

# A CASE STUDY OF CHINA'S WIND POWER RESOURCES\*

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## Abstract

At present, China is the largest energy producer and the second largest energy consumer in the world. With the increasing pressure to cut GHS emissions and to improve energy efficiency, China is now changing its traditional energy mix, mainly through consuming more renewable energy instead of fossil energy. This change has resulted in a policy adjustment which in turn boosts the utilization of the wind power resources. However, the development of the wind power resources in China is confronted with some significant challenges, such as greater installed electricity capacity than the electricity generation, greater electricity generation than the electricity transmission capacity and greater inland wind power generation than the offshore wind power generation. Therefore, the further development of China's wind power electricity in the coming years depends largely on the ways these challenges will be addressed.

**Keywords:** *China, Wind Power, Policy.*

**J.E.L. Classification:** *Q 6.4.*

## Introduction

In 2012, China was the largest producer and the second largest consumer of primary energy in the world. However, China is under the increasing pressure to change its traditional energy structure. In order to reduce GHS emissions and to use energy in a more effective way, China has focused on the development of renewable energy resources. Over the last ten years, Chinese policy has led to a quick growth of the wind power electricity generation. However, China faces several challenges for the further development of the wind power electricity generation, such as the unbalanced growth of the wind power installed electricity capacity and the electricity production as well as the unbalanced development of the wind power electricity generation and the grid-connected electricity. In the coming years, the development of the wind power electricity will be decided by the way how these issues be addressed. The author attempts to make a short discussion of these issues and then gives some tentative policy options.

### 1. China needs a renewable energy policy

In 2012, China's GDP reached 8.26 trillion US dollars and its economy grew at 7.8 percent over 2011. However, China consumed about 3.53 billion tons of primary energy (coal equivalent), ranking the second in the world after the United States. China's energy consumption per GDP is twice higher than the world average<sup>2</sup>. Chinese economy is expected to continue to grow at a rather high rate in the coming years and this means that China will face greater pressure of primary energy shortage. We should look at the current situation of China's energy production and consumption in order to have a full understanding of China's

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\* This paper is based on the PPT presentation made at Romanian Academy, Institute of World Economy, on June 13, 2013.

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<sup>2</sup> See China Energy Statistical Yearbook 2012, China Statistics Press, Beijing, March 2013.

challenges and opportunities.

China is similar to EU in the terms of fossil energy reserves with rich coal resources but poor resources of crude oil and natural gas. Over the last twenty years, China's primary energy production and consumption both increased rapidly and is one of the most important drivers for Chinese economic growth. The present economic growth model, however, is not sustainable in the terms of fossil energy reserves. Because the sustainable development refers to not only meet the needs of current generation but also the future generations should be able to cope with the development challenges.

Looking into the energy mix in China, we can see that the country heavily depends on the coal and other coal-based energy. In 2012, Chinese output of coal was 3660 million tons, crude oil 204 million tons and natural gas 107.7 billion cubic meters. With the rapid development of Chinese economy, the coal-based production system has undergone profound changes over the last ten years. This change is promoted by the needs to improve energy efficiency and to reduce GHG emissions. When Chinese industrial sectors shift to clean and efficient energies, China's energy dependency rose rapidly. In 2012, China produced 3660 million tons of coal and imported 280 million tons of coal, with a relative low dependency rate of 7 %. But in the same year, China imported 272 million tons of crude oil and 42.5 billion cubic meters of natural gas. Thus, China's dependency on imported oil and gas was at 57 % and respectively at 28 %, <sup>3</sup> which is much higher compared with its dependency on coal. For the last five years, China's consumption of coal represented around 67 % of total primary energy consumptions while oil and gas consumptions accounted for about 18.9 % and 5.5 % respectively. It should be noted, with the increasing pressure of GHG emissions reduction, domestic electric power, industry and transportation will prefer to use cleaner energies, such as natural gas.

This transformation will further increase the dependency on crude oil and natural gas, thus challenging China's security of energy supply. The following tables show the primary energy production and consumption in China.

