lower unit cost for tower.

8）Cost of WTG base and wind farm land

Usually, the costs per kW for base construction and wind farm land tend to go down as the size of WTG goes up. Therefore, the imported WTG with larger capacity lead to lower cost per kW for base construction and wind farm land.

Consequently, the quoted prices of imported WTG are much higher than those of domestic ones because of higher manufacuturing cost and labor cost in foreign countries. Furthermore, more expenditures such as import tariff, import VAT, overseas insurance and freight charge are necessary for imported WTG. The transportation cost at home for imported WTG featuring large size are also much higher than those of domestic ones. Althouth the imported WTG are more favorable in terms of the cost for tower manufacturing, base construction and farm land, the total

investment cost for wind farms of imported WTG are much higher than those of domestic ones, which represents the advantage of domestic WTG.

Based on the above comparison, imported and domestic WTGs show different merits and demerits. Therefore, the combination of both options is desirable: introducing latest technologies from abroad to facilitate the WTG production at home. This strategy would enables China to take the advantage of advanced technologies and simultaneously lower the cost, which meet the fundermental objective of the localization of WTG manufacturing.

3. Localization progress of Chinese wind turbine generator

3.1. National programs

3.1.1 Riding the Wind Program

In 1996 the former SPC started “Riding the Wind Program” and organized the cooperation of the domestic manufacturers and the wind power equipment manufacturers abroad. The wind electric equipment manufacture industry system has been set up by introducing the advanced technology and establishing the joint ventures, such as two Sino-foreign joint ventures of Yituo-MADE (Luoyang) Wind Electric Equipment Limited Company and Xian Nordex Wind Electric Equipment Limited Company, by encouraging Xinjiang Goldwind Scientific and Technological Limited Liability Company to build the general assembly factory and by supporting the fittings factories like Baoding Propeller Factory and Xiangtan Electrical Machinery Group Co., Ltd. At the same time, the aiding projects, such as Dali wind farm, Dabancheng wind farm and Huitengxile wind farm, were arranged in the “Riding the Wind Program” in order to install the WTG. It promoted the WTG manufacture industry of China and initially established the wind power equipment industry system of China by exchange technology with market.

3.1.2 National Debt Wind Power Program

In order to advance the development of China’s wind power industry and to change the stagnancy of the wind power industry, in 2000 the former State Economic and Trade Commission (SETC) and the former SPC began to utilize the national debt fund to carry out the National Debt Wind Power Program. It aims at developing the wind power equipment with independent intellectual property rights and reducing cost and increasing the international competitiveness.

The basic idea of the program is to choose the wind farm with rich resource, strong economy and

experienced management to lead the way. By open bidding the model wind farms choose the whole machine factory that chooses likewise the fittings factories by bidding. Those that can't be locally made can be imported. The buyer and seller sign the supplying contract with the progress of localization involved, which can be implemented after registration by the SETC. The model wind farms are obligated to offer the convenient service for the assembly factory, whereas the assembly factory ought to provide timely repair and sufficient after-sale service for the wind farm.

The objective of the National Debt Wind Power Program is to constantly innovate and improve the wind power equipment with independent intellectual property rights, to form mass production, to decrease the manufacturing cost of the wind turbine generator and to enforce the international competitiveness of Chinese wind power equipment manufacture industry.

The model wind farms of the National Debt Wind Power Program have a total installed capacity of 80 MW and are carried out in three stages each with a capacity of not less than 10 MW. The rate of localization for the first stage of 30 MW is 50%. That for the second stage of 30 MW is 75% and for the third stage of 20 MW is 85%. The rate of localization of the WTG is calculated according to the five main component parts: 1) generator; 2) gear box; 3) electric control system; 4) steering device; 5) blade. The unit capacity of the WTG adopted by the model wind farm cann't be less than 600 kW.

The actual annual power output of WTG systems should be not less than 95% of that promised by the whole machine factory. The operation time promised is defined by the buyer and seller. The price of the WTG systems in the National Debt Wind Power Program is decided by bidding with the principle of no more than that of the imported systems.

After selection, Dalian Power Supply Company, Yingkou Power Company, Chifeng Power Company and Xinjiang Wind Energy Company won the qualification of project implementation. The distribution scheme of total capacity is 10 MW for Dalian, 10 MW for Yingkow, 30 MW for Chifeng and 30 MW for Xinjiang. The four wind farms, of Dalian Changhai, Yingkou Xianrendao, Chifeng Dali and Xinjiang Dabancheng, have been put into action until 2004.

According to the operational method of national debt project, the nation provides commercial loans for the national debt project and relieves some interest on loans. Three wind farms, Dalian Changhai, Yingkou Xianrendao and Chifeng Dali are individually relieved from a year interest on loans. Also Xinjiang Dabancheng wind farm is relieved from two-year interest on loans.

The National Debt Wind Power Program is carried out in the valley of development of Chinese wind power industry, which brings the market and environment of development of the localized

WTG systems, stimulates the WTG manufacture industry and furthermore lays a foundation for the constant and healthy development of Chinese wind power industry.

3.1.3 National 863 R&D Project on development of MW size WTG

Naitonal 863 R&D Project is a national hi-tech development program implemented by the Ministry of Science and Technology (MoST). In 2001, the National 863 R&D Project on development of MW size WTG system was arranged by the MoST to encourage localization of the WTG systems under the subsequent energy technology project of the energy technology field. Four subjects are involved in the project, which names and undertakers are following:

- Development of 1.2 MW direct driver WTG without gear box, by Xinjiang Goldwind Scientific & Technological Company, which used to development of MW size stall regulated WTG
- Development of MW size variable pitch and variable speed WTG by Shenyang University of Technology.
- Development of 1.3 stall regulated WTG by Chinese Helicopter Research Institute
- Development of 1.5 MW variable pitch and variable speed WTG by Longyuan Power Group

All of these four subjects are designed to develop MW size WTG systems to satisfy the growing wind power market, among which there are different technologies and installed capacities. The subjects include stall regulated technology, initiative stall regulated technology and variable pitch and speed technology. Xinjiang Goldwind Company changed into direct drive WTG systems without gear box, which stands for the technical direction in future, because it concluded that the stall regulated WTG system has not a bright prospect after a full argumentation during implementation. The subjects involve variant technical fields of current WTG systems. The unit capacity is 1.0 MW, 1.2 MW, 1.3 MW, 1.5 MW respectively. The commercial prototype WTG is required to be made in each subject.

Most subjects proceed well except very few ones and can be finished by the end of 2006 in accordance with current progress. The project is expected to push forward the technical development and manufacture of Chinese WTG equipment, to reach theoretically international level and to develop large-scale WTG prototype which reaches or approaches the top international level so that it paves the way for further research and improvement.

3.1.3.1 Development of 1.2 MW direct driver WTG without gear box by Xinjiang Goldwind Scientific & Technological Company

Project background

The initial name of the National 863 R&D Project undertaken by Xinjiang Goldwind Scientific and Technological Limited Liability Company is “Development of Megawatt size active stall regulated WTG system and its key components”. During the development, some technical problems are found about stall regulated WTG (including active stall), which are listed as following:

- Bad calculation accuracy of dynamic performance in stall area
- Because the curve slope of lift coefficient is negative after stall, that is, the lift coefficient decreases when the attack angle expands, the aerodynamic damping is also negative. It tends to cause blades uncertainty of bending modal and vibration in the lead-lag and flapping direction.
- Wind rotor will receive strong push in stall state because the resistance of the high speed blade to stall state will increase.
- The limited load of stall regulated WTG is larger than that of the variable speed constant frequency WTG.

On account of that, Goldwind Company believe that the stall regulated technique is not the future popular one and it leads to more weight of nacelle and tower because its load is larger than that of variable speed constant frequency type. So, its manufacture cost isn’t easily diminished. The stall regulated technique influences the economy when the WTG is put into market in future and the market application prospect of the achievements from the National 863 R&D Project. With eh approvement of MoST, the project title is formally changed to “Development of 1.2 MW direct drive WTG systems” with a type of Goldwind 62/1200.

Main features of the WTG system

A general design scheme is provided in Goldwind 62/1200 WTG system, comprising horizontal axis, three blades, upper wind direction, variable speed and pitch, direct drive, PM synchronous generator, full power AC-DC-AC converter, connection with the electric network.

It has the following advantages:

- Reliability and availability of the WTG systems are increased due to the decrease of the

transmission parts.

- The efficiency of the WTG systems is improved owing to the adoption of PM power technology and variable-speed and constant frequency technology.
- Noise of the WTG systems is diminished thanks to the decrease of the transmission parts.
- Improvement of reliability helps the WTG systems reduce its maintenance cost.
- Decrease of the transmission parts reduces mechanical lost and improves overall efficiency.
- Application of variable speed and constant frequency can realize reactive compensation.
- Decrease of parts shortens the overall manufacture period.

Miscellaneous innovative techniques are also applied in the type so it takes the following advantages over present direct drive types in current world market.

- High efficiency and wide speed range of the generator（11rpm～20rpm）
- Without excitation lost
- Little maintenance and high availability due to absence of carbon brush and slip ring
- Compact structure and small size of the generator
- The pitch-changeable and belt-drive system needs no fabrication and maintenance.
- The brushless AC motor is adopted in the pitch-changeable system and the capacitor is used as spare power source with a long life and without maintenance;
- The variable frequency device that takes the tested and mature technique has few harmonic components.
- The design scheme of the cabin structure is humanized.

Project progress

Design of the overall machine and the parts has almost come to the end. The design report is edited, involving the overall machine and its subsystems, the parts, calculation report, drawings, instruction book and so on.

The main parts of the first prototype are finished, such as blades, generators, power control device and converter assembly, variable pitch device, yawing system and etc, and some of its fittings are in final processing. Assembly process of the overall machine, preparation of fixtures and the base are also completed. It is predicted to finish assembly at the end of 2004 and to finish

installment, test and preparation at the beginning of 2005.

The second prototype will be finished in August, 2005 on schedule. Detailed design of its main component parts, such as blades, electric control system, converter system and generator, has been fulfilled. The process design is in progress. Some is in trial produce. The localization rate of overall machines will get to more than 90% after accomplishment of the overall project.

3.1.3.2 Development of MW size variable pitch WTG by Shenyang University of Technology

This project will be carried out in three stages. The first stage is for overall design of the WTG systems and individual design of main parts, and analysis of aerodynamics, structure and structure dynamics. The second stage is for manufacture of parts and test of main parts, linkage of surface assembly of the WTG systems. The third stage is for field installment and debugging, preparation, inspection and acceptance of the prototype of the variable speed and constant frequency WTG systems.

Conducted work

- Argumentation of the general scheme and the technical design for the MW size WTG systems with variable speed and constant frequency, including:
  - Design of structure, outline and parameters of the WTG systems
  - General layout of the overall machine
- Design of the key component parts, including:
  - Design, analysis and calculation of the blades' shape, structure and aerodynamics
  - Design of 1 MW double fed generator, calculation of electric magnetism and determination of development scheme
  - Scheme design of the electric control system, including control strategies, control methods and control flow
  - Scheme design of the gear box and the transmission, optimum design of gear box, drive shaft's outline and shape and its parameters, estimation of distribution of the temperature field in gear box and analysis of fatigue behavior
  - Design of variable-pitch mechanism
  - Design of hydraulic, brake and yawing systems
- Analysis and check of aerodynamics, structure, and structural dynamics of the overall machine

- Modeling, test and simulation of 1 MW WTG systems with variable speed and constant frequency, development of simulator stand of the generating system with variable speed and constant frequency
- Completing the manufacture of the fittings for the first prototype, which makes up of blades, generator, gear box, transmission system, yawing system, cooling system, hydraulic system, hub, tower and cabin assembly
- Completing engineering application of the control device with variable speed and constant frequency, and the surface online linkage of main control system and device with variable speed and constant frequency.

Work in process

- General assembly and surface linkage
- Engineering construction of transmission and distribution equipment, preparation of field installment, debugging and preparation

Work in the last two months of 2004

The project team has defined the countdown schedule by the end of 2004. Liaoning Xianrendao wind farm is chosen as the field for installment and operation of the WTG systems.

- Finish lifting the WTG systems on 31, Dec, 2004
- Finish ground online debugging of the WTG systems on 15, Dec, 2004
- Finish general assembly of the WTG systems on 30, Nov, 2004

3.1.3.3 Development of 1.3 stall regulated WTG by Chinese Helicopter Research Institute

In November 2001, Chinese Helicopter Research and Development Institute (CHRDI, abbr. 602 Institute) began to undertake the National 863 R&D Project titled Development of 1.3 MW size stall regulated WTG and its key components.

Jiangxi Zhonghang wind power hi-tech Ltd. was formed In December, 2003, a collaboration of 602 Institute, Beijing Shuguang Motor Factory and Suzhou Zhonghuan Group (private enterprise). The business scope makes up of design, development, manufacture and sale of the WTG system and its fittings; design, test, layout and management of wind farms; technical consultation and service of wind energy field.

The objective of Jiangxi zhonghang is, to finish development of the first practical prototype with 1.3 MW stall regulated WTG system and to pass the 2000-hour operative examination in wind farm by 2005; to develop three prototypes altogether for industrialization, which general performance index and reliability index should reach or approach the kindred type when passing

product evaluation; to establish annual production capability of 20 units of 1.3 MW WTG and realize product serialization.

Development schedule

Scheme design (Jan, 2002 -- Oct, 2002)

The design scheme of the 1.3 MW stall regulated WTG system was completed in Octorber 2002 and passed check and acceptance of the national 863 expert team in Octorber 2003.

Engineering design (Oct, 2002 -- Oct, 2003)

Completing design of the engineering drawings including general assembly drawing, the system assembly drawings and part drawings of hub, transmission, cabin and tower, hydraulic system schematic, cooling system schematic, system installation diagram, and electric schematic of the electric control system, connection diagram and installation layout.

Compiling Key Parts Collection of WTG and other documents about quality control of commission parts, putting forward the quality control request of key parts and commission parts; compiling General Assembly Process of A-type WTG System, and Field Test Item of A-type WTG System etc.

In laboratory, complete the simulation test of grid connection system, central control system and remote monitoring system, test basically feasibility of the electric control design.

All the engineering drawings and documents went through the technological and standard inspection by related sectors of 602 Research Institute, and passed the engineering design evaluation organized by 602 Institute.

Prototype preproduction (from Jan 2004)

Complete engineering design of 1.3 MW stall regulated WTG system by the end of 2003 and begin preproduction of the first prototype from Jan 2004

(1) Sign process and purchase contracts of key components

Choose the cooperator of reliable quality and proper price by competitive bidding. Take a priority to produce and purchase these components from domestic enpterprises to reduce cost and improve localized rate on condition of satisfying technical requirement and reliability.

(2) Preparation for general assembly

All component parts are entering warehouse in succession at present. The documents of installment and debug are finished inside and outside field. According to plan, the shop assembly will be carried in the middle of December 2004, the site installment and debug will be done in March 2005, and the test run will be carried in June 2005.

3.1.3.4 Development of 1.5 MW variable pitch and speed WTG by Longyuan Power Group

In 2002 Longyuan Company began to undertake the national 863 R&D Project titled Development of 1.5 MW Variable Pitch and Speed WTG.. In order to be competent for the project, Longyuan Power Group set up a wind energy development center in Mar 2002. In addition, it built a computer workstation and introduced American ADMAS, the software for analysis of mechanic kinematics and dynamics to implement the development and design by advanced computer simulation technology. All the cooperative agencies and company, such as China Aerodynamics Research and Development Center (CARDC), CAS Electrical Engineering Research Institute, Tsinghua University and China Electric Power Research Institute, make concerted efforts and a certain progress.

In addition, Longyuan Power Group and the undertakers of sub-project arranged more than twenty specialized research institutes and manufactures on blade, gear box and motor controller to research, develop and produce these key components.

The center finished initial design of the 1.5 MW variable pitch and speed WTG system by the end of 2002, which passed the phased check and acceptance organized by the MoST in Oct 2002. The contents mainly include the following.

- Overall design of the WTG system, including, 1) the initial design of overall structure, 2) overall mechanics analysis of the WTG system;
- Initial design of the wind turbine of the WTG system, including 1) aerodynamic shape design of the turbine blade, 2) performance calculation of the wind turbine, 3)structural design of the turbine blades, 4) load calculation of the wind turbine, 5)design of the wind turbine hub and variable-pitch system.
- Initial design of electric control system and cyclo-converter device, including, 1) general technical solutions of the electric control system of 1.5 MW variable speed and pitch WTG system, 2) technical design solutions of the cyclo-converter device of the double fed variable speed and pitch WTG system, 3) design solutions of optimized operational control technology of the variable speed and pitch WTG system, 4)summary of the interface signal of actuators and sensors in the electric control system and the WTG system., 5)completion of building laboratory and preparation for experiment bed, 6) performance test of some fittings and linkage
- Research and initial design of double fed asynchronous motor, including conceptual design, overall design, electromagnetic solutions and simulation calculation;
- Ongrid technology of megawatt size variable speed and constant frequency WTG system.

3.1.4 Wind Power Concession Projects

In December 2002, in order to promote the wind energy scaled up development and commercial operation, the former SPC approved of the concession project proposals for Rudong wind farms in Jiangsu province and Huilai wind farm in Guangdong province. According to the document, the capacity of each wind farm is 100 MW, the unit capacity of WTG is not less than 600 kW, the localization rate of WTG system should be no less than 50%.

The investors for each wind farm are chosed by open bidding. The investor, who promised lowest electricity price and the highest localization rate, will win the bidding.

The concession period is 25 years since the first WTG are put into operation. In concession period, it will have two different electricity prices in the whole concession period. The first price is the electricity price put in by the company that won the bid, which is for the period before the total electricity production by the wind farm up equival to 30,000 hours of full load generation. The second price will be set at the average electricity price in the electricity market, which is for rest concession period after 30,000 hours of full load generation.

Local power grid company will purchase the electricity resulting from the wind farm at the above price, and the incremental electricity price compare to the coal electricity will be share on the privincial electricity grid.

Because the bid is put together by the provincial government, the investor who wins the bidding will sign concession agreements with Provincial Planning Commission and sign purchase and sale contracts with Provincial Power Grid Company.

The localization rate of the WTG system for the concession projects in 2004 has increased up to not less than 70%. The locialization rate is calculated on the rate of WTG system components which is based on the average price in the current market. Table 3-3 is the calculation table for comparison.

Table 3-3 Calculation table for localization rate of WTG system

No.	Components	Reference ratio (%)
1	Tower	16.9
2	Electrical facilities in wind farm (box transformer substation, 10kV/35kV cable)	7.2
3	Nacelle	4.4
4	Generator	7.4

No.	Components	Reference ratio (%)
5	Blade	22.5
6	Gear box	15.4
7	Drive shaft (including bearing, coupling)	3.4
8	Hub (with pitch-variable mechanism)	4.2
9	Yawing system	1.3
10	Central monitoring system	3.5
11	Electric control system	3.5
12	Hydraulic system	2.2
13	General assembly	3.0
14	Spare parts	1.0
15	Others	4.1
16	Total	100

The total capacity of two concession projects in 2003 is 200 MW. Yuedian Group won the bidding for Guangdong Huilai project and took 600kW WTG systems of local Xinjiang Goldwind Company which localization rate over 90%. Huarui Group won the bidding for the Jiangsu Rudong project. The localization rate can meet the request for 50% so long as four items among the above table, that is, blade, tower frame, electric equipment and others are domestically purchased.

The total capacity of three concession projects in 2004 adds up to 650 MW. Longyuan Power Group and Huaneng New Energy Company together won the bid for Tongyu projest in Jilin province each with 200 MW. Beijing International Power New Energy Company won the bid for 100 MW Huitengxile project in Inner Mongolia. Longyuan Power Group also won the bid for 150 MW Rudong project (phase II) in Jiangsu province. In order to meet the request of 70% localization rate, beside the blade, tower frame, electric equipment and others, at least one key component, for example generator or step-up box, and some small components should be produced in China.

There are two more options to meet the request on the localization rate. First is to completely import WTG systems at first and gradually adding local parts in the later WTG systems; second is to match completely imported with completely local WTG systems, as a result, the average localization rate of the WTG systems in all wind farms is not less than 70%.

3.2. Problems and obstacles of wind turbine generator localization

Fluctuating of wind power market development

The most serious influence to the wind power generator localization is the fluctuation of local market. As cost advantage of local WTG mentioned above, the manufactures will try best to arrange the local producing for the necessary of competition and profit. A stable, continuing development wind power market is the precondition of local production. On the contrary, the instable and discontinuous market is harmful. This is one of the reasons why the wind power development in China is slow.

Difficulty in technology acquirement

With a series of policies and measures to stimulate the wind power development in China, the foreign wind power generator manufacturers realized the huge market and continuous development potential of China's wind power. At the same time, China has carried out the reform and opening policy and entered the WTO. Most of the manufactures with considerable market development are more willing to build the factories through full foreign investment or joint venture with dominant stake of stocks. Although this does not conflicted with the stimulation of localization, but under this condition, the Chinese manufacturers have less choice to acquire wind power technologies.

It is more difficult for the domestic manufacturers to acquire technologies and they have to seek other approaches such as study by itself, purchase technologies, joint design, or seek some small foreign manufacturers to cooperate. Theses methods need more time, more financing input, and the technology risk is also huge.

Conflict between performance, quality and cost

Now there still exists the conflict between performance, quality and cost in Chinese WTG manufacturing.

The production with good performance and quality commonly has high cost and price because of high and complex technology, design and manufacturing requirement. The owner of wind farms generally has to make a disicion which one they prefer, local-made WTG or import WTG, based on the detailed condition of wind farm and their capital status. Because of lack of experience and demonstration projects, it is difficult to evaluate the equipments, and the choice is blind in some extents.

From long term perspective, performance and quality are more important than the cost, and should be emphasized. Reducing the cost and price should be based on ensuring the performance

and quality. The operation period of wind farms is generally 20 years, so WTG equipments and key components must be guaranteed to 20 years without large malfunction. It is wrong to seek low cost by decreasing the reliability.

Lack of certification and testing methods

Design certification of wind power equipments is very important, but now there is not any certfication system in China, and lack of the testing and validate method. The wind power equipments developed in China is difficult to take part in the market competition without any testing and certification.

Lack of wind power equipment designers

Because of the slow development of the domestic wind power in the past years, the wind power field is difficult to attract enough person. Until now, there are only about 1000 people involved in wind power industry. Most of them are operation and management person in wind farm and their diathesis need be improved. It is very lack of senior researcher on WTG research and development. Lack of human resource is an important barrier to the wind power development in recent time.

Risk of WTG demonstration

The local-made WTG systems need a demonstration period to testing the performance and quality, and then be accept by market. Who should bear the risk of demonstration and testing? The owner of wind farms are not willing if the price difference between importing and local-made WTG systems is not huge. On the contrary, without demonstration and testing, the local-made WTG can't be improved and form mass produce, and the production cost can't be reduced, which will be a constraint to the technical development. This will be a barrier of localization of WTG.

The government should not intervene in the market too much, but can strengthen the support degree to local manufactures and help them to improve the anti-risk ability.

3.3. Why China must develop its own MW size WTG?

The advantage of megawatt size WTG comparing with hundreds kW size is mainly that the sweep area of the rotor is larger and at the same location, and acquiring more wind resource. The advanced electrical and controlling technology could be easy to applied in bigger WTG unit to increase it's efficiency and comprehensive economic benefit. Although at the initial stage, the megawatt size is poorer in economy, the cost will decrease with technical development. In the Europe market, the market share of megawatt size WTG is more than 50% in 2001, and more than 70% in 2003. And in 2004, 2 MW WTG and bigger units became to the dominated units, which shows the trend of international wind energy development.

The population density in the coast of China is big and the shrimp pool and protection forest bestrew along the coastline. And also because the wind speed reduced very quickly after landing, the area for wind farm is very limited. Megawatt size WTG have obviouse advantages in the coastline.

3.4. Opproach of WTG localization

3.4.1 Build the joint-venture enterprises

Under Riding the Wind Programme implemented by the fomer State Planning Commission, with the idea of getting the technology by sharing the market, two joint venture enterprises have been established. Yituo MADE Wind Equipment Company is invested by No.1 Tractor Factory (Yituo) and MADE of Spain jointly to produce the AE46-660kW WTG systems. Xi'an Nordex Wind Equipment Company is invested by Nordex in Germany and Xi'an Aero Engine factory jointly to produce N43-600kW WTG systems. According to the contract, the foreign companies should transfer their technology to joint venture companies, assemble the WTG in China, and increase the localization rate gradually. But in actual management, the foreign company is negative to transfor the technology to joint venture company and to produce the components in China, and only want the joint venture company responsible for maintainance and after sale service. Moreover, the wind market at that time is small, these two joint-venture companies couldn't grow up even with the subsidies from the former SDPC and the implementation of National Debt Wind Power Project. Now, Yituo MADE Wind Equipment Company stopped production because the Gamesa, which purchased MADE and became the shake holder of Yituo MADE, refused to fulfill the signed contract.

The foreign companies are afraid this cooperation way because the joint venture could train another competitor in this feild. For example, ten years ago the Vestas in Denmark and Gamesa in Spain established the joint venture company in Spain. When Gamesa grow up, Gamesa purchased the stock of Vestas in joint-venture company. Gamesa became independence to Vestas and even more the competitor to Vestas in the international market.

Currently, the approachs of establishing joint-venture is quite difficult.

3.4.2 Full foreign investment enterprises

The assembly manufactures and components enterprises with powerful strength and main market share, such as Vestas, GE Wind, Gamesa and LM are inclined to apply the full foreign investment type, and choose the eligible component enterprises in China. As their plans, these subsidiary companies in China will supply both Chinese wind market and some foreign market near China.

The advantage of this way is to cultivate the producing capability of local component manufacture enterprises, and increase the localization rate quickly. The disadvantage is that the foreign enterprises don't transfer the technology to Chinese companies. Some of these manufacturer will sign the contract with local component enterprises, in which the components enterprises will be forbidden to supply the components to other assembly companies. These foreign assemble enterprises will monopolize domestic excellent component companies, and decrease the capability of local assembly manufactures.

3.4.3 Production license

The general way is that Chinese partner acquires the manufacture technology of the WTG and the technical requirement of key components, and gets the aid of production ability after paying the technology transfer fee to the foreign partner. The foreigners can get a percentage income from each production after scale producing.

The advantage of this way is to avoid the conflict difficult to harmonize between the partners. The foreigners can get return from transferring technology and expanding market share. The Chinese partners can acquire the technology and master them, working on the local-made development and forming our own development ability after accumulating experience, and he constraints from the foreigners are little.

The disadvantage is that the transfer fee is high and it is difficult to acquire the most advanced technology, and normally, it is constrained to sale the products to the foreign market.

Under the current condition, this way is accepted by the two partners. Xinjiang Goldwind Company acquired 600 kW WTG technology from the Jacobs Company of Germany and now the localization rate has reached 90%. Because of the decreasing of cost, over 300 order forms are got and over 100 WTG systems are on operation with good profit. This WTG type sale less in Europe, but succeed in China after transfer. Two years ago, the REpower Company transferred 750 kW technology to Xinjiang Goldwind and Zhejiang Windey respectivley. Now these two companies have over 80% localization rates and started small-scale production. Xinjiang Goldwind company plans to develop the 800kW WTG system with own intelligent property right based on the experience of 750 kW WTG production.

Recently, several domestic companies signed the production license with foreiegn companies. REpower Company transfered the 1.5MW WTG technology to the Dongfang Turbine Company, Furhlaender Company transfered the 1.5MW WTG technology to the Dalian Heavy Engineering and Crane Group, Furhlaender Company transfered the 1 MW WTG technology to the Zhonghang Huiyang Propeller Factory.

3.4.4 **Joint design**

Some small consultant companies in Europe have ability and experience to design the WTG.. Chinese companies could cooperate with these companies, and make full use of their intelligence and shorten the development process of new WTG, and improve the design ability. These companies will get the consultation fee from Chinese partner and Chinese partner will get the independent intellectual property rights. The Chinese designers will work together with the foreign designers to develop the scheme and conduct the design and calculation together. Also the foreign experts will come to China and give supervise on testing and demonstration works until the operation of the phototype WTG and industrialization production.

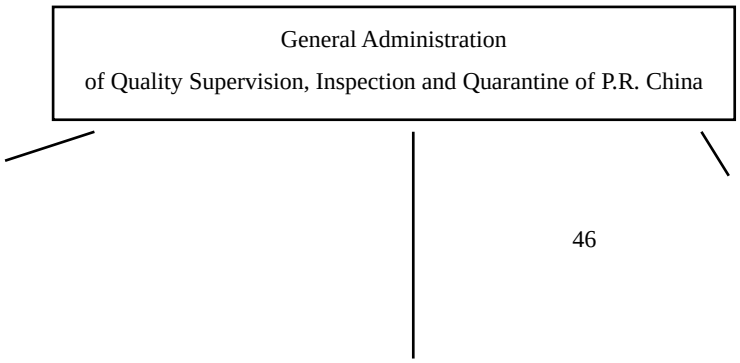
This option has not the successful experience until now.

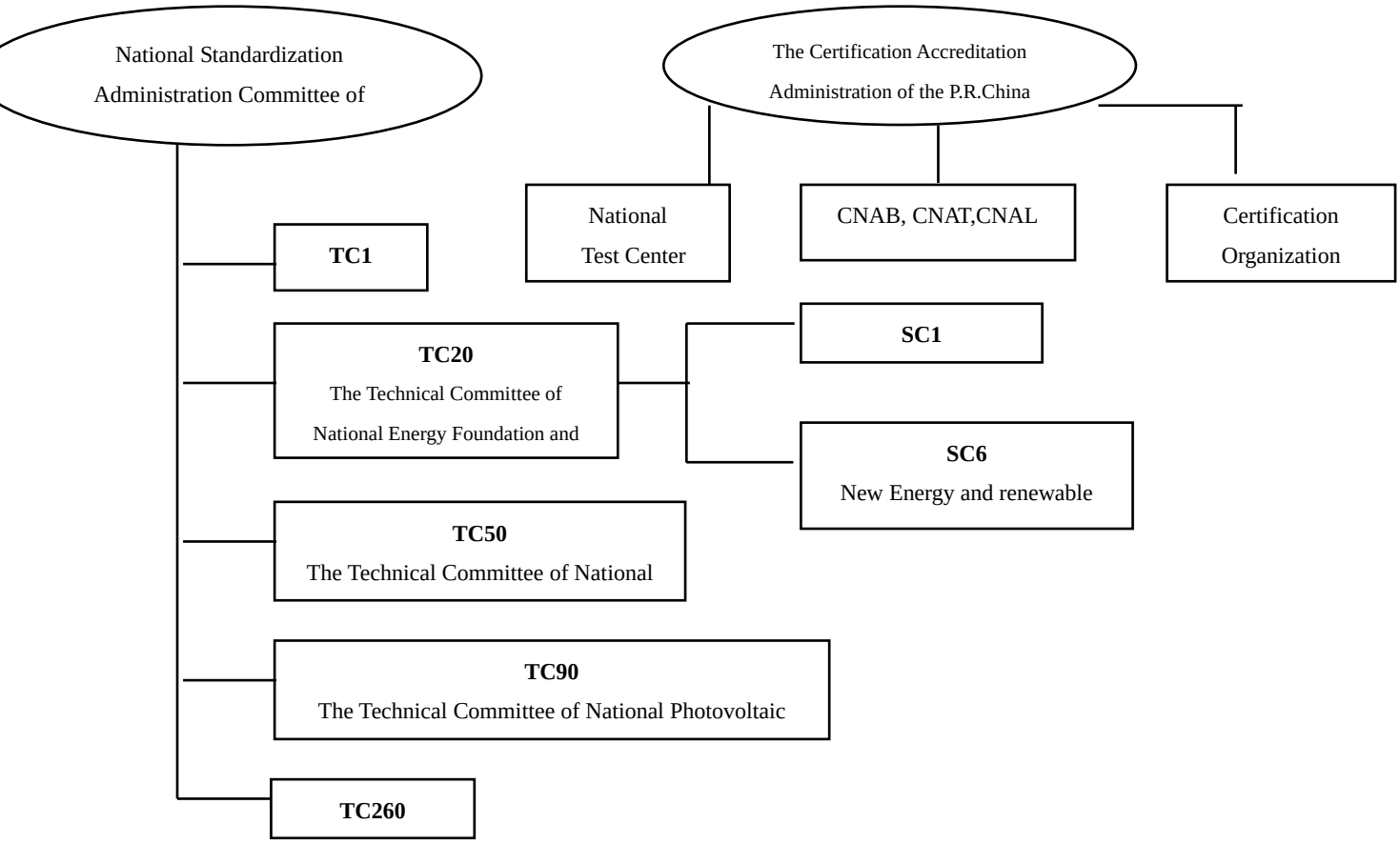
Another approach is that some little companies in Europe have the design capability, and poor manufacture and market deploitation capability. They can benefit each others with Chinese companies of wind power equipments. The Goldwind company and the Vensis company in Germany co-developing the 1.2MW direct-drive WTG is just a good example. The Germany partner has the experience of design and the Chinese partner has the strength of manufacture of permanent magnetic materials. They could work together, drew upon each other's strengths and complete the research of prototype WTGs in a short term.

4. WIND TURBINES STANDARD OF CHINA

4.1 The Structure of China Standardization Administration System

As a professional standard committee, National Wind Mechanic Standardization Technology Council (TC50) is approved by National Quality Technique Committee at 1985. National Wind Mechanic Standardization Technology Council undertakes the organization of national wind mechanic standardization technique, and takes charge of the national wind mechanic standardization technique, which contacts with IEC/TC88. TC50 is under the supervision of the National Standardization Administration Committee. Before 1999, TC50 had mainly worked at the establishing of the standardization of off-grid WTG system, after that, mainly worked at the establishing of the standardization of grid connected WTG system.





4.2 Enacted standards of wind turbine systems

Including 20 national standards, 4 industry standards, CHINA enacted 24 standard of wind turbine generator systems after year's efforts with the standardization of off-grid, grid connected wind turbines generating system and wind farm.

Table 4-1 Enacted national and industrial standards of WTG systems in China

	Standards name and Standards number		**Standards type**	**Date of enforcement**	**Scope**
1	Standards number	GB/T 2900.53-2001			
	Standards name	Electro technical terminology - Wind turbine generator systems	Product basis	2002.4.1	Wind turbine generator systems
2	Standards number	GB 18451.1-2001			
	Standards name	Safety Requirements	Product security	2002.4.1	Wind turbine generator systems
3	Standards number	GB/T 18451.2-2003			
	Standards name	Acoustic Noise Measurement Techniques, edition 2	Product method	2003.9.1	Wind turbine generator systems

4	Standards number	GB/T 19069-2003			
	Standards name	The controller of wind turbines generating system – Technical condition	Product	2003.9.1	Wind turbine generator systems
5	Standards number	GB/T 19070-2003			
	Standards name	The controller of wind turbines generating system - Test method	Product method	2003.9.1	Wind turbine generator systems
6	Standards number	GB/T 19071.1-2003			
	Standards name	Asynchronous generator of wind turbines generating system Part 1: Technical condition	Product	2003.9.1	Wind turbine generator systems
7	Standards number	GB/T 19071.2-2003			
	Standards name	Asynchronous generator of wind turbines generating system Part 2: Test method	Product method	2003.9.1	Wind turbine generator systems
8	Standards number	GB/T 19072-2003			
	Standards name	The tower of wind turbines generating system	Product	2003.9.1	Wind turbine generator systems
9	Standards number	GB/T 19073-2003			
	Standards name	The gearbox of wind turbines generating system	Product	2003.9.1	Wind turbine generator systems
10	Standards number	GB/T18710-2002			
	Standards name	Methodology of wind energy resource assessment for wind farm	Basis	2003.1.1	Wind farm
11	Standards number	GB/T 8116-1999			
	Standards name	Wind-generating sets-Type and basic parameters	Product basis		Off-grid wind turbine generator systems
12	Standards number	GB/T 10760.1-2003			
	Standards name	The generator of off-grid wind turbine generator systems - Part 1 Technical condition	Product	2003.9.1	Off-grid wind turbine generator systems
13	Standards number	GB/T 10760.2-2003			

	Standards name	The generator of off-grid wind turbine generator systems - Part 2: Test method	Product method	2003.9.1	Off-grid wind turbine generator systems
14	Standards number	GB/T 13981-1992			
	Standards name	Design general requirements for wind energy conversion system	Product	1993.1.1	Off-grid wind turbine generator systems
15	Standards number	GB 17646-1998			
	Standards name	Safety Requirements for Small Wind Turbine Generators	Product security	1999.10.1	Off-grid wind turbine generator systems
16	Standards number	GB/T 19068.1-2003			
	Standards name	Off-grid wind turbines generating system - Part 1: Technical condition	Product	2003.10.1	Off-grid wind turbine generator systems
17	Standards number	GB/T 19068.2-2003			
	Standards name	Off-grid wind turbines generating system - Part 2: Test method	Product method	2003.10.1	Off-grid wind turbine generator systems
18	Standards number	GB/T 19068.3-2003			
	Standards name	Off-grid wind turbines generating system - Part 3: Wind tunnel Test method	Product method	2003.10.1	Off-grid wind turbine generator systems
19	Standards number	GB/T 19115.1-2003			
	Standards name	The off-grid wind-PV hybrid generating electricity of household-use Part 1: Technical condition	Product	2003.10.1	Off-grid wind turbine generator systems and Wind-PV hybrid system
20	Standards number	GB/T 19115.2-2003			
	Standards name	The off-grid wind-PV hybrid generating electricity of household-use Part 2: Test method	Product method	2003.10.1	Off-grid wind turbine generator systems and Wind-PV hybrid system
21	Standards number	JB/T 7878-1995			

	Standards name	Terminology of wind energy conversion system	Product basis		Off-grid wind turbine generator systems
22	Standards number	JB/T 7879-1999			
	Standards name	The rule for naming the product of wind energy conversion system	Product basis	2000.01.01	Off-grid wind turbine generator systems
23	Standards number	JB/T 10300-2001			
	Standards name	Wind turbine generation system - design requirement	Product	2001.12.1	Wind turbine generator systems
24	Standards number	JB/T 10194-2000			
	Standards name	Rotor blades - wind turbine generation system	Product	2000.10.1	Wind turbine generator systems

4.3 Wind turbine generator systems standards being established

Now, 24 standard of Wind turbine generator systems are being established, including 1 national standard and 23 industry standard.