**Table.1. China's Total Production of Energy and its Composition (from 2006 to 2011)**

Year	Total Energy Production (10Ktce)	As Percentage of Total Energy Production (%)			
		Coal	Crude Oil	Natural Gas	Hydro/Nuclear/ Wind Power
2006	232167	77.8	11.3	3.4	7.5
2007	247279	77.7	10.8	3.7	7.8
2008	260552	76.8	10.5	4.1	8.6
2009	274619	77.3	9.9	4.1	8.7
2010	296916	76.6	9.8	4.2	9.4
2011	317987	77.8	9.1	4.3	8.7

Source: National Bureau of Statistics of China, 2012.

**Table.2. China's Total Consumption of Energy and its Composition (from 2006 to 2011)**

<sup>3</sup> China's dependency for crude oil will rise to 60% in 2013 according to some statistics. See Research Report, CNPC Economics and Technology Research Institute, Beijing, April 2013.

Year	Total Energy Consumption (10Ktce)	As Percentage of Total Energy Consumption (%)			
		Coal	Crude Oil	Natural Gas	Hydro/Nuclear/ Wind Power
2006	258676	71.1	19.3	2.9	6.7
2007	280508	71.1	18.8	3.3	6.8
2008	291448	70.3	18.3	3.7	7.7
2009	306647	70.4	17.9	3.9	7.8
2010	324939	68.0	19.0	4.4	8.6
2011	348002	68.4	18.6	5.0	8.0

Source: National Bureau of Statistics of China, 2012.

## 2. China's advantages for developing renewal energies

Generally, Chinese economy is still heavily coal-based, which is environmental unfriendly and low energy efficiently. Chinese government regards this as a serious challenge for the country's future development and the cooperation with other countries. Moreover, Chinese government has targeted the national energy self-sufficiency at 85 percent for 2015. Because China is under growing pressure to change its traditional energy structure, those clean energies, especially renewable energy, will be seen as a potential option. Then it should be asked, does China have adequate resources of renewable energy to meet the economic development needs in the coming years? The answer is "yes".

China is rich in resources of renewable energies, especially the hydropower, solar-power and wind power. The country has a long history and rich experiences in using water resources to generate power for industry and agriculture. In 2011, China's hydropower installed electricity capacity achieved 230 gigawatts(GW), representing about 21 percent of total domestic installed electricity capacity. China is currently the largest user of hydropower in the world by the standard of electricity generation. By comparison, the use of solar-power and wind power started late but has developed very quickly over the last ten years. In 2011, the total domestic photovoltaic power installed electricity capacity reached 3000 megawatts(MW) and the grid-connected wind power installed capacity was 47 gigawatts(GW) in 2012, ranking No.1 in the world.<sup>4</sup>