Table 4-2 Wind turbine generator systems standards being established in China

	Standard grade	**Standard name**	**Be replaced Standard number**	**Standard character**	**Proposed date of enforcement**
1	National standard	Assembly and installation criterion Wind turbine generator systems		Recommended	
2	Industrial standard	Installation criterion Off-grid wind turbine generator systems		Recommended	
3	Industrial standard	Reliability requirements Off-grid wind turbine generator systems		Recommended	
4	Industrial standard	Acceptance criterion Off-grid wind turbine generator systems		Recommended	
5	Industrial standard	After sale technical service Off-grid wind turbine generator systems		Recommended	
6	Industrial standard	Rotor blades Off-grid wind turbine generator systems		Recommended	
7	Industrial standard	The gearbox of off-grid wind turbines generating system - Part 1 Technical condition		Recommended	

8	Industrial standard	The gearbox of off-grid wind turbines generating system -Part 2: Test method		Recommended	
9	Industrial standard	The controller of off-grid wind turbines generating system - Part 1 Technical condition	JB/T 6939.1-1993	Recommended	
10	Industrial standard	The controller of off-grid wind turbines generating system -Part 2: Test method	JB/T 6939.2-1993	Recommended	
11	Industrial standard	The braking system of off-grid wind turbines generating system - Part 1 Technical condition		Recommended	
12	Industrial standard	The braking system of off-grid wind turbines generating system -Part 2: Test method		Recommended	
13	Industrial standard	The yawing system of off-grid wind turbines generating system - Part 1 Technical condition		Recommended	
14	Industrial standard	The yawing system of off-grid wind turbines generating system -Part 2: Test method		Recommended	
15	Industrial standard	The tower of off-grid wind turbines generating system		Recommended	
16	Industrial standard	Off-grid wind turbines generating centralized power supply operation and management criterion		Recommended	
17	Industrial standard	Off-grid wind turbines generating system basis and connector technical condition		Recommended	
18	Industrial standard	Baking system of wind turbines generating system - Part 1 Technical condition		Recommended	
19	Industrial standard	Baking system of wind turbines generating system - Part 2 Test method		Recommended	
20	Industrial standard	Yawing system of wind turbines generating system - Part 1 Technical condition		Recommended	
21	Industrial standard	Yawing system of wind turbines generating system - Part 2 Test method		Recommended	
22	Industrial standard	General hydraulic pressure system - wind turbines generating system		Recommended	

23	Industrial standard	Low speed wind turbines series，type and basic parameter， technical condition，installation criterion			
24	Industrial standard	Small wind turbine for water and generator test method			

4.4 International correlative WTG standard

- IEC WT 01:2001

  System for Conformity Testing and Certification of Wind Turbines - Rules and Procedures

- IEC 61400-25

  Communications for monitoring and control of wind power Plant

- IEC 61400-24

  Lightning protection for wind turbine systems

- IEC 61400-23

  Full-Scale Structural Testing of Wind Turbine Blades

- IEC 61400-21

  Measurement and Assessment of Power Quality Characteristics of Grid Connected Wind Turbines

- IEC 61400-13

  Measurement of Mechanical Loads

- IEC 61400-12

  Wind Turbine Power Performance Measurement Techniques

- IEC 61400-11

  Acoustic Noise Measurement Techniques, edition 2

- IEC 61400-2

  Safety Requirements for Small Wind Turbine Generators

- IEC 61400-1

  Safety Requirements

- ASTM E 1240-88

  Standard Test Method for Performance Testing of Wind Energy Conversion System

- ASME/ANSI PTC 42-1988

  Wind Turbine Performance Test Codes

- ANSI/IEEE 1021-1988

  Recommended Practice for Utility Interconnection of Small Wind Energy Conversion System

4.5 Existing problems

Now the standards of the product and inspection of grid connected wind turbines generating system are basically complete. During these standards, some directly equal to the standard of IEC, especially those important basic standards. For example, GB 18451.1-2001, the Security Requirements of Wind Turbine Generator Systems, which is a base of the design and administration of wind turbine generator systems, equals to IEC 61400-1 standard. For historical reasons, international standards mainly developed in Europe, which adapt to Europe wind conditions and circumstance properly. But there are many differences between those of China and Europe. As an example, typhoon often occurs in the southeast of China, but seldom occurs in Europe. However, this is not considered in these international standard. The situation that typhoon leaded to damage of wind turbine has occurred in China, Japan and India. Now it is in great need of evaluating these international standard in base of China condition. Some of these standard should be improved according to the wind conditions of China.

Besides the standard and criterions, Guide Book for Design and Certifications is also in great need as complement of the standardization implement. The guide book will give the detail implement methods for research, development, design, and certification of wind turbine generators. For example, supply the load calculation method; clarify how the wind circumstance affects the wind turbine generator systems; how to decide the operating condition according to the wind conditions, and load calculation under such operating condition. It is a popular and development tide to establish Guide Book for Design and Certifications. Nations such as Denmark, German, India and Holland have already established national or organic Guide Book for Design and Certifications. Because of guarantee of widely applicability, the standard and criterions usually are fundamental and general demands, especially those international standards. But the guides can supply the material method. Therefore, China not only needs applicability evaluation and complement for some standards, but also urgently needs Guide Book for Design and Certifications.

5. WIND TURBINE GENERATOR TEST CENTER OF CHINA

5.1 Current condition of wind turbine generator test center in China

Now there is still no completive wind turbine generator test center in China. Approved and supported by CNCA and National Development and Reform Committee (NDRC), China General Certification Center takes charge of establishment of the wind turbines industry inspection center of China.

5.2 Importance and necessity of the establishment of WTG test center

With the support of related national departments, Chinese wind turbine industries have gained prominent achievement after 20 years development. Xian Weide, Yituo Meide, Xinjiang Goldwind, Zhejiang Windey and Beijing Wandian have built the capacity of manufacturing 600kW WTG, and Baoding Huiteng has the ablility to produce blades for 600kW and 750kW WTG. Gearbox factories, for example Chongqing Gearbox, Hangzhou Gearbox, and Nanjing Gearbox have developed the gear box for wind turbines, and have mass-produced. Electric machine factories, for example Xiangtan Electric Machine, Lanzhou Electric Machine and Yongji Electric Machine have developed asynchronous generators for WTG. China has primary ability to produce wind turbines generation system now. Commercialization and industrialization development of wind energy have became one of important works for related national departments. Quality control, testing and certification, as the basic work for commercialization and industrialization, is one of the key urgent problems need resolve now.

The importance of developing testing and certification are listed as below:

- Improve the quality and credit of homemade WTG and key components.
- Promote the wind farm developor to adopt homemade WTG systems.
- Promote the development of homemade WTG components and supply certification and inspection service for components export.
- Meet the quality certification and inspection demand from the wind energy developer, underwriter and investor.
- Via establishment and actualization of certification and inspection, promote the technical development of wind energy equipment, and improve international competition ability of homemade wind turbines generation systems.
- Develop inspection of import equipments and guarantee quality for local users and

ensure import equipments fit Chinese wind farms.

- A set of certification system of WTG equipments has been established in Europe, which has fastest development of wind energy technique in the world. Some certification organizations, such as GL and DNV has established and authorizated. Recent years, America has found that, native manufacturers are at disadvantage in international trade of wind turbines generation equipments without certification system and native certification organizations, so America also actively construct native certification inspection system to eliminate trade technical obstacle, to protect the interest of native manufacturers, to create fair compete circumstance for native manufacturers.
- Help companies to establish quality control system and enhance quality management level.
- Realize national macro control on products quality.
- Reduce quality responsibility risk of industry enterprises.

5.3 Tasks needed to accomplish

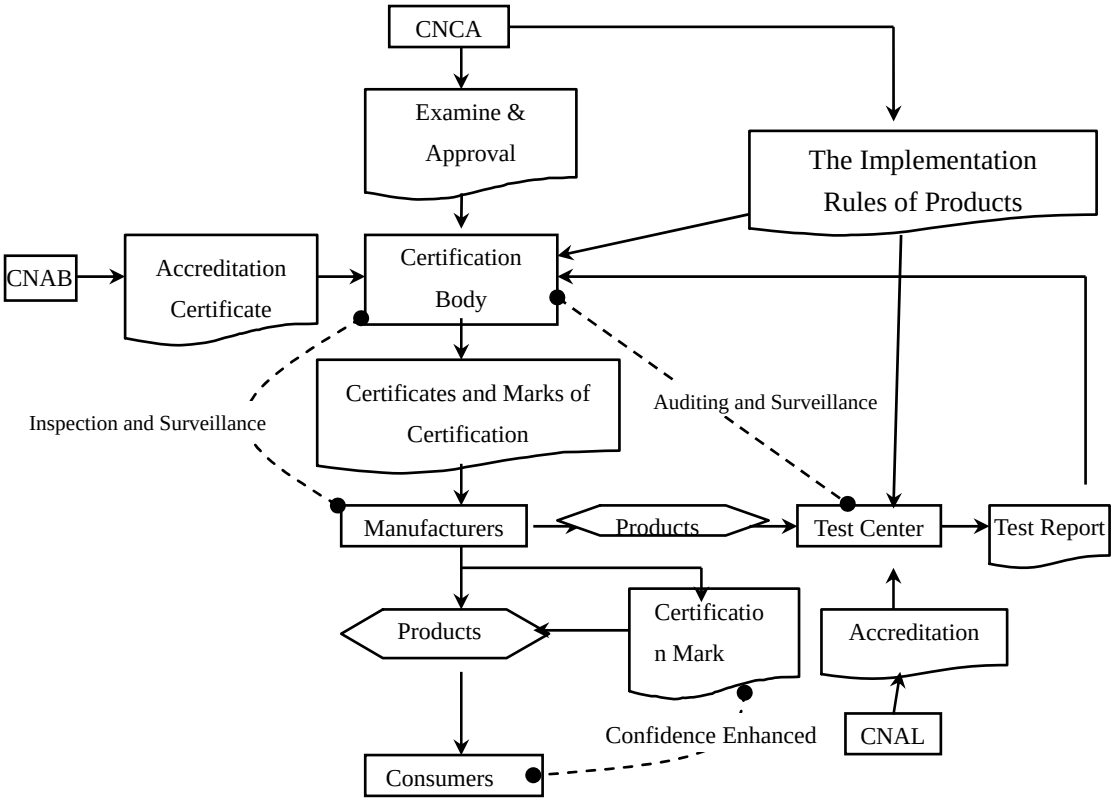
CGC takes charge of the establishment of WTG Testing Center, and build up a work gourp to launch this work as soon as possible. After finish Testing Center Quality Manuals, Program Files, Testing Technique Manuals, and equipping testing equipments, training personnel, CGC will supply for CNAL's authorization.

6. THE CERTIFICATION OF WTG EQUIPMENTS OF CHINA

6.1 The certification accreditation administration and Implementation system of China

In history, the certification accreditation administration of China is composed of certification accreditation administration respectively established and implemented by every department and industry in their relational domains. Thus there are many problems such as multiple policies, crossed administrations, insufficient inspections. In August 29, 2004, State Council decided to found CNCA, thus unify supervise, administration and coordination of national certification and accreditation. The foundation of CNCA indicates that certification system of China will establish new administration mode according to the demand of market economic system, develop certification according to the civics treatment principle of WTO and establish certification accreditation rules and assessment eligibility rules according to criterion, consistent, efficiency principle.

The certification accreditation administration system of China is show as below:



Remarks: CNCA: The Certification Accreditation Administration of P.R.China

CNAB: China National Accreditation Board for Certifiers

CNAL: China National Accreditation Board for Laboratories

CNAT: China National Auditor and Training Accreditation Board

(1) CNCA implements pre-positive admission for certification organizations, that means only after approved by CNCA and gaining corporation qualification, can certification organizations start certification jobs within certification scope. Now China General Certification Center(CGC) is the only one certification organization approve by CNCA to develop certification of renewable energy source equipment such as solar energy water heater, solar PV system and wind turbines generator.

(2) Nation unifies accreditation systems. That means accreditation organizations approved by CNCA evaluate the certification, inspection, testing ability of the certification organizations, test organizations and laboratories, in addition, certificate the eligible certification organizations. Now the accreditation organizations approved by CNCA are CNAB, CNAL, and CNAT.

(3) According to the products certification rules approved by CNCA, certification organizations attest the products of manufactures, certificate the eligible manufactures, and allow eligible manufactures to mark certification signs on their products.

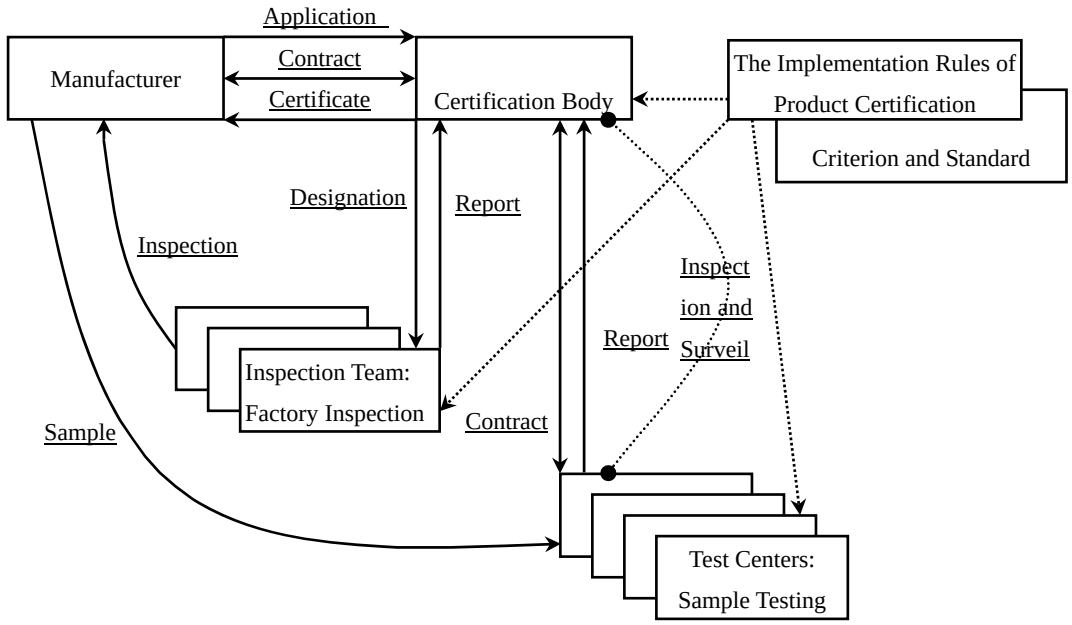
(4) According to the consignations of certification organizations, those test laboratories, which contracted with certification organizations, test and evaluate products samples from manufactures according to related standards and products certification rules. At last, certification reports are wanted.

(5) Manufactures consign certification organizations to do product certification, and to promise necessary conditions.

(6) Certificates and signs of certifications awarded by the certification organizations are authority guarantee of products' quality, which are independent of the both sides of supply and demand. Consumers can diff good products from bad ones according to certificates and signs of certifications, thus improve purchase confidence.

Manufactures apply certification organizations for certification, and certification organizations primarily check the applying enterprises. If eligible, certification organizations will send acceptance and sample notices, on the same time, send test task notice to test organizations. Test organizations test the product samples according to the products certification rules and related criterions and standards. After testing, test organizations will hand test reports to certification organizations. When certification organizations approve these test reports, they will notice applying enterprises and select factory check group members to check factories. Factory check group will put in factories check reports after checking. At last, if certification organizations approve factory check reports, they will certificate these manufacture enterprises. The process of

certification is show as below:



6.2 Wind turbines equipment certification system of China

6.2.1 The develop situation

Now there is still no relational wind turbines equipment certification system in China. Most of wind turbines equipments built in all native wind farms are import models, and most of these generators have GL or DNV certification. One of the important reasons for which there are still no native established quality supervision or certification for several years is that most wind turbines generator systems are not made in China. On the other hand, because there is still no complete certification system, native wind turbines generator systems development has been affected. Thus the quality certification development has been scheduled, and its necessary and importance have noticed by national relational departments. These will promote the development of wind turbines generator system localization.

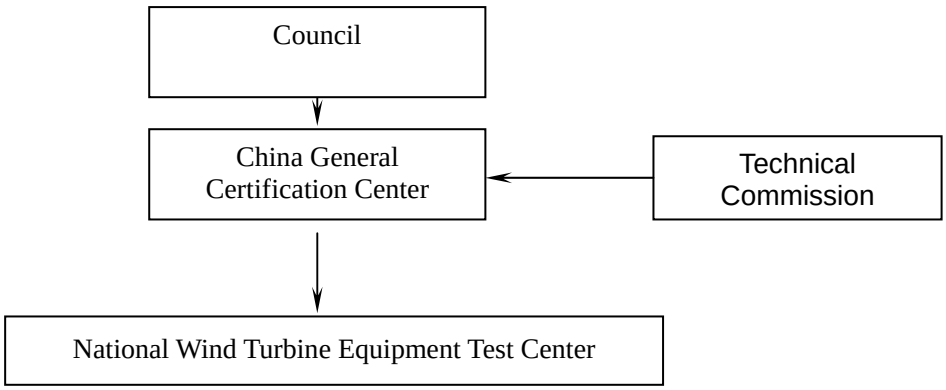
6.2.2 The certification scope and criterions

Certification scope: wind turbines and important parts (rotor, gear box, generator, tower, control system, yawing system).

Products technique characters: high tech products of aerodynamics, material-dynamics, vibration, fatigue, electronics, mechanics and material are correlative.