## 3. China's wind power electricity generation

### 3.1. China has rich resources of wind power

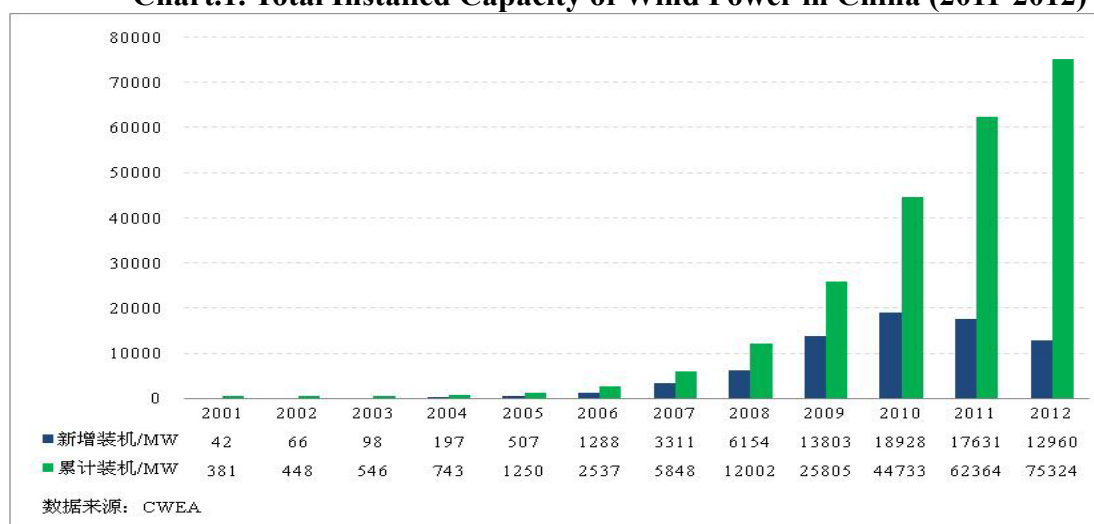
In China, the resources of wind power are over 3000 GW, of which only a small amount is developed and used. Since the introduction of "Law on Renewable Energies" in 2005, China has undergone a rapid development of wind power generation. The installed wind power electricity capacity rose from 1250 MW to 75.95 GW over the period 2005 - 2012. "China Energy Policy 2012", adopted by Chinese government in 2012, claims that the wind power installed electricity capacity has to reach 100 GW by 2015 (even so, only about 3 % of China's resource of wind power is used).

As the following tables show, in 2012 the total wind power electricity installed capacity was 75.95 GW (ex. Taiwan), with a rise of 20.8 % over the previous year. At the same time, the new installed capacity of wind power for 2012 was 12.96 GW, decreasing

<sup>4</sup> China began to use nuclear power in the 80s and in 2011 national nuclear power installed electricity capacity was 12.54 giawatts (in operation) and 29.24 gigawatts (under construction). See China Energy Statistics Yearbook, China Statistics Press, Beijing , March 2012.

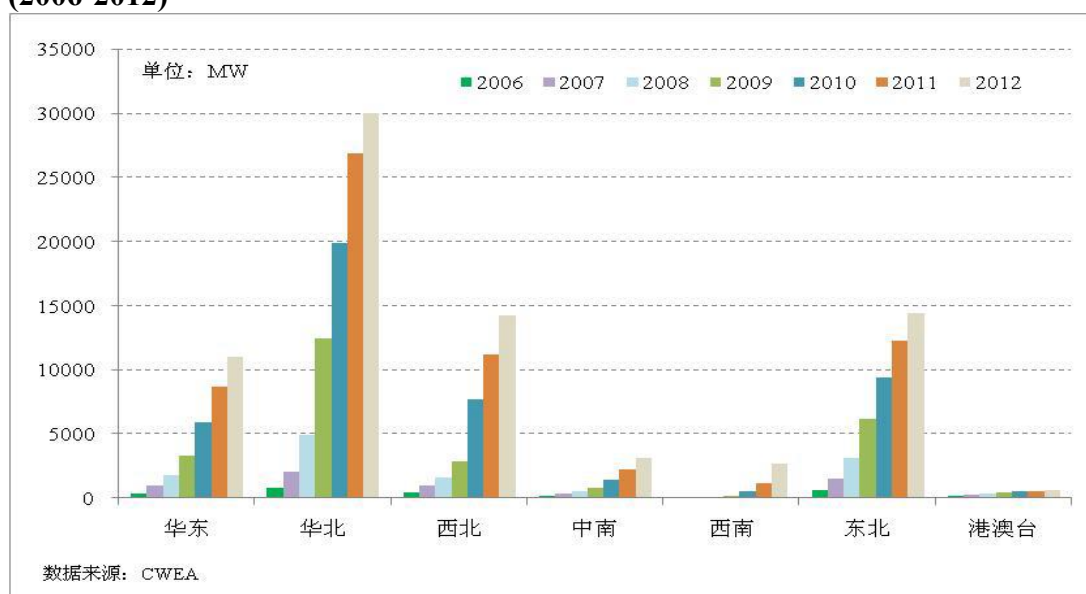
about 26.5 % over 2011 mainly due to the intense competition in the domestic and overseas markets.

**Chart.1. Total Installed Capacity of Wind Power in China (2011-2012)**



Note: Blue columns represent the new installed capacity and the green ones represent the total installed capacity.  
Source: China Wind Energy Association/CWEA, 2013.

**Chart.2. Regional Distribution of Total Installed Capacity of Wind Power (2006-2012)**



Note: From left to right: eastern provinces, northern provinces, north-west provinces, central provinces, west-south provinces, north-east provinces and Hong Kong, Taiwan and Macao.  
Source: China Wind Energy Association/CWEA, 2013.

There has been an interesting feature in the regional distribution of wind power resources in China. The onshore wind power resources are mostly concentrated in the inland areas such as Inner Mongolia, northwest, north and northeast provinces. At the same time, China's offshore wind power resources mainly concentrate in the coastal areas, which extend from Bohai Bay to South China Sea. This kind of distribution of wind power resources has an obvious impact on China's wind power development strategies.

**Table.3. China's Top Ten Areas of Wind Power Installed Electricity Capacity**

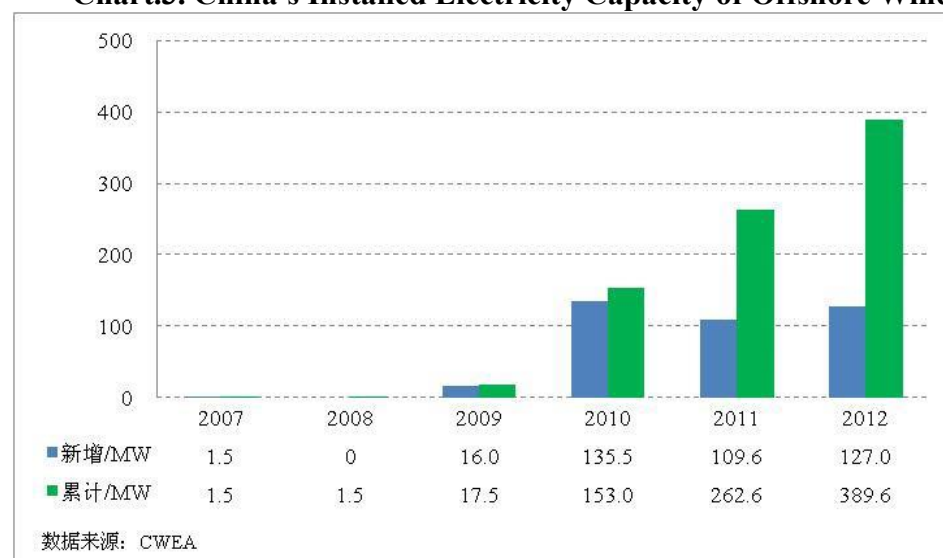
**in 2012 (according to new and total installed capacity)**

Area	Rank	2011 Total/MW	2012 New Added/MW	2012 Total/MW
Inner Mongolia	1	17504.4	1119.4	18623.4
Hebei	2	7070.0	908.8	7978.8
Gansu	3	5409.2	5409.2	6479.0
Liaoning	4	5249.3	869.8	6118.3
Shandong	5	4562.3	1128.7	5691.0
Heilongjiang	6	3445.8	818.6	4264.2
Jilin	7	3564.4	433.0	3997.4
Ningxia	8	2875.7	690.0	3565.7
Xinjiang	9	2316.1	990.1	3306.1
Shanxi	10	1881.1	1026.0	2907.1
<b>Total*</b>		<b>62928.2</b>	<b>13017.0</b>	<b>75945.2</b>

\* Include Hong Kong, Taiwan, Macao

Source: China Wind Energy Association/CWEA, 2013.

**Chart.3. China's Installed Electricity Capacity of Offshore Wind Power in 2012**



Notes: The blue columns represent new installed capacity and the green columns represents total installed capacity

Source: China Wind Energy Association/CWEA, 2013.