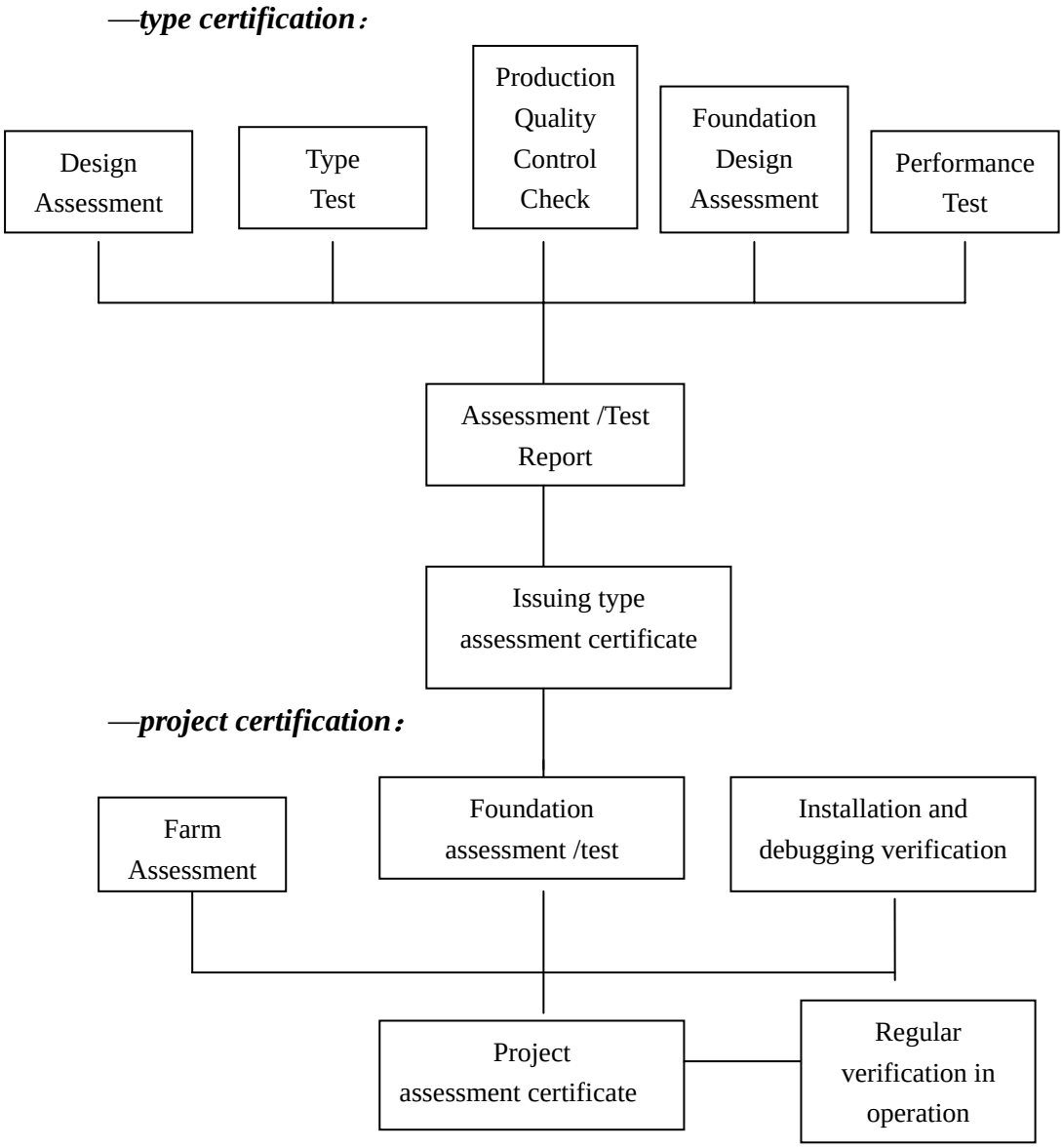
Certification criterions: relational national standards, relational international standards.

6.2.3 Structural establishment



6.2.4 Certification pattern

IEC WT System certification system is adopted:



The wind turbines equipment certification mode includes two parts:

The first part is model certification. That means coherence evaluation of new type wind turbines equipments via design evaluation, mode test and produce field inspection. Type certification is used to confirm that wind turbines are designed, tested, manufactured according to design conditions, appointed standards and other standards, and to verify that wind turbines are installed, running, maintained according to demands of design documents. Type certification applies to a series of similarly designed and manufactured wind turbines. Type certificate will be award if relative technique demands are met.

The second part is project certification. The purpose of project certification is to evaluate wind turbines passed type certification and tower design suit to environment conditions, applicable constitutions, power parameters and other demands correlate to wind farm. Certification organizations should evaluate whether the wind source condition, other circumstance condition, electric grid nets and soil condition accord to wind turbines design documents and tower parameters or not. Project certificates are available only if the results of periodic running testing of approved equipments suit to relative technique demands.

6.3 International Wind turbines equipment certification system

6.3.1 European wind turbines equipment certification system

European nations such as Denmark, Holland and German not only keep ahead at wind turbines technique but also have the most complete, perfect wind turbines generator quality certification system. The relative conditions are as below:

Certification category:

Because wind turbines involve many problems such as security, circumstance affection, electric grid nets safety, wind turbines equipment certification systems established in European nations, such as Denmark, Holland and German, are the safety and eligibility certification.

Certification organizations

Now, European wind turbines equipment certification organizations include GL, DNV, LR, and they all have gained respective authorization from related government agencies. During these wind turbines equipment certification organizations, GL and DNV have the most market shares. It is remarkable that DNV and RISO constructed a new associated certification organization at September 1999. That exerts the abundance experience, fame and global service network of DNV in quality certification field, and the technique advantage, powerful test ability of RISO in wind turbines generators.

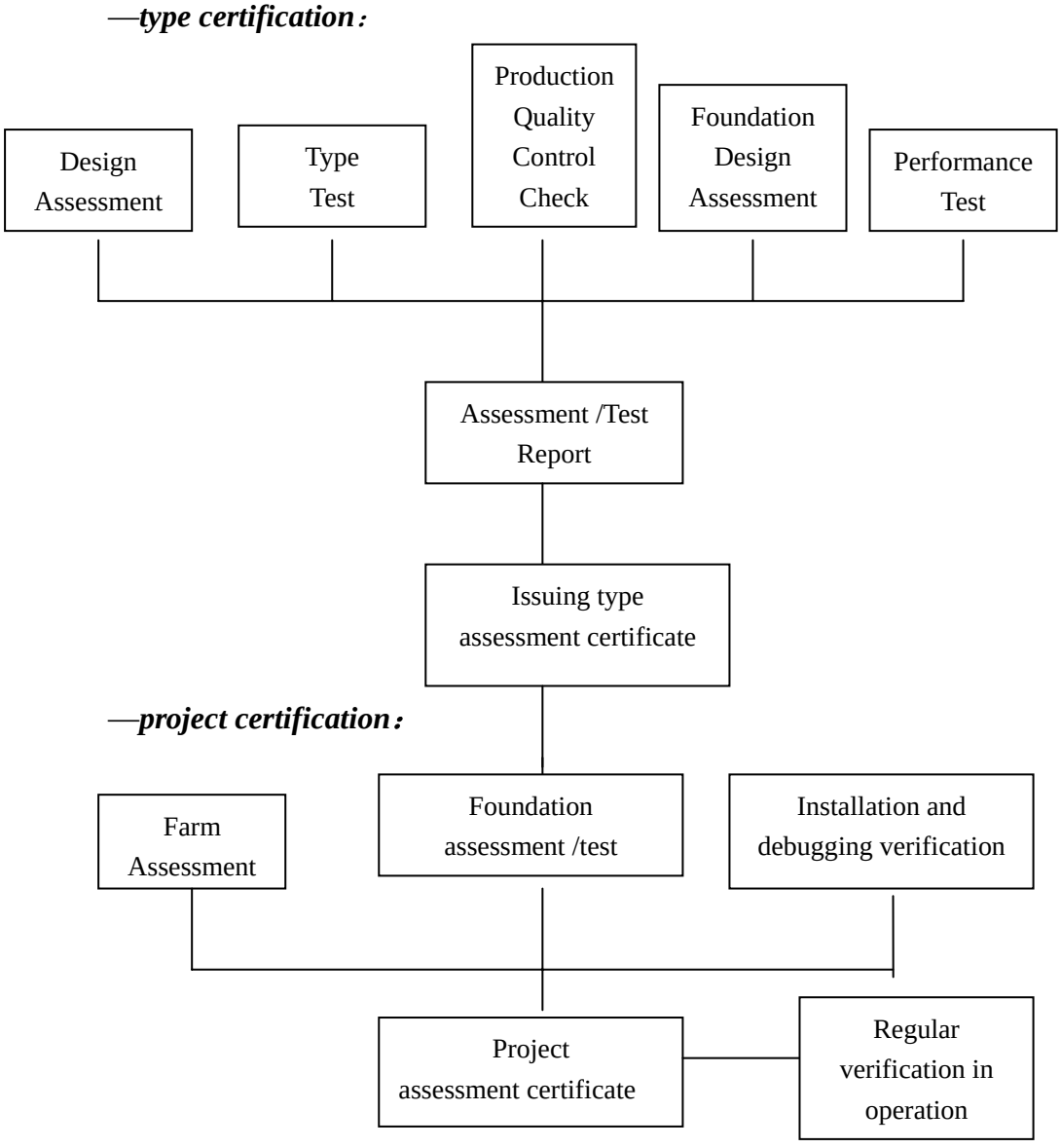
Certification criterions and standards:

- GL wind turbines system criterion, which is the most authoritative and widely used criterion
- IEC61400 standards series

Certification modes and demands:

Now, there are some differences between European nations. To unify certification program and demands, promote free trade, prevent non-impost technique rampart, IEC founded work group to establish standard of Wind Turbine Generator Systems: Wind Turbine Certification (IEC61400-22). This standard (IEC WT system) has been admitted as the fourth certification system by IEC CAB.

The brief of certification mode of this standard is listed as below:



Remarks：1. Certification to important components and complete machine is included in type certification；

2. Complete machine and important components should be verified in manufacture.

6.3.2 American wind turbines equipment certification system

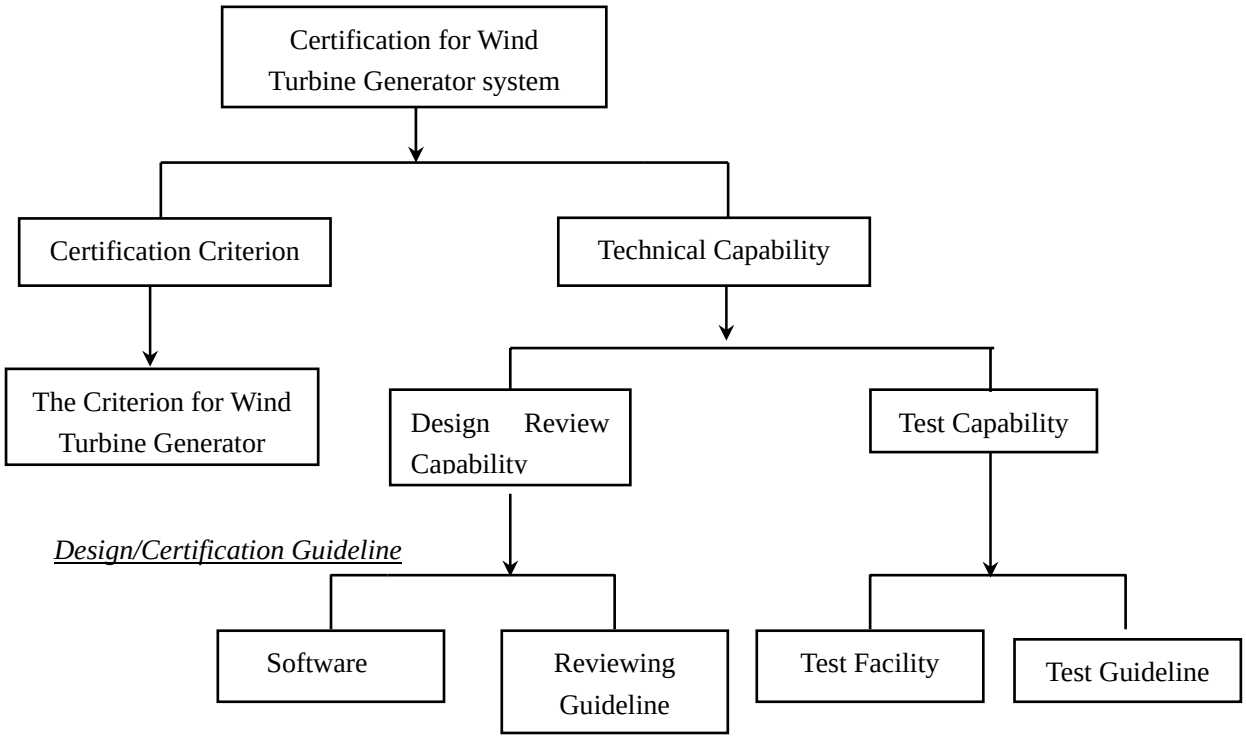
Basically, America did not develop any certification before. Till 2 years ago, American government found that native wind turbine hampered in export trade because of none of certificates. Thus, now they start to establish their certification systems. NREL takes charge of organizing to establish certification system. NREL's major is technique issues, such as design evaluation and test and UL has been determined as the certification organization.

6.4 Mutual certification between Chinese and foreign certification systems

To promote Chinese wind turbines equipments export trade, especially accessory export trade, to develop Chinese wind turbines international competition ability, and to eliminate technique trade rampart on China which are set by foreign countries through measures of certification/test evaluations, it is very important to consider the problems of mutual certification between native and foreign during the process of establish Chinese wind energy certification systems. Now the best way resolving this problem is contracting "mutual certification treaty" between certification organizations. CGC has contracted primary mutual certification treaty with UL, and the next step is to prepare for a machine type certification. These will be technique base of mutual certification.

6.5 The precondition of actualization Chinese wind turbine equipment certification system

Modern large-scale wind turbines are high tech products, also are small-scale electric station systems with all parts. So it is more complex than other product certifications. First of all, certification criterions are necessary for certification tasks, and a simple standard is far insufficient to contain and explain the necessary technique demands of such a complex and self-system product. Thus many standards are necessary. Rather than other products whose consistency to standards can be verified only by inspection and test, wind turbines need more measures such as design evaluation to assure its consistency to standards. The material technique ability necessary for wind turbines equipment certification center is show as below:



Remarks：At present, the Ministry of Science and Technology offers some fund support through the Naitonal 863 R&D Project to develop the ability construction needed in certification. China General Certification center has undertaken this project.

7. Chinese incentive policy and planning on wind power industry

7.1 Current incentive policy of central government

Renewable and clean energy are encouraged and supported to apply by Chinese government, which can be found in the Electricity Law, the Energy Conservation Law and the Prevention and Cure of Air Pollution law issued by the People's Republic of China. To promote the wind power, former State Plan Commission, Statel Economy & Trade Commission and other related departments are positive to establish industry planning, and have issued many policy documents such as New and Renewable Energy Development Program (1996-2010), Chinese 21st Century Agenda, New and Renewable Energy Industry Development Plan, and Tenth Five-year Plan on Energy Conservationa and Resource Comprehensive Utilization to give a guideline to the renewable energy development including wind energy.

In order to promote the quick development of Chinese wind farm construction, in 2003 National

Development and Reform Commission (NDRC) distributed Notice on the Prophase Work of Large-scale Wind Farms Construction and raised the requirement and deployment to the contents, achievements, organizational management, and outlay resource of the prophase work of large-scale wind farms in China. ***

7.1.1 Regulation about wind electricity in grid

Related central government agencies, for example former Ministry of Electiricity, former State Economy & Trade Commission, former State Development and Plan Commission, and Ministry of Science & Technology, have made regulations about the wind electricity interconnected with grid. The general regulation is that the electric grid administration department should permit wind electricity into the nearby grid and purchase the whole power amount. The grid-connected wind electricity price will be determined according to reasonable profit, which is the cost of generating plus the cost of repaying the capital with interest. The additional price compare to the convertional electricity price will be shared equally in whold grid after the utility purchase wind power generation. These rules have played very important roles to solve the problem of connection with wind power generation and the grid. But because the problem of fixed electricity price has not been solved locally (it is separately handled by local government according to different situations), it is not sure how much the price difference between wind power and conventional power will be shared equally, and in addition there is no standard power purchasing agreement to rely on.

In the Notice of Electricity Price Reform (Guo Ban Fa [2003]62), printed and distributed by the State Council Office on July 3, 2003, the State Council ruled that: New energy resources such as wind power and geothermal energy, and renewable energy do not currently take part in the competitive market. The grid enterprises have priority to purchase new and renewable electricity according to the price determined by the government or bidding. In the future, when the power market becomes matured, the government will determine the proportion of new and renewable energy in the power sector, and an industrial market of new and renewable energy resources with competition will then be set up. So the rules have been authoritatively fixed that wind power should not have to join in the competition of the electricity grid, which thereby removes a large obstacle in the development of wind power during the reform of power sector.

7.1.2 Import tax

The Customs Authorities have ruled that the import tax of assemblying WTG is 12% (8% in 2004) and for component parts it is 3%, but the value-added tax rate is 17% for the importation. The equipment cost covers 70% of total cost, the total cost of wind electricity will increase about 20% if selcting the imported equipment.

On the other hand, the central government has listed wind power generation into the Priority Industry Catalogue Encouraged (revised in 2000). It rules that imported equipment for selfuse could be exempted from custom tax and value-added tax for importation. But at the same time, all types of assembling WTG are listed in the Imported Goods Catalogue Not Exempted Custom Tax for Civil Investment (revised in 2000). According to this regulation, the wind energy projects

with the civil investment will increase about 20% of total cost if selecting the imported equipment.

7.1.3 Value added tax on power sales

The VAT for general products is 17% in China. According to the regulation (Cai Sui [2001]198) issued by Ministry of Finance and State Tax General Bureau, since on January, 1, 2001, the VAT for wind electritcity will decrease to half (8.5%). This is real good incentive policy for wind energy development. Based on this regulatiom, because wind power does not consume any fuel and there isn't any deduct, the real VAT of wind electricity is still higher than that of the convertional electricity.

7.1.4 Loan with interest discount

The funds for technological reformation in the SETC can afford loans with interest subsidy and 70MW wind power projects have been listed in the SETC Shuangjia Program. After acceptance and putting into operation, 1 or 2 years loan interests can be subsidized by the State. This is essential support for wind power. But at present, in general situation, wind energy project is very difficult to get these loans with subsidy. The financial costs for wind energy projects are high because of high commercial loan intrest.

7.2 Current incentive policy of local governments

7.2.1 Guangdong province

Guangdong province has rich wind resource, and also is one of the earliest provinces to develop wind farms. In the past years, the Guangdong provincial government has issued a series of incentive policies, which speed development and application of the wind projects in Guangdong in a large extent.

On May, 1999, the Plan Commission and Science&Techonology Commission of Guangdong province forwarded the notice of *Some Issues about Further Support the Renewable Energy Development* issued by NDRC and MOST. Considering the situation and condition in Guangdong, the notice raised some favorable measures, mainly including:

- The construction-used land, in principle confiscate land according to base area of each WTG, and the temporary land used for wind farm construction and land for WTG's affiliated establishment, will be determined as actual situation.
- The income tax from wind power company in the loan payback period, which will be check and clarify by privincial responsible organization, will be pay back to the company. The return of VAT will stop after the payback period.
- Permit wind electricity inconnection with nearby grid, and the Utility should purchase the whole wind power generation under the grid generation is permissed. During the loan back period, the price different higher than the grid average electricity price will be

shared in local regional grid.

On July, 2001, the Provincail Plan Commission, the Provincial Economy & Trade Commission, and the Provincial Price Administration issued the Notice of Opinion on Promotion of Wind Development in Guangdong Province(Yue Jia Ji [2001]587). The notice give more incentive policy on wind energy based on the condition of Guangdong:

- The government encourages developing wind power generation with multi-way financings. The governement will develop a provincial wind energy development plan, and it is planed that the new wind energy installation in 10th Five-year period will be 300 MW.
- The grid management branch must permit the wind farm connect to the nearby grid, and purchase the whole power amount. The grid-connected wind electricity price can't be higher than the electricity sale price in Guangdong grid. After the price competition for grid interconnection, appropriate policy support should be consided to wind power generation
- The wind power project must strictly control the engineering cost, and now the limitation target is blow 8000Yuan per kW (including transmit projects). The wind power projects should give the prirority choice to the large scale WTG made in China, and the WTG localization rate needs be more than 40%. The return rate of capital must be beyond 10% calculated with 15 years of the depreciation period and 15 years of loan back period.
- The construction-used land, in principle confiscate land according to occupying the land of each WTG; and the land used for wind farm affiliated establishment, is confiscated as actual occupying land. And the wind electricity can apply and get the tax reduction policy according to related regulations.