### 3.2. China's wind power equipment manufacturing capacity

In 2005, Chinese government introduced a national strategy to develop wind power generation. Since then, there has been a rapid market expansion as more electric producers, driven by the huge potential profits, shift to the manufacturing of wind power equipments, especially the small-medium size wind turbines.

In 2012, China's top 20 wind turbines almost take up 98 % of domestic market share in the terms of new installed capacity, with Gold Wind representing 19.5 %, followed by United Power and SINOVEL. The largest five makers represent nearly 60 % of the domestic market share. The market situation is showed by the following two tables.

**Table.4. China's top 20 makers of wind turbine in 2012 (new installed capacity)**

Rank.	Maker	Installed No.	Installed Cap/MW	Installed Cap/%
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1	Gold Wind	1600	2521.5	19.5
2	United Power	1302	2029.0	15.7
3	SINOVEL	699	1203.0	9.3
4	MINGYANG	739	1133.5	8.7
5	XEXC WP	445	893.0	6.9
6	Shanghai Electric	430	822.0	6.3
7	Envision Energy	328	544.0	4.2
8	Gamesa	265	493.2	3.8
9	DEC WP	311	466.5	3.6
10	Vestas	244	414.4	3.2
11	CSIC HAIZHUANG	214	399.5	3.1
12	CSR WP	252	385.8	3.0
13	WINDEY	263	364.5	2.8
14	SANY Electrical	166	275.0	2.1
15	ChinaCreative	174	263.1	2.0
16	XJ WP	86	172.0	1.3
17	HEWIND	76	114.0	0.9
18	TEWIN	52	78.0	0.6
19	GE WP	40	60.0	0.5
20	INHE WP	23	57.5	0.4
Other		163	270.5	2.1
<b>Total</b>		<b>7872</b>	<b>12960</b>	<b>100</b>

Source : China Wind Energy Association/CWEA, 2013.

**Table.5. China's top 20 Makers of Wind Turbine in 2012(total installed capacity)**

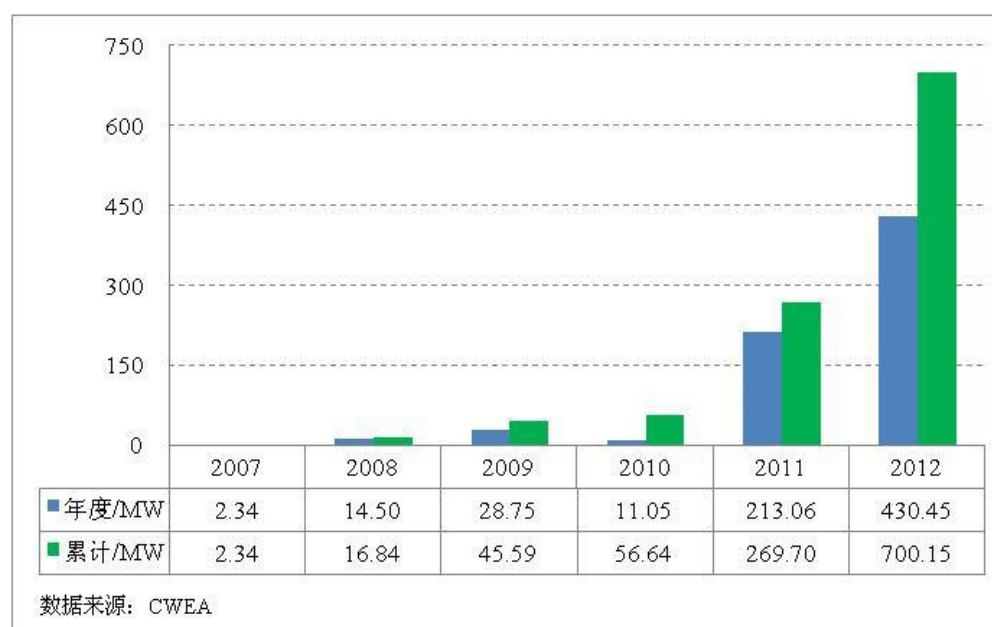
Rank	Maker	Installed No.	Installed Cap/MW	Installed Cap %
11	Gold Wind	12227	15200.4	20.2
2	SINOVEL	9178	14180.0	18.8
3	DEC WP	4901	7364.5	9.8
4	United Power	4801	7311.0	9.7
5	MINGYANG	2802	4256.5	5.7
6	VESTAS	3175	3979.9	5.3
7	GAMESA	3220	3279.1	4.4
8	XEMC WP	1345	2694.5	3.6
9	Shanghai Electric	1582	2603.5	3.5
10	GE	1082	1635.5	2.2
11	China Creative	1045	1571.1	2.1
12	WINDEY	1429	1462.5	1.9
13	CSR WP	823	1302.3	1.7
14	Envision Energy	827	1292.5	1.7
15	CSIC Haizhuang WP	689	1274.8	1.7
16	Suzlon	649	901.3	1.2