On April, 2004, the Provincail Price Administration issued the Notice of Announce the Electricity Price of Grid-connected Wind Power. This document is based on the Notice in 2001 and gives more incentive policies on the wind electricity price on grid:

- The wind electricity price on grid of new wind energy project in Guangdong province will be standlized as 0.528 Yuan/kW (including tax) except the national wind concession projects. The national wind concession projects will keep the bidding price. For those wind energy projects, which is operating now but have not determined the electricity price yet by official organization, the electricity price on grid will follow this price since the wind farm put into commercial operation.
- The grid-connected price doesn't contain the cost of transmitting electricity project. The transmitting project constructed by the wind project owner, after check, can get back the cost of repaying the capital with interest based on the grid-connected price. If the transmitting project is not handed to the utility and operated and maintained by the project owner, the operation and maintain cost can be added. The detailed cost standard of repaying the capital with interest and the operation will be checked and approved by

local price branch and sent to the provincial price branch for validation.

- The electricity supply company must strictly implement the published grid-connected price. It is forbidden to transfer the cost such as line loss to the wind projects, which will reduce the wind electricity price in disguised form.
- For those wind projects, which have been put into commercial operation and also have determined electricity price by official organization, the electricity price will temporary keep the orriganal price. Next step, the Provincial Price Administrator will check these projects' cost and validate the new price based on check.

7.2.2 Xinjiang autonomous region

On February 2001, Xinjiang Land and Resource Bureau issued the document on Temporary Land-used Standards for Wind Power Project (Xin Guo Tu Zi Han [2001]14). The contents mainly included:

- The construction-used land, in principle confiscate land according to base area of each WTG, and the temporary land used for wind farm construction and land for WTG's affiliated establishment, will be determined as actual situation.
- The area permanently occupied by wind power project construction will be calculated in different method based on its function, and the detail calculation method are listed.
- In the controlling area of wind farms, the land except the permanently occupied area mentioned above, can be the protecting area of wind farms, and apply the land registration procedure as "other right". It can be used by the former land user, which can't hedge the safe operation of the wind farms.

On February 2003, The High and New Technology Research Development Compendium (2003-2010) of Xinjiang was issued, which gave the regulation on the guidelines, total target, main task and priority fields of high and new technology development plan and raised the main measures.

7.2.3 Jilin province

In 1995, the Notice of Support Policy to Wind power generation in Jilin was issued by several departments jointly of Jilin province. The notice determined to give some policies to support wind energy development in Jilin, which contains:

- The wind electricity price will be determined according to its cost, which is called electricity price paying capital with interest;
- Will give some subsidies on the interest if possible;
- The income tax paied by wind energy company will be paid back by local financial department
- The VAT will be temporally 6%;
- The wind energy company will pay the land occupation tax for the actual occupying

land of each WTG.

- The land use of wind farms can mark out one land area, transact the approve procedure of land use, and can get the construction land use with delivery or issuing way.

7.3 Plan of wind power development

In 2004, NDRC issued the Medium and Long-term Development Plan on Wind Power Generation in China (2004-2020). This is the first national wind power generation plan in China. This Plan raised the guideline, objectives, tasks and measures for Chinese wind energy development based on the analysis the problems existing and summary the experience and lessons learned. Besides to guide the direction of Chinese wind power generation development, this plan will also play very important roles on promoting and accelerating the adjustment of energy structure, and developing a new field for sustainable energy development.

Guidelines

1) Promote the industrialization with scale up development. The development of wind power generation should rely on the projects, drive the industrialization with scale up development, and promote the technology level and producing capacity with industrialization, then can reduce the development cost and grid-connected electricity price, improve its economic profit and market competition strength. Based upon the experience of wind concession projects, develop tens of large-scale wind farms with 100-200 MW capacity, and form 5-6 wind power base with 1000 MW size capacity.

2) Adjust measures and plan according to local conditions in order to properly distribute, highlight emphasis and prior develop the better resource. In the coast area with developed economy, exert its economic strength. In the northwest, northeast and north China, exert its resource strength; build large and extra-large wind farms. On the other areas, properly construct all scale wind farms; make full use of the wind resource. Prior develop the wind farms near to load centre, easy to connect to grid and with good resource, plenty prophase work.

3) The wind power generation development should assort with conventional generation. The wind power generation should be planned as provincial (regional, municipal) unit. The capacity of wind power generation in each province should not exceed 10% of the total grid-connected capacity, increasing with the total installed capacity growth. To some provinces with plenty resource and stable wind power generation, the ratio of wind power generation can increase properly under the precondition of grid safe operation.

Development goal

By 2005, the total wind power installed capacity will reach 1 gigawatts, the increased installed capacity will be about 540 MW. The work will focus on the fast construction of several 50-100 megawatts medium-large-scale wind farms with good prophase work and better condition, especially the two wind concession projects with 100 megawatts in Huilai, Guangdong province and Rudong, Jiangsu province. At the same time, some medium-small scale wind farms construction with good prophase work and better condition should be advanced. Grasp the

resource assessment and the prophase work, creating a better base for the wind power generation development in the 11th five-year plan and latter periods.

By 2010, the total installed capacity of wind power generation should reach 4 gigawatts, Build the complete industry system of wind power generation, and the technology and assembling capability should reach the international level. Basically the large-scale wind farms will be constructed domestically, make effort to decrease the construction cost, improve the management level, and the grid-connected electricity price should further decrease, to make the wind electricity can compete with the conventional energy, becoming cleaning energy providing comparatively large-scale electricity. At the same time, study to establish the law and policy to promote the development of wind power generation, making the policy of RPS and green certification trade put into effect.

By 2020, the total installed capacity should reach 20 gigawatts. In the east coast and north region with abundant resource build several gigawatts size wind power generation bases. Further increase all of the technology and economic index, and the competition strength and pay off through the scale development.

8. Obstacles and policy suggestions

8.1 Clarify the development idea and develop the route map for localization development

Obstacle

Although Chinese government had ever framed the development plan of wind industry, the planning and goal of the 8th, 9th, 10th Five-year Plan is only guidance, lack of constraints as law. Until now, China has no clear long-term goal and strategy of wind power yet, and is not clear about the wind power's status, function and the proportion in the power system. So it is not clear what purpose to develop wind power. Is it to protect the environment and reduce the GHGs emission, acquire the enough electricity supply, or both?

Aiming that the import WTG have more than 90% market share in Chinese market, Chinese government bring forward the localization development direction, but what's the definition and connotation of localization, how to cultivate Chinese equipment manufacturers to develop their own products with intellectual property rights is still not specific.

Suggestions：

- Establish the development plan of wind power, clarify the long-term development goal and strategy, and the position and function of wind power generation in environment protection, energy supply and electricity supply.
- Establish the near-term goal and strategy. Focusing the localization issue, clarify the

idea and route map for WTG localization, and related central governments should be determine to be responsible for the implementation.

8.2 Implement incentive policies and promote the commercialization development of wind power

Obstacles:

As shown by both domestic and foreign experiences, certain stimulating policies are the basic guarantee to improve the development of renewable energy. Especially for the initial stage of development of the industry, the commercial market has not formed, it is very necessary to take effective and available policy steps according to different situations. This is the common experience of countries all over the world with faster development of their wind power industries.

Although related governmental agencies established some stimulating and favorable policy, such as the local power company must purchase whole wind power, the price equal to generation cost and repaying capital with interest, proper profit principle, and the VAT decrease to half and so on to promote the development of wind power. Because of lack of clear cost share system, the local power companies need to bear the price different between wind electricity price and conventional electricity price. This made the policy implementation is difficult and has some resistance.

Because the local power branch has the deterministic right to the grid-connected electricity price and electricity purchase agreement, some incentive polices is easy to implement for the wind power generation companies invested by local power branch, but it is uncertainty for the wind power generation company invested by non-power company. This makes mon-power companies to worry about risk of wind power generation investment. Now, most of the large-scale wind power generation projects are invested by power companies and its subsidiary companies. Few non-power system investors generally cooperated with local power companies. And once getting the support of power companies, they will try for a higher electricity price. This condition makes the project developer lack of the motility to reduce cost and electricity price. The wind power generation industry is lack of competition. It will be difficult to accomplish commercialization if this condition is not broken.

For introducing competition mechanism, NDRC organized and implemented two biddings for wind energy concession projects. Through these biddings, the wind electricity price decreased efficient through the participation of foreign, private, and state-owned corporations. In the current institution, the bidding for concession projects organized by central government is efficient to induce competition.

Policy suggestions:

- Implement cost share mechanism, confirm the cost share principle of consumer to bear the different price of wind power generation, and make clear the scale of share and accounting method, create a stable market environment for wind power investor and attract all kinds of invest into the development of wind power generation.

- To realize existing rules, the utility should allow wind farms to interconnection with the nearby grid and purchase the whole amount of wind power at the approved price. And wind power electricity will not competite with convertional electricity on the price.
- Continue the bidding activities for wind concession projects to introduce the competition in wind power feild, and encourage different investors participate in the development of wind power projects.

8.3 Assessment wind resource as a base for large-scale wind power development

Obstacle

Wind resource data is the foundation of economic evaluation and feasibility study of wind farm, also important evidence to select the site. But until now China haven't organized any detail wind rerourse investigation and assessment works. The current wind resource assessment is completed by Chinese Meteorological Research Institute. They completed the solar and wind resource distribution map according to the data from more than 2000 meteorological stations. According to their results, Chinese wind resource is abundance. But these data can't meet the request for evaluateing and selecting the sites for wind farm. The off shore wind resource data is still blank now.

Presently, lack of enough credible data is one of the common and prominent problems in Chinese wind resource development. Because of shortage of detailed data, the project development, site selection, planning and design met a series of barriers. The preparetion times are postponed very lone, and sometimes, some wind farms have to regestration first and evaluate the projects later. The resulte is that some wind farms have poor economic benefits and harmed the interest and passion of investors, which damaged the development of domestic wind power.

Besides those mentioned above, the investment on the wind farm preperation is limited in China, and the government investment has not regulation and formal financing channels and the prophase work is weak. Because of lag of evaluation, programming and design, the eligible potienal wind projects are limited. All of problems on wind resource assessment brings a lot of difficults on developing the national and privincial wind energy plan.

Policy suggestions

- Build the financing approach of preparation work. Suggest building a normal national approach of wind power prophase work and arrange some budget on that every year. These budget will be used for standard and codes development, wind resource assessment, wind power plan development and prophase work, to make clear the valuable wind resource, and develop wind resource map and database, and provide trusted evidence for developing national wind energy plan and promoting wind energy

development.

- Induce the market mechanism into the prophase work of wind power projects. Besides the outlay by government, the market behavior should be combined, add the reserve of actual projects and promote the large-scale development.
- Strengthen off shore resource measure and study . China has long coasting, and off shore wind resource is abundant. Moreover, because of close to the load centre, the off shore wind resource will be highlighted. The input on the study of off shoare wind power should be strengthened, and the sites selection and resource measure and evaluation should start ready for the off shore demonstration projects in future.

8.4 Establish the standard, testing and certification systems of WTG

Obstacle

Now the products standard and testing standard about the grid-connected WTG are almost completed, but some important technologies standards is directly same with the International Electrotechnical Commission (IEC) standard, which is based on the environment and condition of Europe, and urgently need some applicability assessment and modification according to China's condition.

Now there isn't any testing centre for wind power generation and wind power products certification system. The governmental branch in charge has authorized to do the feasibility study and preparation works on establishing the testing centre and certification system.

Policy suggestions

- Build and complete the products standard and testing standard system of WTG. According to the status of wind power technology and condition in China, to evaluate and modify some standards.
- Build up the testing centre for wind power generation equipments as soon as possible, to conduct testing of WTGs and component parts, and ensure to provide eligible wind power products.
- Build up the certification system of Chinese wind power products, and sign the mutual certification treaty with international certification organization, begin the certification work, help the companies build the quality control system and promote the management level, and also help Chinese wind power companies and products into the international market.

Volume II

National Action Plan

For

China's Wind Power Industry Development

Wind power is a renewable clean energy because wind power generation neither uses mineral resources, nor causes pollutant and greenhouse as emission. Therefore it is a new energy source helping the objectives of man-nature harmonious coexistence and social and economic sustainable development. Since the past twenty years, wind power technology has been developed from small generator system of isolated operation to large-scale centralized power generation systems, with more advanced technology and broader applications. Along with more focus on the global climate change problems by international community, wind power has gained significant recognition. By the end of 2004, global total WTG installation has reached 47.317 GW, while Germany, the largest installed country, has operated 16.63GW.

So far, many countries have formulated wind power industry development policies, supporting wind power as an important strategy in the energy development. In favor of various incentive and support policies, worldwide wind power development grows very fast in the recent years with over 30% of annual installation increase. Wind power has become one of the technologically most mature and best scale-development and commercial prospect new energy sources.

The ‘China wind power industry development action plan’ is made in considering China’s wind power current status and by borrowing international experience. Purpose of the action plan is to speed up wind power development in China so that the country’s wind power design and manufacturing techniques can be shortly improved, construction cost and grid-connected tariff can be soon reduced, and wind power can become an important energy source of large-volume and clean power supply.

1. Current Status

1.1 Wind farms in China

In the year 2004, the country’s newly installed wind generator systems were 249 sets, with total installed capacity 197 MW. 4 new wind farms were built. Compared with annual new installation 98 MW in 2003, the 2004 growth rate of annual new installation was 101%.

Up to 2004, China had 44 wind farms located in its 14 provinces with total 1291 wind generator systems. Overall installed capacity summed up to 760 MW. Based on the total installation capacity of 567 MW, the increase rate of the year 2004 was 34.7%. Top three provinces in wind power installation were Inner Mongolia, Liaoning, and Xinjiang.

The newly increased market share in the year 2004: locally made products shared 25% market, of which Xinjiang Goldwind had the largest market share: 20% of new installation in the country and 82% of the locally made products, while newly imported products shared 75% market, of which Spain Gamesa had the largest share: 36% of the new installation in China and 48% of all imported products.

The accumulated market share by the year 2004: locally made products shared 17.8% market, of which Xinjiang Goldwind company had the largest share: 11.7% of the overall installation in China and 66.2% of overall domestically manufactured products, while foreign manufacturers shared 82.2% overall market of the year, of which Denmark NEG Micon had the largest market proportion: 29.7% of the accumulated installation and 36.1% of all imported products.

1.2 Overview of Chinese wind power system manufacturers

By the end of year 2003, there have been six major wind power system manufacturing enterprises, including Xinjiang Goldwind Science and Technology Co., Ltd., Zhejiang Windey Wind Generating Engineering Co., Ltd., Xi’an Nordex Wind Electric Equipment Limited Company, Yituo-MADE (Luoyang) Wind Electric Equipment Limited Company, Shanghai Shenxin Wind Energy Generating Equipment Co., Ltd., and Beijing WanDian Co. Ltd.

In 2004, three companies, Dongfang Turbine Factory, Dalian DHI & DCW Group, and Baoding Huiyang Aviation Airscrew Factory, signed the technology transfer contract with foreign companies to get the MW capacity WTG production licenses and began to enter wind energy industry. All of these three companies are expected to product their first sample generator in 2005.

Xinjiang Tebian Electricity Company Shenyang Wind Power Co. Ltd and Jiangxi Zhonghang Wind Power High-Tech Co. Ltd are two new companies established in 2004 for wind generator systems development, design, and manufacturing. Technologically supported by Shenyang Institute of Technology, sponsor of MW capacity wind power generator system project in the National 863 Program, and China Helicopter Design Institute respectively, the two companies are conducting their own R&D projects and expected to product their first sample generator in 2005.

The first sample system of 600KW variable frequency constant speed wind turbine generator developed by Harbin Power Plant Equipment Group Corporation is to be installed in 2005 while R&D for a 1.2MW WTG is already started.

Furthermore, some other companies are preparing to enter the wind power system manufacturing industry, including technology development, market investigation, and cooperation negotiation.

The WTG models produced by the above mentioned Chinese companies include 200kW, 250kW, 600kW, 660kW, and 750kW stall regulated generator systems. Only the 600kW WTG system produced by Beijing Wandian Company features variable pitch propellers. Table 2-2 gives the main technical parameters and technological characteristics of the domestic WTG systems. The product variety is not wide-ranging and gives limited choice for domestic customers, compared with the case in some foreign products.

Most of the above six factories of WTG sets have been established in the last 3 to 5 years. Through introducing and assimilating mature foreign wind turbine technologies, they have already gained the capability of designing and manufacturing Hundreds kW capacity WTG sets, especially the 600 kW systems. However, the R&D activities of wind power technologies of own intellectual property rights are still rather weak.

1. Xinjiang Goldwind Science & Technology Co., Ltd., founded in February 1998, is a new high-tech enterprise set up by companies such as Xinjiang Wind Power Company, China Water Conservancy Investment Company, Xinjiang Wind Energy Institute and several individuals who provided funds together. It is the first joint-stock enterprise that has an ability to produce WTG systems in batch process at home. By the end of 2003, the company had produced and sold 81 sets of 600 kW wind generator systems. The longest business operation of the systems has already exceeded three years. The company has introduced foreign manufacturing technologies for 750 kW WTG systems and has already produced 2 sets and put them into operation by 2003. At present it is developing a new type of 1.2 MW no gearbox WTG system within the framework of the National 863 Program.

2. Xi’an Nordex Wind Power Equipment Limited Company, set up by Xi’an Aero-Engine (Group) Corporation and the German Ende Company, is a joint venture enterprise producing wind power generators. The company was established in June of 1998 with registered capital US$ 2.1 million, of which the Chinese side owns 60% share and the German side accounts for 40%. Period of the joint venture is 30 years. This company has introduced the manufacturing technologies of 600 kW WTG systems from the German Nordex Company and so far has already produced and sold 35 systems of 600 kW wind turbines.

3. Yituo-MADE (Luoyang) Wind Power Equipment Co., Ltd., co-funded by China No. 1 Tractor (Yituo) group Co., Ltd. and MADE Renewable Technological Company of Spain National Utilities Electric Co. in Jan. 1999, is a Chinese-foreign joint venture enterprise mainly producing large-capacity wind power generators. With its total investment funds 6 million US dollars, the joint venture is designed to have a production capability of 140 WTG systems per year. The company has introduced the technology for manufacturing 660kW WTG systems from the Spanish MADE Company and so far it has

produced and sold 8 sets of 660 kW WTG systems.

4. Zhejiang Windey Wind Generating Engineering Co., Ltd. is set up by Zhejiang Electromechanical Group Co., Ltd, Zhejiang Electromechanical Design & Research Institute Co., Ltd, Zhejiang Yongxin Chemical Co. Ltd and some individuals with registered capital RMB 25.51 million Yuan. Main products of the company include 250 kW, 600 kW and 750 kW WTG systems and among them, 250 kW and 600 kW sets have already realized local manufacturing. At present, it is developing 750 kW WTG systems under the company's project of the National Scientific & Technical Key Problem Tackling Program during "The Tenth Five-Year Plan" period (2000-2005). By cooperation with German Repower Company, advanced foreign technologies were introduced and transferred. The first 2 sets of 750kW WTG systems were installed in Changdao, Shandong and started to generate electricity at the end of September 2003. Based on this technology, it is carrying on the development of megawatt grade large-scale wind power generators.