17	SANY Electrical	379	598.0	0.8
18	Nordex	471	574.2	0.8
19	HEAG	450	560.1	0.7
20	YINXING Energy	496	505.0	0.7
Other		2193	2777.5	3.5
<b>Total 计</b>		<b>53764</b>	<b>75324.2</b>	<b>100</b>

Source : China Wind Energy Association/CWEA, 2013.

Globally, the competition has become increasing intense as more wind turbine makers of developing countries enter the markets. China is one of the important exporters of small-medium wind turbines. In 2012, China had seven biggest exporters of wind turbines, with a total exported installed capacity of 700 MW (ex. foreign invested firms). The United States is the largest overseas market for Chinese-made wind turbines. Gold Wind, the largest exporter, has established at least three R&D centers in the United States, EU and Australia.

**Chart.4. Export of China's Wind Turbines (By the end of 2012)**



Note: Blue columns represent new installed capacity and green columns represent total installed capacity for export.

Source: China Wind Energy Association/CWEA, 2013.

**Table.6. Export Destination of China's Wind Turbines (by the end of 2012)**

No.	Country	Quantity	Capacity/MW	No.	Country	Quantity	Capacity/MW
1	USA	182	327.75	11	Thailand	7	13.00
2	Turkey	36	54.00	12	Sweden	2	6.00
3	Italy	22	52.50	13	Iran	3	5.50
4	Bulgaria	34	51.50	14	Chile	5	5.34
5	Ethiopia	34	51.00	15	Cuba	6	4.50
6	Spain	12	36.00	16	Britain	3	3.75
7	Brazil	23	34.50	17	Kazakhstan	2	1.56
8	Australia	13	19.50	18	Belorussia	1	1.50

9	Ecuador	11	16.50	19	Uzbekistan	1	0.75
10	India	10	15.00	<b>Total</b>		<b>407</b>	<b>700.15</b>

Source : China Wind Energy Association/CWEA, 2013.

#### **4. China's Policy on the Wind Power Electricity Generation**

##### **4.1. China has adopted a national energy policy**

In China, the policy for developing wind power could not be divorced from a broader energy policy.<sup>5</sup> In 2012, Chinese government publishes “China’s Energy Policy 2012”, a white paper outlining the pathways of energy development in the coming years. It claims that China’s energy development still faces some significant challenges. For example, “fossil energy resources have been exploited on a large scale, causing a certain amount of damage to the eco-environment” (see “China’s Energy Policy”, 2012). China should improve energy efficiency, energy security and reduce GHS emission mainly through scientific technological and system innovation as well as the further development of new and renewable energy resources and promotion of the clean efficient development of utilization of fossil energy resources. The white paper set a target for the renewable energy which should achieve 11.4 % of total primary energy consumption by 2015 and 15 % for 2020.