5. Beijing WanDian Co., Ltd. (shortly WanDian), established in 1994, belongs to China Academy of Launch Vehicle Technology and is the unique domestic specialized company engaged in developing, designing and manufacturing large-capacity variable pitch WTG systems. Wandian Company, taking advantage of experience of hi-tech space science, designed and produced the variable-pitch WD646 WTG system by itself and put them into operation in the Inner Mongolia Huitengxile Wind Farm. In recent years, Wandian Company has produced and installed 3 sets of WD646 WTG systems for Inner Mongolia Xilinhaote wind farm. Meanwhile, it has developed blades used for 600kW variable-pitch WTG systems and the hydraulic pressure service system. Nearly 95% of this complete system is locally manufactured. Wandian Company has also produced complete sets of 250kW WTG blades for German HSW 250T WTG systems in the Inner Mongolia Zhurihe Wind Power Farm and finished the repairing and restructuring project of American Zond wind turbines in Inner Mongolia's Huitengxile wind farm. Wandian Company also undertakes R&D of blades for MW capacity WTG systems under the National 863 Project during "The Tenth Five-Year Plan" period, and the R&D of 750kW and MW level WTG systems.

6. Shanghai Shenxin Wind Energy Generating Equipment Co, Ltd was established in 1999 with the support of Shanghai Electric Group Company to develop wind power generators. The company, in collaboration with Xinjiang Wind Energy Company, has produced and installed 2 sets of 600 kW WTG systems.

7. **Xinjiang Tebian Electric Corporation Shenyang Wind Power Co., Ltd** was established by Xinjiang Tebian Electric Apparatus Stock Corporation and Shenyang Industry University in December 2004, with 25 million Yuan registered capital. The Xinjiang Tebian Electric is the largest enterprise in China producing transformers, electrical wire and cable and has advantage on capital, electrical technology and marketing, while Shenyang University of Technology plays technical supporter for this company, which is undertaking National 863 Program titled "1 MW variable pitch and speed wind turbine generator. It is planned that the first 1MW wind turbine generator system will be installed in Xianrendao wind farm located at Yingkou, Liaoning province. Focusing on both manufacturing and marketing, Xinjiang Tebian Electricity plans to install 10 sets of WTG systems at the wind farm for further test and improvement.

8. Dongfang Turbine Factory, having more than 7000 employees, is one of the largest steam turbine manufactories in China. In 2004 its production capability reached 14 GW and became its historic record. The factory's main products include 300 MW, 600 MW and 1000 MW large steam turbines. Dongfang Turbine Factory have entered wind turbine generator manufacturing since it signed the contract with German Repower on 1.5 MW wind turbine generator system technology transfer on October 1, 2004 to get the production licenses. Dongfeng began to take part in wind power equipment bidding since 2005.

9. Dalian DHI & DCW Group Company Ltd is established in December 2001 based on Dalian Heavy Group and Dalian Crane Group. Signed contract on October 1, 2004 with German Fuhrlaender on

1.5 MW wind turbine generator manufacturing technology transfer, the group company began to enter wind turbine generator manufacturing. FM1500 wind turbine generator system will be authorized to be produce in DHI & DCW. As plan, the first 1.5MW wind turbine generator system will be produced in June 2005. And, it has won a contract to construct a 12MW wind farm in Tuojidao.

10. Harbin Power Plant Equipment Group Corporation is one of the biggest generator equipment manufacturing bases in China. Its annual output in 2004 exceeded 10 GW generators. The group company started wind generator R&D effort in the late 1990s, especially on variable speed and constant frequency 600KW WTG systems. The first sample generator is under assembling period and is planned to install in Mulan wind farm. The company plans to research and develop 1.2MW WTG in 2005.

11. Baoding Huiyang Aviation Airscrew Factory, founded in 1960 and affiliated to China Aviation Industry Second Group, is the only research and manufacturing enterprise in China on aviation airscrew and helicopter energy components. It has about 2800 employees including more than 800 technical personnel. The factory is the stockholder company of Zhonghang (Baoding) Huiteng Wind Energy Equipment Company. In 2004, it signed technical transfer contract with German Fuhrlander Company to get the production license of 1 MW WTG and started WTG assembling industry. A new subsidiary is being registered to produce 1MW WTG systems. The first 1MW WTG will be assembled in the late of 2005 and will be installed and operated by the end of the year.

12. Jiangxi Zhonghang Wind Power Sci-Tech Co., Ltd is founded in December of 2003 by China Helicopter Design & Research Institute (602 Institute), Beijing Shuguang Electric Machine Factory, and Zhonghuan Textile Industry (Hangzhou) Group. China Helicopter Design & Research Institute (602 Institute) is the technical support for Jiangxi Zhonghang. Having 2100 employees including 1480 technical staffs, the Institute is the only one in China doing helicopter design, experiment and relevant research. Jiangxi Zhonghang has been involved in wind energy equipment research, design and development since 1980s and has successfully produced 100W, 200W, 500W and 3kW wind turbine generator systems. 13 units of 3kW systems have been in operation. In the late 1990s, Jiangxi Zhonghang completed the research program on 600kW wind turbine generator system key technologies and therefore the company has the capability of producing 600kW WTG systems. Since 2002, 602 Institute is undertaking the National 863 Program on research of MW grade stall regulated wind turbine generator systems. Zhejiang Zhonghang plans to produce, install, and operate the first 1.3MW WTG system in 2005.

In conclusion, R&D capability on wind power technology with own intellectual property rights is still weak in China. Introducing and assimilating mature foreign technologies, even copying these technologies, is still the most popular method in Chinese companies. Actually, key technologies in the wind generator design are impossible to be transferred since they are the survival basis for any foreign wind turbine generator manufacturer. Then why do we still need to “introduce, assimilate, and absorb” the already developed advanced foreign WTG technologies? The reasons are: Chinese WTG manufacturers consider more their own interests and development independently, lack of technology; without an effect information exchange and technology sharing mechanism; and lack of service providers and intermediary agencies who can provide technical and economic services on wind farm and WTG manufacturing.

2. Obstacles and Problems of China Wind Power Industry Development

Wind power industry in China starts late. After more than twenty years efforts, by the end 2004, 44 wind farms have been built with total installed capacity of 764 MW. Wind generator systems of 200kW, 250kW, 330kW, 600kW, 660kW, and 750kW can be made domestically. However, China’s wind power installation capacity only ranks number 10, which is very inconsistent with the country’s vast territory and rich wind energy resources. Compared internationally, China has still a long way to go. For example, imported WTG systems still account for more than 82% of the total installed capacity, while the existed made-in-China WTG systems are mainly based on some mature foreign technologies through technical transfer. There are few self-designed systems. There are three major obstacles recognized in China wind power industry development: expertise and technology, financing, and mechanisms and policies.

2.1 Expertise and Technology

1. Human Resource Capacity Building

Renewable energy technology R&D talent is generally weak and dispersed, which cannot meet the need of large-scale development. So far in China's wind power industry, there is no specialized wind power generator technology research and development body. Such an organization is so important in tracing and learning international advanced technologies, and in training WTG system designing, manufacturing, testing, and operational management experts. More importantly, it can conduct leading research on wind power technologies so that Chinese wind power technology can compete at international market.

According to an estimate, only tens of specialists in overall China conducting wind power policy studies, project planning, and R&D activities and they work in more than 10 different organizations. This situation is far from 2020 strategic objectives of 20 GW wind generation and 100 thousand research persons and engineering technicians. Organizational capacity building and personnel training is a significant step in fulfill China renewable energy strategic targets.

Along with China's fast development of wind power industry, requirement of technical training for wind power generator design, manufacture, installation, operation, and repair will be rapidly increased since the current very limited number of the qualified. Furthermore, there are few technical and economic service providers and intermediary agencies for wind farm construction and operation and wind power equipment manufacturing. With more and more new wind farm projects, large number of expertise are needed for related technical consultancy and technical service in wind farm preparation projects and developer support, pre-construction consultancy, wind energy survey, site selection, planning, design, construction supervision, management services, installation engineering, operational management, monitoring, examining and repair, and follow-on services, etc. Therefore, training is imperative for the fast wind power industry development needs. Meanwhile, the third industry of wind power technology consultancy and technical services needs to be developed actively to meet the new market requirement of specialized talents on design, engineering, operation management, and maintenance in the fast developed wind power industry in China.

2. Technological Obstacles

Human resource and technology are closely related. Nationalization and localization of wind generator technologies have become a bottleneck restricting China's WTG system development. These technological obstacles exist in multiple dimensions in WTG system design, component manufacturing, and wind turbine test and authentication to name a few. Currently about 82% installed WTG systems in China are imported. Reasons include that first, made-in-China WTG systems do not have enough continued operational time to be proved and tested by authorized certification system, and secondly, compared with imported products, locally made systems have no cost advantage. The limited market share affects new product investment by Chinese manufacturers so that MW class WTG system manufacture is still blank in China. This will certainly not meet the large-capacity generator market for Chinese wind farms. Mean while, it is difficult to lower the unit cost because of small production capability, and the high cost in turn has restricted increase of production size. In order to resolve the dilemma, manufacturers need to continuously improve their technology and product quality and reduce the cost from inside potentials, as well as national support policies and wind farm developer's confidence in using homemade WTG systems. Anyway only China develops its large-capacity WTG systems with Chinese technologies it can follow up with the world advanced wind power technology development steps.

The second obstacle in technology aspect is the large fluctuation of wind power output due to the uncertainty of wind, which makes electricity grid peak regulation even more difficult or requires larger grid backup capacity. This is the inhere disadvantage of wind generation and therefore is one of the fundamental reasons why wind power is not welcomed by utility companies. Along with larger proportion of wind generation in the entire grid installations, this problem will be more conspicuous.

3. Resource Assessment Problems

Abundance of wind energy resource is one of the most fundamental and key factors in wind farm site selection and construction. This will directly decide success or failure of a wind farm project. Importance of wind energy survey and appraisal is well recognized in the wind power advanced countries. For instance, the US energy department, European Union, and India Administration of Unconventional Energy have all input special fund in their thorough wind energy resource surveys and worked out detailed wind resource atlas and computerized wind energy resource databanks, which provide project owners with credible data in wind farm appraisal. After gaining enough experience of demonstration projects, Europe has started building commercialized sea wind farms. The planned installation capacity is multi-times larger than land wind farms. Looking at China wind resources atlas, the best wind energy resource areas are in the North China, Northeast, and Northwest China, a belt region of 5000 km from horizontally and 200 km to 300 km vertically the narrowest, and 500 km at the widest. Compared with that in Germany, if only 10% of the wind energy resource is developed in the region, at least 1 billion kW capacity can be installed. China has an over 5000 km coastline and its continental shelf stretches nearly 100 km. At China Bohai Bay, the average seawater depth is about 4 meters. So at the entire Southeast coastline plus near offing area, the developable wind energy resource can be at least more than 1 billion kW. China's developable wind energy potential should be at least 2 billion kW.

However, there exist some difficulties in resource appraisal in China.

China's wind energy resource is less proved. Lack of credible data becomes one of the common problems. Without detailed resource data, a series of difficulties are hard to overcome in wind farm project approval, site selection, and project planning. This would result in project delay such that some wind farms are approved before the project evaluation. These premature projects often result in big unnecessary loss. So far China has never organized a national level wind energy resource assessment, while the current wind resource assessment is completed by Chinese Meteorological Research Institute. Based on data collected at over 2000 meteorological stations, they worked out the all country on-land solar energy and wind energy resource map. The map shows the abundance of China's wind energy. However it can not meet the requirement of selecting wind farm site and project proposal, even though it is generally significant for a guideline of Chinese wind power industry development.

Pre-development phase investment is not enough. There lacks of capital for wind farm project preparation. There is no regular budget source for government organizations to do wind power planning, which have resulted in lags in wind power pre-project assessment and evaluation, overall planning, and project design. Small list of potential projects has made the national and provincial-level wind power development planning a very difficult task.

Offshore wind resource data is still blank. China has a long coastline with abundant offshore wind resource potential near the load center. Offshore wind energy will definitely be a key resource in the future Chinese wind power development. Therefore it is very important to conduct offshore wind resource assessment and appraisal.

2.2 Financing Problems

1. High Cost

Electricity tariff is always an issue of the current wind power projects. Public impression on wind-generated electricity is no more than environment protection plus high price. Although the wind power tariff in China have been reduced to current 0.55-0.65 Yuan/kWh since the beginning of wind power commercialization development. However if compared with the average grid-connected tariff of 0.35 Yuan/kWh from coal generation, wind power price is still 50% higher. Following reasons have caused wind power higher cost:

Wind farm construction needs large unit investment. At the beginning when China started wind power development, capital investment in wind farm used to be as high as 10k Yuan per kilowatt. With improved WTG system manufacturing technologies, cost is reduced gradually. Presently a new wind farm capital investment is about 8000 Yuan per kW, which is still 60% higher than that of a coal generation

plant. There are many reasons of the large unit investment, while low rate of localized equipment is the main reason. Because large proportion of equipment relies on import, cost is affected by exchange rate fluctuations. For instance, cost of the imported wind generators in 2001 once dropped to US$500 per kilowatt and has rebounded back to US$630/kW recently. High cost in auxiliary engineering such as road and grid connecting system also resulted in higher wind farm investment. Since the areas of good wind resource conditions are generally located in remote and deserted mountainous regions, desert areas, or sea islands, it is far from major transportation and electricity grid. New roads and output cable systems need to be constructed. This costs generally 10% of total investment.

Based on an investigation in 2000 on the current wind farm construction in China, grid connecting system, including wind farm center transformer substation and high-voltage cabling line, costs 12% in average of the total wind farm investment, which is 4% higher than that in Denmark. This is mainly because of the limited coverage of Chinese power grid. Many wind farms locates far from main electricity grids. In addition, in most of Chinese wind farms, gird connection system cost is in the burden of project developer, with only few exception. In some cases, the local power company is involved in wind farm project investment. In these cases, agreed between the project developer and the local power company, the latter takes charge of part or full connecting system cost. While in other cases of wind power concession program implemented by the National Development and Reform Commission (NDRC), provincial power companies are required to pay part of connecting system cost. Since wind farm annual operational time is about 2000-2500 hours, if a power company takes charge of connecting system cost including its operation and maintenance, the power company is probably hard to recover the investment only by charging transmission fee from the wind farms. Therefore relevant incentive policies for power company investment in the wind farm connecting system are needed along with the power system reform in China to promote the wind power development.

The higher cost scenario in wind power generation can only be changed when wind power technology is further improved, WTG system market developed, or conventional fuel price increased (e.g. through levying CO_2 emission control tax). Another issue worth to be noticed is that when compute and compare current kWh electricity tariffs, only direct generation costs are considered (e.g. costs of fuel, installation, operation, maintenance, and technical investment to reduce emission), but not the “external cost”, i.e. the social benefit in resource saving, pollution control, and the greenhouse gas reduction. This will not help a comprehensive cost contrast between wind and other electric generation technologies and places wind power in an unequal competition.

2. Financing Problems

Wind farm development in China witnesses a poor financing condition. Due to wind power project’s large initial investment and inadequate short-term economic payoff, financing organizations are not confident in wind power investment. For many years, financing cost in China’s wind power industry has been very high and lack of favorable long-term loan capital. Commercial banks provided long-term loan duration are usually 5-8 years. If using the past additional cost considering capital and interest payback, the short loan duration will result in a high electricity tariff for wind power generation, generally about 0.7-0.8 Yuan/kWh. In order to constrain the increasing generation cost and lower the electricity price, the former State Planning Commission decided to adjust the grid-in electricity tariff accounting approaches. In a document “State Planning Commission’s Instruction on Regulating Electricity Tariff Management Related Problems” (Bill code: Planning/Price [2001] 710) issued on April 23, 2001, it requires that a power generation project defines its average grid-connected electricity price according the project’s business duration. In such an accounting system, wind power business-duration tariff can be lowered to about 0.6 Yuan/kWh. However the next problem is that because of big debt pressure, it is hard for a wind power company to be profitable. Some companies may even need short term loan for a capital turnover and no way to talk about benefit. Investor’s confidence is harmed. If commercial banks can provide over 15 years business loan plus favorable interest rate, it will help abate wind power companies’ debt pressure, reduce financing cost, and lower the electric purchasing price.

Like hydropower, wind power does not consume fuel and other raw materials. Therefore in the Value Added Tax there is basically no incomes deduct. The real VAT for wind power is still higher than other conventional electricity even though it is half levied. This does not embody national incentive policies for

wind power development. In 2003, the WTG system import tariff was 5%, import related VAT was 17%. Total tax rate of the above two was as high as 23%. Only the import tax burden had increased nearly 1000 Yuan/kW of wind farm cost. As for income tax, though some local governments regard wind power companies as high-tech enterprises and let them enjoy a 15% favorable tax rate. But this benefit has not become a national policy. All these will certainly result in higher tariff due to the loan payback and make wind power less attractive to both end customers and project investors. In addition, since wind farm construction needs a large amount of capital, although there may be a stable income in case of electricity purchase and price problems were well resolved, profit margin could be low and investment return could be a long period. Therefore more attention should be paid to the wind farm long term financing problems. At present, since there does not exists a wind power development fund in China and regular business loan from domestic commercial banks has a high interest rate, wind power as a national support industry should receive some special low interest loans within the framework of national incentive policies. Meanwhile, it also depends on Chinese commercial banks' knowledge and recognition toward renewable energy, including wind power projects. Anyway, in order to develop large-scale commercialized wind power projects, the long-term financing channels must be well worked out.

2.3 Policy and System Related Obstacles

So far, majority of the Chinese wind power companies are those affiliated companies under local Power Company, independently capitalized sub corporations, stock company controlled by Power Company, and some business closely related with Power Company. There is very few totally independent wind power enterprises. This phenomenon is concerned with China's wind power pricing system. Since China started its wind power commercialization development, wind power tariff has been going down continuously from the beginning 1 Yuan/kWh down to the current 0.55-0.6 Yuan/kWh. Even so the current wind power tariff is still higher than average grid connected price. According to the former Power Ministry, the added costs should be shared within the grid. As for the cost burden share method, there is no clear regulation on whether it is by the provincial grid, regional grid, or among the all over the country grid. This unclearness has resulted in difficulties in implementing the policy. In practice, the more wind power companies an area has, the heavier it paid the burden. This gives large economic pressure to the regions with advantageous wind resource condition (most are slow economy development regions) and large wind power development scale. In these regions, the resulted added wind power cost is entirely shared by end users and is hard to be digested within the grid. This is unfair and has restricted wind power development. Because all society and all mankind could be of benefit from wind power in the improved environment, it is rational and fair that the additional wind power burden above the average purchasing price should of course be shared by the entire society. It is necessary to clearly define from policy perspective the wind power added cost burden sharing scopes and approaches.