As one of the most significant renewable energy resources, the wind power played a key role in meeting the national target. Under the “Twelfth Five-Year Plan”(2011-2015),<sup>6</sup> China should coordinate the development of onshore and offshore wind power resources. By 2015, the installed wind power electricity capacity will be 100 GW, of which 5 GW will be generated from offshore wind power resources.

##### **4.2. Specific policy measures have been taken to achieve the target**

###### **4.2.1. The preferential price**

Chinese government urged the national power grid corporations to buy all electricity generated by wind power under such price composition as: generating costs, investment and interest repay and reasonable profits. The power grid is asked to provide the nearest network connection for all electricity generated from wind power. When the price of wind power electricity is above the average electricity price, the power grid must share the excess costs across the whole grid system.

###### **4.2.2. The price subsidy**

From 2002, Chinese government begins to offer a special price support to the wind power generation. In the single year of 2002, almost one hundred thirty eight million yuan(16 million US dollars) is provided for the wind power generators and the total amount of price subsidy has risen to five thousand eight hundred and fifty million yuan(688 million US dollars), of which about two thousand and fifty million yuan(315 million US dollars) go to the wind power generators in the area of Inner Mongolia.

###### **4.2.3. The tax privilege**

At the moment, China’s wind power electricity generators are required to pay only 50 % of value-added tax (VAD). Furthermore, all wind power electricity generators enjoy an exemption of corporate income tax during the first three years of their operation. In the latter three years of operation, the corporate income tax rate for all wind power electricity generators is only 6.25 %, almost half of other firms who must pay 12.5 % of their revenue as income tax. Chinese makers of wind turbines, moreover, may enjoy more tariff preferences depending upon the size of wind turbines produced by them. For example, if a Chinese maker

<sup>5</sup> China Energy Policy 2012, The Information Office of the State Council, the People’s Republic of China, October 2012, Beijing.

<sup>6</sup> The Twelfth Five-Year Plan for National Economic and Social Development of China, The State Council of PRC, March 2011, Beijing.



produces wind turbines of over 1.2MW and it needs to import key materials or components for the production process, then it may enjoy refunding for these imported materials or components. However, if a Chinese maker produces bigger wind turbine, saying over 1.5MW, then the import duty on the key materials or components will be fully exempted.

#### **4.2.4. The investment support**

Since 1987, Chinese government has introduced loan interest initiative to boost the investment in the renewable energy projects in the rural areas. The central government and local government will share the obligations, with the former responsible for providing subsidy to the R&D projects, pilot demonstration projects, while the latter is responsible for supporting the promotion of use of solar and wind power.

#### **4.2.5. The financial support on R&D**

From 2008 to 2011, the Chinese government introduced several types of important financial subsidies and funds to stimulate the development of some key technologies for large wind turbines. For example, the government encourages the domestic wind power equipment makers to establish their own research and development centers focused on the development of independent core technologies. China begins to pay more attention to the capacity-building, especially the capacity of developing MW wind turbines.

### **5. The Challenges of China's Wind Power Generation**

At the moment, the further development of wind power resources in China is facing many kinds of obstacles, of which some are rather serious. The lack of correct understanding and solving of these problems will impose a negative impact on the development of this sector, therefore causing the failure in meeting the national energy target.

#### **5.1. The market distortion**

The policy to boost wind power generation has brought some consequences. Since 2005, a large number of wind turbine makers have appeared in China. As a result, almost all makers find that they have to cope with the intense competition and in some cases the market environment is increasingly worsening. A report of China Venture shows that over 60 % of China's largest and stock market-listed wind turbine makers is facing great financial loss, meanwhile, the foreign invested firms such as Vestas, Suzon and Repower is losing their shares in Chinese domestic market(China Venture, 2012).

#### **5.2. The grid connection and outlet**

In 2012, the coal-based electricity took up almost 81 % of China's total electricity generation, followed by the hydropower generation by 16 % and nuclear power generation by 2 %. Other renewable energy represents about 1 percent. At the moment, the electricity pricing mechanism results in a reluctance of the power grid to buy more wind power generated electricity because: (a) when the wind power electricity price is the same as the price of coal-based power electricity, it will be rather hard for the power grid to make extra profits. (b) buying more wind power electricity means buying less electricity from other sources, especially coal-based power electricity. What makes things worse is that the power grid's loss is not compensated by the government. (c)the trans-regional outlet is a more serious problem than any issues noted above. The transmission of wind power electricity generated in Inner Mongolia, for instance, must use the power grid's networks of Liao Ning province. In this case, who will pay for the power grid's loss in Liao Ning province? Is it the central government or the local governments?

#### **5.3. Can the subsidy policy be sustainable?**

The present price subsidy for the wind power generation is mainly ensured by the state finance. In 2012, the size of such subsidy is 5,800 million yuan (900 US dollars).As mentioned above, the wind power generation business has developed very quickly since 2005 and by 2015 the total installed wind power electricity capacity will achieve 100 GW. Will the

central government be able to continue to undertake such big size of funds? By comparison, the US and EU use the revenue from tax on fossil energy to promote the development of renewable energy. So it is still uncertain whether the subsidy policy in China can be sustainable. In addition, the state financial support aiming at promoting wind power generation and the power grid got little financial support. As a result, the power grid lacks motivation to buy more wind power electricity.

#### **5.4. Regulatory policy**

Before 2011, the local government was authorized to examine and approve the wind power projects whose installed electricity capacity was below 50 MW. To avoid the strict examination from central government, many wind power projects under this ceiling sprang up all over the country. These small wind power generators compete for the limited resources of wind power farms and the competition for profitable wind power farms is particularly fierce. In 2011, National Bureau of Energy of China introduced a new policy, under which only the wind power generation projects that are covered by the state plan may be given financial subsidies (National Bureau of Energy of China, August 2011).

#### **5.5. The unbalanced development of wind turbine makers**

The policy to promote the quick development of wind power turbine producers in China, led to a serious market excess capacity. In 2011, the production of wind turbines was 30 GW while the installed capacity was only 16 GW, which means that there was about 50% of market excess capacity. Considering this, Ministry of Industry and Information Technology of China raised the threshold of market access for all wind power turbine makers. A recent study made by Deutsche Bank claims that if China continues to rapidly develop wind power in such a way, that by 2020 the unused electricity installed capacity of wind power will likely rise to 29 GW.<sup>7</sup>

#### **5.6. The uneven regional distribution**

In China, the wind power resources are mainly distributed in the inland and border areas but the electricity end-users are usually located in the coastal areas, especially the metropolis in the eastern part of the country. The network load of power grid in the inland areas is usually lower than that of coastal areas. So, it is important to accelerate the development of offshore wind power generation.

#### **5.7. Uneven Capacities**

China's production capacity of wind power electricity exceeds the installed capacity of wind power turbine. Furthermore, the pace of development of wind power generators is faster than the pace of grid-connection of wind power electricity. In 2012, the installed capacity reached 75.94 GW and the grid-connected wind power electricity was only 60.83 GW with an existing gap of 11.15 GW.

### **Conclusions**

In short, China should do something to balance the development of wind power generation and the improvement of the power distribution system, which will be very important for the further development of domestic wind power resources. The way out of the dilemma is to take the following actions as soon as possible:

- a. China should review the regulatory policy and give a more strict examination procedure on the wind power projects;
- b. China should invest more in offshore wind power generation projects and change the overdependence of inland wind power resources;
- c. China should create a fair market environment so that the wind power electricity

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<sup>7</sup> Deutsche Bank, Prospect of China Wind and Photovoltaic Report 2012, Chinese Edition, Beijing, February 2012.

- operators can improve their profit-making capacity;
- d. China should raise the level of financial support for research and development in new wind power technologies;
  - e. China should increase investment in the grid so that the wind power electricity generators and the electricity distributors both can benefit from such investment.

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