Because of the higher wind power tariff and difficulties of burden sharing, only Power Company or the Power Company related enterprises could easily obtain the grid connection permit and bear the higher tariff. Therefore it is very difficult for outside power system investors to develop wind power projects independently. They usually find an ally from local Power Company and once received the Power Company support, they will generally try to obtain a high tariff. The inadequate competition does not encourage project developers to reduce development cost initiatively and then lower the power price. It will harm China's wind power long-range development. In order to break through the situation, competition should be introduced and multi-source investment be realized. In 2003 the first group of concession biding demonstration projects, organized and implemented by the National Development and Reform Commission (NDRC), was recognized as a successful trial in solving this problem. The public bidding attracted many different investment bodies to participate, including state enterprises, private companies, and Sino-foreign joint ventures. The bidding also resulted effective cost reduction. Under the current Chinese investment system, the national wind power concession bidding approach is proved to be an effective way of introducing competition. However in the long-range perspective, the key issue is to solve the marginal price sharing between wind power and conventional electric generating technologies. Once the added costs are proportionally burdened by end users and partly compensated by utility companies, the original obstacles can be resolved and capital from various channels can enter the wind power development smoothly.

3. Guidelines for National Wind Power Development Target and the Action Plan

China's wind power development target is to have an accumulative wind installation of at least 20 GW by 2020. Wind power in China has developed for over 20 years. But compared with that in Europe, America, and India, there exists a big lag in either WTG system manufacturing industry base or testing and certificating method. What the most needed in China is a national team of qualified specialists to become the backbone for Chinese wind power R&D efforts. In order to realize wind power industrialization, it is a necessary condition to have a design capability of complete WTG systems with Chinese intellectual property rights and a national testing and certification system. Looking at international trends, there is a huge global market potential for wind power industry and a bright developing perspective in the future. First of all, it is imperative for China to train a specialized team of wind power know how and set up the national wind power equipment testing and certification system, in order to implement its wind power industrialization and achieve the national development target, so that Chinese wind power can become a new economic industry, can play the role of regulating the country's energy structure, and can guarantee its energy safety.

The wind power industry development in China has already been 5 to 10 years behind the advanced level in the world. If we now start R&D from the beginning, it is neither economical nor realistic. China should adopt a "borrowing" strategy. Actually, during the current restructuring, separating, and reforming process in European Union economy, wind power is also restructured. After many technical people left large companies, they established smaller ones, or they created their own enterprises, while others may find a new position in the job market. However the ideas, component manufacturing facilities, design theories, and technologies can be of the first class in Europe. Many small companies there with only 3-5 technicians can have very advanced WTG system design. We can fully use this resource of expertise.

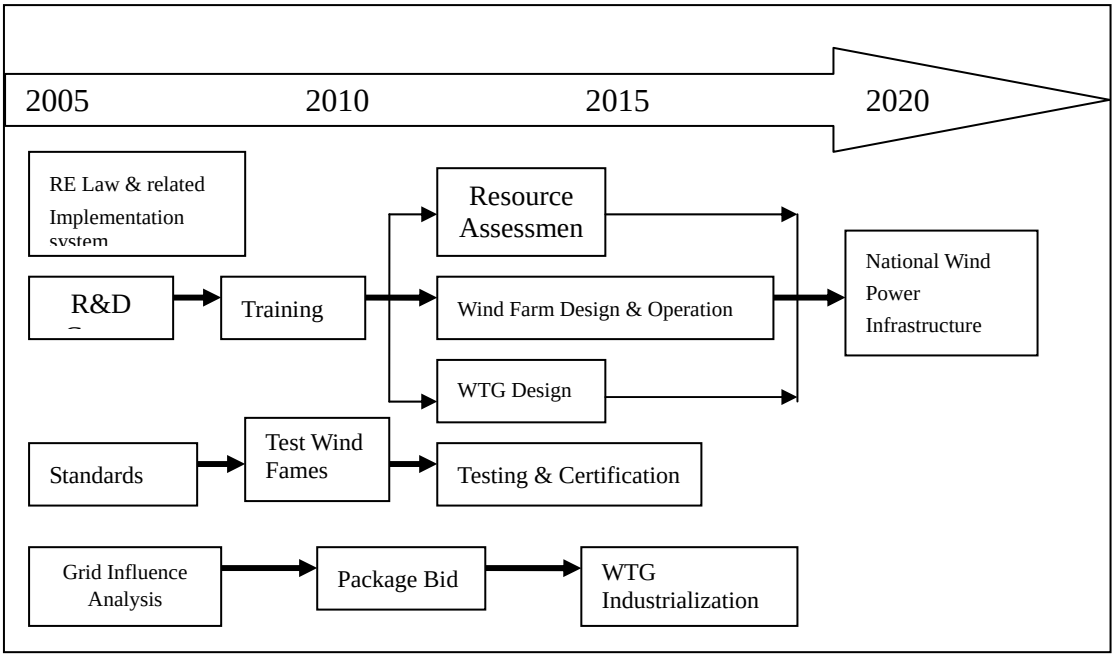
Based on Chinese situation, a phase-wise implementation approach is needed for wind power industrialization. We divide the 2020 target implementation into three phases:

Phase One (2005 to 2010): To complete China's wind power development policy framework, continue the all-country on-land wind resource survey, start the offshore wind resource survey pilot project, conduct a reliability study on wind farm generation grid connection system, establish and improve China wind turbine testing and certification system, and prepare to establish a national WTG system design and wind farm development research body. At a 500 MW capacity wind farm, by using competitive bidding approach for a package of wind farm development and entire WTG system manufacturing, China will support 2-3 domestic or controlled joint venture manufacturers (assembly factories) with annual output of 200 MW MW grade WTG systems such that the WTG system at the new wind farm will completely be localized (or at least 90% of the WTG components are localized). As for WTG system testing and certification, two rounds of site testing of local technology WTG systems will be conducted before 2009, and Chinese WTG certificates will be issued by 2010.

Phase Two (2011 to 2015): During this period, a national expertise body will be established, which is qualified in conducting the independent WTG system design, wind farm engineering, and wind farm operation and management. Again at 500 MW capacity wind farm, by using competitive bidding approach for a package of wind farm development and entire WTG system manufacturing, two more domestic or stock controlled joint-venture manufacturers will be supported. Meanwhile, a countrywide coastal area and offshore wind resource survey will be conducted to establish foundation for the wind farm development and WTG manufacturing industry in China. By the end of 2015, at least 5 domestic or stock controlled joint venture manufacturers of annual output capability MW grade 200 MW WTG system will be established, and over 95% of WTG system components installed at the new wind farms will be locally manufactured.

Phase Three (2016 to 2020): Wind farm development and operation will largely be based on Chinese technologies and WTG industrialized. Chinese technologies will go into the world wind power market.

Generally, going through the above three phases, China will establish its own wind power industry. A diagram of the phase wise development is as follows:

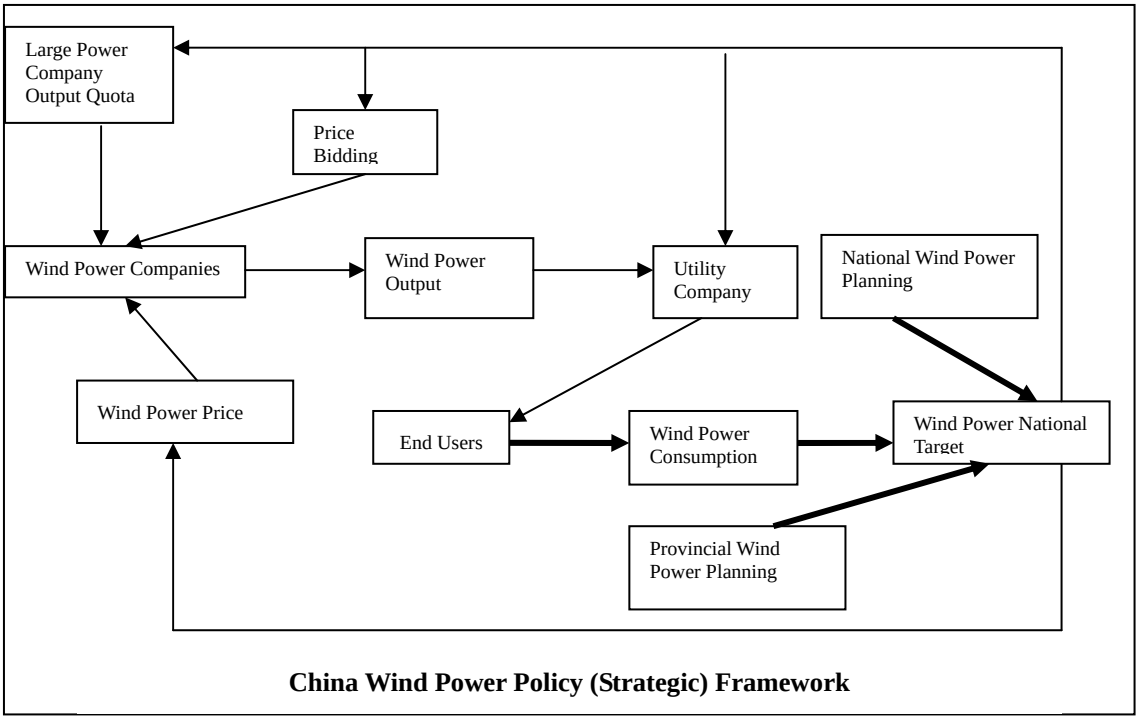


4. National Action Plan

4.1 National Legal and Policy Framework Supporting Wind Power Development

On February 28, 2005, *The Renewable Energy Law of The People's Republic of China* was passed at the tenth National Peoples Congress's 14th meeting and was issued by the President Hu Jintao by his No. 33 order. The Law will be enforced from January 1, 2006. This becomes a great event in the Chinese renewable energy community. The issue and enforcement of the Law will play an important role in China's renewable energy development and will contribute to the social sustainable development.

Under the legal system of the Renewable Energy Law, China's future wind power policy framework will be demonstrated in the following figure:



China Wind Power Policy (Strategic) Framework

In this framework, central government will make a wind power total generation target, i.e. 4 GW by 2010 and 20 GW by 2020. This target will be issued in form of legal document and implemented through the national and provincial wind power development planning. Power companies must purchase all the electricity generated by the qualified wind power generation companies according to the State-issued wind power tariff and the bided price to guarantee achievement of the country's total wind power installation target. Government will also give large power company certain amount of renewable energy generation quota.

In order to establish and implement the policy framework and complete some detailed procedures for executing the Renewable Energy Law, some activities are defined in the following:

4.1.1 Activities

4.1.1.1 Formulate Grid Connection Standards (Wind Farm Grid Connection Technical Specification)

If connecting to the power grid, Electricity generated by power plant must meet some power supply quality requirement; including the electric power quality and power supply reliability.

1) Power Quality

Electric energy quality, or power quality, is a quality measurement of the generated electricity on the grid. The power quality can be divided into Electric Voltage Quality and Frequency Quality. The voltage quality is further divided into voltage amplitude and voltage waveform respectively. The voltage amplitude can be measured by several indicators, such as voltage deviation, fluctuation and flicker, negative-phase voltage factor (degree of three-phase voltage unbalance), while quality of waveform can be measured by the sine wave distortion. Frequency quality is indicated by frequency deviation. China has worked out related standards concerning the power quality, which can be used in measuring the output energy quality in WTG systems or at the wind farm grid connecting points. For the popular WTG system using asynchronous generators, the grid side decides its output voltage and frequency. Once the power quality in the grid is good, so is the electricity quality generated from the WTG systems. In case of abnormal grid parameters, the WTG systems can immediately detect the fault and take action of cutout. Therefore the power quality by the WTG systems using asynchronous generators can be completely

guaranteed.

While at some currently installed WTG systems using power conversion apparatus, such as double-fed machine, and using synchronous generators, harmonic current could be happened during the power generation. However the harmonic control technology is rather sophisticated presently so that each time harmonic current can be constrained by the WTG system itself within safety range.

2) Reliability of Power Supply System

Because of small scale of China wind power development, wind farms generally have small influence to the grid operation. With the future large-scale wind farm development, wind power capacity will be increased in its share in the entire grid volume. Wind farm connection onto the grid, separation, and power fluctuation will have a direct effect on the grid operation. Safe and stable running of large wind farms will be closely related to the grid normal operation. Therefore it is necessary to evaluate its power supply system reliability when establishing a large wind farm.

Reliability of power supply system from a wind farm is characterized by several factors such as reliability of wind farm equipment, wind resource conditions, wind farm operation, and outside grid conditions, etc. Currently, related standards and norms are available (Standard DL796-2001/DL/T797-2001) in China concerning wind farm equipment requirement and wind farm operation and management. This will help promote Chinese wind farm operational management and improve equipment availability.

Along with the increased size of Chinese wind farms, large wind farms as one of the important power supply sources will increasingly affect on stability of power network operation. Improvement of wind farm power supply reliability will greatly help a stable grid. Therefore the operation of wind farms and WTG systems will not only depend on a stable power grid, but also provide a support to the entire grid stability.

Contribution from wind farms or WTG systems onto the grid can be actively controlled in the following several aspects:

- Wind farm switch in;
- Reactive power regulation;
- Active output;
- Actions at (short time) abnormal network;

So far, there is not a complete system of wind farm networking connection standardization in China. From a long-term perspective, it is very important to formulate the large wind farm grid connection standards and assessment approaches, which will no doubt help a healthy development of Chinese wind power industry.

In order to help the implementation of China Renewable Energy Law, the wind farm grid-connection standards must be issued and enforced before the end of 2005.

4.1.1.2 Wind Power Tariff

To implement the Renewable Energy Law and ensure the national wind power development strategy operational and achievable, wind power grid-connected tariff becomes an urgent task.

According to the policy framework of future wind power development, electricity network must purchase all the electricity generated by wind farms. But the purchasing prices must consider the average generating cost of the current wind power generating technology, the different local resource, and the future wind power technology development trends. Wind power tariff need to be defined by government under the assistance of experts.

4.1.1.3 Wind Power (RE) RPS Target and Management Procedures

For the Renewable Portfolio Standard (RPS) system, an international approach is to set up target for utility suppliers. Full RPS implementation needs a complete and competitive power market and a power trading system. Since power system reform in China has not been completed and it is impossible to establish an expensive power trading system, the RPS system, which is popular in the Western countries, is difficult to be implemented in China. This is why the mandate grid-connection and fixed tariff were adopted in the Renewable Energy Law. In China's situation, the top five largest State power-generating group corporations have controlled over 80% power generation plant. Taking advantage of the large groups will help promote China RE development and implement the sustainable energy strategy. In order to achieve the 2020 national RE targets, setting up RPS targets for the large generation enterprises can be an appropriate and effective method.

To set up RPS targets for RE technologies, the following studies are necessary:

- Investigate China large RE generation enterprises, to decide what level of the enterprises should take the objectives.
- How to define the level and how to do the target setting.
- RPS implementation monitoring and management, RPS obligation bodies
- Penalties for violating RPS.

4.1.2 Implementation plan and Budget

4.1.2.1 Wind Farm Grid-Connection Standard (Wind Farm Grid-Connection Technical Specification)

Formulating Wind Farm Grid-Connection Standard (Wind Farm Grid-Connection Technical Specification) can probably be a number-one task. If a utility company do not purchase all the electricity generated by wind farms, the future wind power development policy framework could not be successfully implemented just like a kite with broken line. This job can be organized by the future WTG certification in line with national standardization department by inviting relevant experts, and should be finished by the end of 2005.

Budget: 1.60 million Yuan.

Funding Sources: Word Bank/GEF "Renewable Energy Development Scale-up Program" and Denmark Government Program.

4.1.2.2 Wind Power (RE) Grid-Connected Tariff

The wind power grid-connected tariff must be integrated within the research activities of RPS system for RE technologies and become one of the key components of the future Chinese Renewable Energy Law. This research can be conducted by certain specialized national institutes and should be finished by the end of 2005.

Budget: 1.20 million Yuan.

Funding Sources: WB/GEF "Renewable Energy Development Scale-up Program"

4.1.2.3 Wind Power (RE) RPS Target Implementation Management

Implementation management for RPS target of RE technologies is the implementation details of the

“Renewable Energy Law” to ensure the national RE development total objectives. The implementation management procedures can be formulated by relevant specialized national institutes and should be completed after one year of the Law effective and enforcement.

Budget: 0.82 million Yuan.

Funding Sources: WB/GEF “Renewable Energy Development Scale-up Program”

Total budget of above three activities: 3.62 million Yuan.

4.2 Establishing a National Wind Resource Assessment (or Wind Power Development Research) Center

Based on current basis and organization, a national wind power assessment center (or national wind power development research center) will be established soon. The center will be an operational and self supported consulting body. The research center starts from wind resource assessment and develops into an institute of wind farm design, operation and management consulting, and WTG system overall design.

4.2.1 Activities

4.2.1.1 National Wind Resource Survey and Assessment

Abundant wind resource is a necessary condition for wind power development. Concerning China’s 2020 installation target of 20 GW, the first important question is the layout of the 20 GW installations across the country. To choose the most suitable wind farm sites, a critical task is to be clear about China’s wind resource current status, locations, and geographical variations, i.e. the wind resource characteristics. An objective and veracious wind resource assessment will become the important guarantee of the successful wind power scale development and wind farm projects in China. Starting from 2003, NDRC plans to conduct a nation wide wind resource assessment and wind farm site selection effort in a two years time and have chosen 30 potential large wind farms of more than 100 MW installation capacities for wind measurement. This assessment will complete an all-China wind resource evaluation through site observations, surveys, and setting up wind measurement towers at the potential wind farms, with reference to national and self-established weather station data, basic wind farm baseline data, collected offshore and ocean data, and related scientific survey data, etc. So far this activity is implementing by the National Meteorological Bureau, to achieve the following results:

- Formulating “China Wind Resource Assessment Technical Methods”;
- Developing “Wind Power Assessment Factors Computing Software”;
- Developing “China Wind Resource Databases”;
- Formulating “Wind Farm Meteorological Observation Evaluation and Calibration Technical Specifications”; and
- Finishing “China Wind Resource Assessment Complete Report”;
- Formulating “Wind Farm Wind Observation Instrument Inspection and Calibration Standards”.

However present efforts in this activity are still far from meeting the requirement of China wind power development, especially the target of 2020. The large-scale development of China wind power industry need rich and credible wind resource characteristics and resource distribution information. The next important job is to make high resolution (5 km) regionalized wind resource maps for preparing the potential wind farm site selection and wind power installation. Furthermore, offshore wind resource

survey activities should also start soon.

4.2.1.2 Training

It is an urgent task to train and establish a specialized expert team at national level. The training courses will include wind resource assessment methods, wind farm design (WTG system selection, micro site selection, and optimal output techniques), wind farm operation and management, and WTG system design, etc.

4.2.2 Implementation Plan and Budget

Renewable Energy Development Center of Energy Research Institute NDRC, the National Meteorological Bureau, and the China Hydropower Engineering Consulting Group will implement this activity, respectively.

4.2.2.1 National Wind Research Survey and Assessment

By 2010, 10 or 5 km resolution national and regional maps of wind resource characteristics will be protracted by using GIS technology and combining multiple data sources of remote sensing, and site measurement methods.

To support the national 2020 wind power development target, data will be collected by measuring at selected 30 potential wind farms in 2006-2007, and at 50 more potential wind farms in 2010. Since it is impossible to do all the site measurement, ground observation plus meteorological and satellite data will be used for theoretic calculation.

Before 2015, an all country 10 km resolution offshore wind resource map and topography maps will be completed.

Budget: 100 million Yuan.

Funding Sources: NDRC (66 million Yuan), WB/GEF CRESP (16 million Yuan), RE Special Fund (10 million Yuan), Denmark Government Fund (4 million Yuan), and EU RE Program (4 million Yuan).

4.2.2.2 Training

First of all, equipment, analysis software, and application software need to be purchased. Training methods will include ‘coming in’ (inviting prominent international experts), ‘going out’ (training at foreign organizations), training classes, and workshops.

Budget: Equipment and software purchase (3 million Yuan), personnel training (12 million Yuan).

Funding Sources: WB CRESP

Total budget of the above two activities: 115 million Yuan.

4.3 WTG system testing and certification

In the past twenty years, wind power in China has had a great progress. However compared with EU countries, even with its neighboring country India, China has a long way to go in both technology and development scale. Lack of a national WTG system testing and certification capability has become a bottleneck of China’s wind power industry development.

Establishing China WTG testing and certification system and carrying out certification will help achieve the following objectives:

a. To improve quality and trust in the locally-made WTG equipment;

b. To promote developers using made-in-China WTG systems;

c. To promote component manufacturing localization and provide certification service for exporting local parts;

d. To meet the requirement of developers, insurance companies, and investors for quality certification;

e. Through implementing standards and norms, to improve China's WTG system technical progress and further improve the international competitive capacity of the locally made WTG systems;

f. To provide certification service to imported equipment so as to strengthen quality control for Chinese users and ensure equipment appropriateness in Chinese wind farms;

g. In the wind power fastest developed Europe, an advanced WTG equipment certification system has been established. The well-known certification organizations include GL (German Classification Society) and DNV (Norway Classification Society). China should establish its own certification system, which will help eliminate technology gaps in trade, protect the interests of domestic manufacturers, and create an equally competitive environment for domestic equipment developers;

h. To help establish a quality insurance system and improve quality management in Chinese enterprises;

i. To achieve national overall quality control; and

j. To reduce quality responsibility risks at manufacturing industry.

China has not established an effective WTG quality monitoring system so far. 85% of installed WTG systems are imported from abroad. Most of these systems have obtained GL or DNV certificates. **For many years, domestic quality monitoring and certification system has not been established because of the low level of WTG system localization. Lack of such a comprehensive certification system in turn has in certain degree affected the localization process.**

4.3.1 Activities

4.3.1.1 Design a WTG Certification System Proposal

1) Certification requirement: key components of wind turbine generating system (wind rotor, gearboxes, generators, towers, control systems, and yawing systems, etc.)

Product technical specifications: A WTG system is composed of many high-tech products relating to air dynamics, material science, oscillation and fatigue technology, electronics, mechanics, and many other scientific areas.

2) Certification principles：

—Related national standardization;

—Related international standards;

—The issued design and certification guidelines.

3) Certification Organizations: Based on the currently approved RE product certification organizations.

4) Certification Method: By adopting IEC WT System. Wind Turbine Generation System quality certification include the following two parts:

Part I: **Model Certification**. Assess a new model of WTG equipment to see whether its design, experimentation, manufacturing meet the required standards. Purpose of the model certification is to determine that the model system is designed, tested and manufactured according to the required procedures, standards, and other technical specifications and to prove that the WTG system can follow the specified requirement in its installation, operation, and maintenance. The certificates will be issued to the

same model WTG systems with the same design and manufacturing procedures meeting certain required technological conditions.

Part II: **Project Certification**. Purpose of the project certification is to evaluate whether the model-certification-passed WTG system and its tower base design will meet the environment conditions, used materials, and the power quality parameters, and whether it meets the other site related requirements. The certification organization should assess the site wind resource conditions, other environmental conditions, electric grid conditions and soil characteristics to prove that the WTG system model design match the tower base design. The issued project certificate maintains effective only when the certified equipment passes the regular testing and inspection during its operation and the check results should meet the related technical requirements.

4.3.1.2 Technology Related Capacity Building Required in WTG System Certification

Modern WTG equipment (systems) involves many high technologies. It is a small but sophisticated power generating system. Quality certification of such product can be much more complicated than other ordinary products. First of all the certification must have certain bases of references. Only one simple standard is far from covering the all the necessary technical requirement for such a complicated and systematic product. Multiple standards are generally needed. Testing and experimentation alone can not prove its accordance with regulations and standards. **Therefore a design evaluation is necessary besides testing and experimentations.**

4.3.1.3 China Wind Power Equipment Standard and Design/Certification Guidelines

Product standards and testing standards have been completed for grid connected WTG systems. Some of the standards adopt directly those from IEC. , Especially some important basic standards such as GB 18451.1-2001 concerning WTG safety requirement, which is equivalent to IEC61400-1 standard, have become the basic reference to the WTG system design. **Historically, these wind technology international standards were mainly established based on European technological environment and wind resource conditions**. In China, they are very different. For example, Typhoon happens frequently in China's southeast costal area. There is nothing about it in those standards. However, WTG system damages because of typhoon occurred occasionally in China, India, and Japan. **Therefore, appropriateness assessment of the international standards in China becomes a necessary activity and some of the standards need to be improved according to Chinese situations.** The most urgent improvement is on the "GB 184511.1-2001 WTG system safety Requirement, for instance, we need to consider China's typhoon, sand storm, and cold environmental conditions in the standard document and add some complement based upon the IEC standards. Actually, India and Japan are doing the same work. The Indian certification procedures have included their special environment requirement.

Besides standardization, an appropriate "design/certification guideline" can help the standard implementation. The guideline will provide specific implementation methods for WTG system R&D and certification procedures. For example, it will provide load computation formula; indicate how wind condition will affect WTG systems, and how to determine the systems' working condition under the wind and other conditions, and how to do the load computation under different working conditions. "Design/certification guideline" has been an international practice. Organizational and national design and certification guidelines have been published in Denmark, Germany, India, and the Netherlands. Because standards need broad suitability, they are often very general. International standards are more general. For instance, some standards have indicated what working conditions need evaluation, but not provide specific evaluation method, while the guideline will give detailed methods. Therefore, writing a "design/certification guideline" is an urgent task in China beside standard improvement.

4.3.1.4 Capacity Building for China WTG System Design Evaluation

WTG system design evaluation is to look at its safety and reliability. The key questions and

technical difficulties of the design evaluation include how to determine a WTG system especially the GW-grade system's load at different environmental conditions and combined operational status, how to analyze the WTG system structural dynamics, and hot evaluate the large WTG control and safety protection system; especially:

1) Formulate wind power generating system design evaluation guidelines with focusing on standard technical specifications and formulate guidelines for load computation, strength analysis, fatigue analysis, gearbox design analysis, and control system safety control system reliability analysis; and formulate parts and systems inspection list.

2) Purchase internationally advanced computation software systems and execute the relevant training.

4.3.1.5 China Wind Power Industry Test Center

1) Organization of the National Wind Generating Equipment Quality Monitoring Test Center

Because of the size and weight of gearboxes, generators, vane wheels, and other large important parts, they are difficult to move. Establishing an independent test lab will need high budget, while manufacturer facilities of these parts have their own self-contained test capabilities. The important parts test laboratories can be distributed at these specialized manufacturers. When needed, the test center can send specialists to do the test themselves, or monitor the test process, and provide test report later. This method is an international practice, called witness test lab, in this way, cost in establishing the national wind power equipment quality monitoring and test center can be greatly reduced.

2) Experimental Wind Farms

According to the requirement of IEC and countries that have established certification systems of wind power equipment test, entire WTG system practical operation test should be carried out in the system load, power curves, power quality, noise, and safety features. Germany, Denmark, and some other countries all have established their experimental wind farms as for certification test sites and experiment bases of newly developed WTG models. For the similar reasons, China needs to set up such national experimental wind farms.

4.3.2 Implementation Plan and Budget

The wind power system test center can be set up by China General Certification Center together with related Chinese organizations. Establishment of the experimental wind farm will be jointly invested by several large enterprises.

4.3.2.1 Test Center Management Committee

A national wind power equipment quality monitoring and test center management committee will be established, composing of representative from NDRC Energy Bureau, National Certification and Accreditation Administration, and related specialists. The committee will be responsible for guidelines and policies and for monitoring the fairness and independence of the test center activities. The committee's responsibility will also include approval of the center's quality principles and targets, monitoring of the center's activity fairness, examination of annual report and work plan, handling customer complains, and examination of financial situations.

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4.3.2.2 Test Center Preparation Working Group

The China General Certification Center (CGC) in Beijing will be responsible for establishing a

working group for preparing the National Wind Power Equipment Quality Test Center and starting the preparation work. The activities include:

- Test center funding and registration;
- Test center organization and technical capacity building;

—Formulating test center quality manual, procedure and technical handbooks;

—Equipment purchase and personnel training;

—Accredited by China laboratory accreditation committee;

—After approval by National Certification and Accreditation Administration, the test center will start running; and

- Experimental wind farm construction.

—Test center investment budgetary estimation;

—Wind farm site selection and solve the (national approval) grid connection permission and purchase price problems;

—Start the experimental wind farm construction.

4.3.2.3 Budget

Activity 3.1.1：500 k Yuan.

Activity 3.1.2：1 million Yuan.

Activity 3.1.3：1.6 million Yuan.

Activity 3.1.4：1.5 million Yuan.

Activity 3.1.5：16.80 million Yuan.

a. Test instrument and equipment including: load test, noise test, and power curve test, and power quality test, etc. Purchasing foreign equipment and training will cost about **2 million Yuan**.

b. Experimental wind farm project: Total installation 20MW, composed of central control building, transmission substation system, and auxiliary subprojects, such as grid connection transmission line and substation, communication and automatic control system, central control room, plus other subsystems, **costing 10.8 million Yuan**.

c. The first prototype system (600KW, or 750KW) for certification: **4.0 million Yuan.**

Total cost for test and certification: 21.4 million Yuan.

4.4 Wind Power Manufacturing Industry Development

In 2003, manufacturing cost for MW WTG systems was 8000-9000 Yuan/kW. This cost is expected to reduce to 7500 Yuan/kW in 2010, and about 6500 Yuan/kW in 2020. According to Chinese wind power development objectives, the accumulated investment in 2020 will be much as 200 billion Yuan, with a 200 k to 250 k job market. To realize this target, wind manufacturing localization and industrialization become a precondition.

4.4.1 Activities

4.4.1.1 Wind Farm Grid Connection Influence Analysis

According to China national wind power development objectives, wind power installation by 2020 will contribute more than 20 GW, accounting for a 2% of the total electricity generating installation in the country. International experience tells us that the 2% contribution will result no influence on the entire grid. However, there is an unbalanced wind resource distribution and China has not realized all-country grid networking and controlling system. After 10-15 years later, wind power installation at some areas could be as high as 15-20% in the entire network. No one can tell what will happen, as there do not exist a theory or practical experience on this. It is very important to study the wind farm characteristics and influence on the whole grid due to special wind resource features.

4.4.1.2 WTG System (Complete System and MW generator) Development

Improving competitive capability of Chinese manufacturers is one of the strategies of Chinese wind power industry. Wind Turbine Generator Systems concentrate many sophisticated technologies in the areas of air flow dynamics, strength science, automatic control, electric engineering, and compounded materials, etc. With advanced WTG technology, many business areas can be conducted in the wind power industry, such as repairing, operation and wind farm management. Therefore WTG technology becomes the key for wind power competition in the future. Take the GE example; based on its WTG system technology, GE involves all the areas in financing (rent), research, wind farm site selection, operation, and maintenance. Actually, the added value of technical service and manufacturing is larger than that of wind farm investment. GE is gradually penetrating the entire wind power market. China must support domestic enterprises for their own technology-based competitive capability.

By 2010, China total wind power installation will achieve 4 million kW. During the five years between 2006 and 2010, China will have a new installation of 600 MW per year. If considering a “ add more each year” practice, suppose the new added installation in 2006 is 400 MW and with annual increase of 100 MW of that new installation, the situation will be: the newly added installation is 50 MW in 2007, 600 MW in 2008, 700 MW in 2009, and 800 MW in 2020. When in 2010, 90% of parts will be localized. We also hope there are 4 domestic enterprises with annual output of 150-200 MW WTG systems. At least 2 of them are domestically invested or controlled joint ventures. This will ensure the localization objectives of Chinese wind generator manufacturing industry.

The 2020 objective is to install 20 GW wind power capacity. Between 2011 and 2015, annual new installation will be 1.2 GW, and 2 GW between 2016 and 2020. To achieve this target, three more domestically invested or controlled joint venture WTG system manufacturers need to be established in from 2011 to 2015. During that time, 5 such enterprises will take part of the market competition for China WTG manufacturing localization and industrialization.

The current Chinese WTG system manufacturers include:

① Xinjiang Jinfeng (Gold wind);

② Zhonghang (Xi’an) Nordex;

③ Jiangxi Zhonghang Wind Energy Sci-Tech Co. Ltd.;

④ China Longyuan Electric Power Group Corp.;

⑤ Shengyang University of Technology Wind Energy Research Institute;

⑥ Zhejiang Windey;

⑦ Shengyang Heavy Machine Tool Factory;

⑧ Jiangxi Jingdezhen Helicopter Institute;

⑨ Chian Huayi Elec.Apparatus Group Co., Ltd. (HEAG);

⑩ Dalian Heavy Machine Tool;

⑪ Harbin Electric Generator Factory;

⑫ Dongfang Electric Generating Equipment Factory;

⑬ Shanghai Electric Group;

⑭ China Shipbuilding Croup, Chongqing Shipbuilding Corp.;

⑮ Shanghai Tianyu Electric Co. Ltd. (Private).

Tasks of supporting the WTG system manufacturing and localization include：Overall design, assembly, and industrialized manufacturing of MW variable speed constant frequency wind power generators and MW direct current driven permanent magnet machines.

4.4.1.3 Wind Power System Parts and Accessories Industry

Key parts of a WTG system include: blades, controllers (electronic control systems), generators, gearboxes, wheel hubs (including variable pitch propellers), and yawing systems. So far in a WTG system, towers, engine room, wind farm electric apparatus, and blades (under MW grade) can be locally made, which accounts 51% of parts in a WTG system. Table 2 is an estimate of the WTG system localization.

Activities of parts localization include:

① Blades (for MW generators) manufacturing technology and design software development;

② Variable speed constant frequency generator control system development;

③ R&D of variable speed constant frequency generators; and

④ Wheel hubs (including variable pitch propellers).

Table 2: Estimation of WTG system localization

No.	Parts	Localization Rate(%)
1	Tower	16.9
2	Electric (package substation, 10kV/35kV Cable wire)	7.2
3	Engine room	4.4
4	Generator	7.4
5	Blade	22.5
6	Gearbox	15.4
7	Main shaft (including primary shaft bearing and	3.4

	couplers)	
8	Hubs (variable pitch propellers)	4.2
9	Yawing systems	1.3
10	Central control system	3.5
11	Electric control system	3.5
12	Liquid Pressure system	2.2
13	Assembly	3.0
14	Spare parts	1.0
15	Other accessories	4.1
16	Total	100

Primary Chinese parts manufactures include:

① Chongqing Gearbox Co. Ltd.

② Nanjing High-speed Gearbox Corp.

③ Hangzhou Advance Gearbox Co. Ltd.

④ Yongji Electric Machine Factory, China North Railvehicle Group

⑤ China Lanzhou Electric Machine Factory;

⑥ Zhuzhou Electric Generating Equipment;

⑦ Zhonghang (Baoding) Huiteng Glass-Fiber Reinforced Plastic Corporation;

⑧ Shanghai Fiber Reinforced Plastic Institute.

4.4.2 Implementation Plan and Budget

4.4.2.1 Wind Farm Grid Connection Influence Analysis

Many countries in the world have successful wind farm grid connection influence analyses. China can borrow these international experiences to work out a Chinese grid connection strategy. For instance, UK has made a lot of studies on its wind resource characteristics and wind farm optimal operation and proposed a multi-technology RE strategy by complementing distributed power sources, solar, hydropower, and biomass generations. China can do the similar study by domestic institutes and complete before the end of 2006.

Budget: 2.0 million Yuan.

4.4.2.2 Wind Generator Development and Parts Manufacturing Industry

These efforts will be supported in the following methods:

1. Local design, made for wind farms:

Wind technology manufacturing is closely related with wind farms. Wind farm produces electricity and sell to grid, while manufacturers as backyard make generators installed at the wind farm. This method is just a possible way. The final objective for wind technology is to penetrate into service and then to the wind market development.

2、Cooperative design or buying technology:

In Europe there are some small consulting companies having expertise of WTG system design. We can use their talent to catch up Chinese WTG system R&D pace. Chinese side can pay design consultancy and obtain the intellectual property rights. Methods could be sending Chinese experts to their design studios and work together with them, or foreign experts can be invited to Chinese R&D centers on design and certification, until prototype test and into manufacturing.

In another situation, some small companies in Europe have strong design capability, but either high manufacturing cost, or lack of market development skills. Their working together with Chinese corporations can take each other's advantages. For example, China Gold Wind has jointly developed the 1.2MW direct current driven permanent magnet system with German Vensis. During the collaboration, technical people from both sides work together and learn each other, by taking advantage of German WTG design experience and Chinese permanent magnet material production. The prototype machine was produce in a short time period. The product was successfully used in replacing old equipment.

Implementation Approach:

Between 2005 and 2010, China will adopt a wind farm development and WTG system manufacturing package bidding method in 500 MW wind farms to support 2 or 3 domestic invested or controlled joint venture enterprises of MW-grade 200 MW capability. All used WTG systems will be localized at the new wind farms (parts localization rate will be over 90%). Winning enterprises must have completed two round of local made system on-site tests before 2020.

From 2011 to 2015, in the same method, China will support two more enterprises for a 200 MW capability of MW-grade WTG system.

Purpose of this approach is to support Chinese technology and as well expand wind power market in China. The market will drive the manufacturing industry development, and in turn, the manufacturing industry will promote further wind power market prosperity.

Next activity: Write biding documents.

Funding Sources: CRESP and NDRC Industrialization Public Bidding Project.

Budget:70 million Yuan.

Annex Table:

Budget

Activities	Budget Calculation (Unit 100,000 Yuan)			
	Enterprises	Government		**Total**
		CRESP	**NDRC & Joint Programs**	
I. Legal & Regulation System		***362***		***362***
1. Wind Farm Grid Connection Standards (Technical Specification)		160		160
2. Wind Power (RE) Tariff		120		120
3. RPS Wind Target and Implementation Administration		82		82
II. China Wind Resource Assessment (Wind Power Development Research) Center		***3100***	***8400***	***11500***
1. Wind Resource Survey and Assessment		1600	8400	10000
2. Training (including Equipment and Software)		1500		1500
III. Certification and Accreditation		***2140***		***2140***
1. Certification System Design		50		50
2. Certification Capacity Building		100		100
3、Standard and Design/Accreditation Guidelines		160		160
4. WTG Design Evaluation Capacity Building		150		150
5. Wind Power Industry Test Center		1680		1680
IV. WTG Manufacturing Industry Building	***73000***	***7200***	***7000***	***87200***
1. Wind Farm Grid Connection Influence Study		200		200
2. WTG System Industrialization				
2005 -- 2010	36000	4000	4000	44000
2011 -- 2015	37000	3000	3000	43000
Total	**73000**	**12802**	**15400**	**101202**