

RENEWABLE ENERGY IN CHINA AT PRESENT AND ITS FURTHER DEVELOPMENT

XIN SUI

Research Center for Sustainable Hydropower Development, China Institute of Water Resources and Hydropower Research, Beijing, 100038, PR China

CHUNNA LIU

Research Center for Sustainable Hydropower Development, China Institute of Water Resources and Hydropower Research, Beijing, 100038, PR China

ZHENLI HUANG

Research Center for Sustainable Hydropower Development, China Institute of Water Resources and Hydropower Research, Beijing, 100038, PR China

Global climate change is a concern throughout the world. In the world climate conference in Copenhagen, China's government made a commitment that, by 2020, China would reduce CO₂ emissions per unit of gross domestic product (GDP) by 40%–45% of the 2005 levels. In order to keep up the rapid economic development without generating excessive CO₂ emissions, China's government is looking for a responsible way to promote the renewable energy. In this paper, we describe and analyze the strategy and opportunities of promoting renewable energy in China, regarding to the national development plan. Then a description of the different types of renewable energy in China, such as wind and solar energy, has been evaluated. Further, we indicate the main problems renewable energy is now facing and analyze the advantage and necessary of developing pump-storage hydropower. At last, the potential development of pump hydro storage is predicted, with mention of both pumped storage and increased hydro capacity.

1 INTRODUCTION

Global climate change is a concern throughout the world. In the world climate conference in Copenhagen, China's government made a commitment that, by 2020, China would reduce CO₂ emissions per unit of gross domestic product (GDP) by 40%–45% of the 2005 levels. In order to keep up the rapid economic development without generating excessive CO₂ emissions, China's government is looking for a responsible way to promote the renewable energy. As specified in the 11th Five-Year Plan for Development of Renewable Energy, consumption of non-fossil fuel will account for 15% of the primary energy consumption by 2020, and carbon emissions will reduce by 40% to 45% by 2020 compared with 2005. Thus, in few years Chinese government has taken several steps to reduce the use of fossil fuels-based energy while promoting renewable generation.

Renewable energy sources have some advantages when compared to fossil fuels. Increased use of renewable energy can have an important environmental effect. Nevertheless, few if any of the environmental externalities of energy use are incorporated into their cost, and this is one of the reasons that renewables cost more than competing energy sources. Renewable energy resources provide a large share of the total energy consumption of China. It is accepted as a key source for the future for China.

2 Wind energy

2.1 Wind energy potential in China

With large land mass and long coastline, China has relatively abundant wind resources. According to the estimates by China Meteorological Administration, based on the relatively low height of 10 m above ground, the theoretically exploitable wind resource represents a potential power generation capacity of 4350 GW, and the technically exploitable wind resource 297 GW.

Table 1 The wind energy distributing zone and the share percent of country area.

Wind energy index	Best abundant	Better abundant	Available	Deficient
Wind energy density (W/m^2)	>200	200–150	<150–50	<50
Average wind speeds (m/s)	6.91	6.91–6.28	6.28–4.36	<4.36
Accumulative total hours when wind speed ≥ 3 m/s	>5000	5000–4000	4000–2000	<2000
Accumulative total hours when wind speed ≥ 6 m/s	>2200	2200–1500	<1500–350	<350
The share percent of country area (%)	8	18	50	24

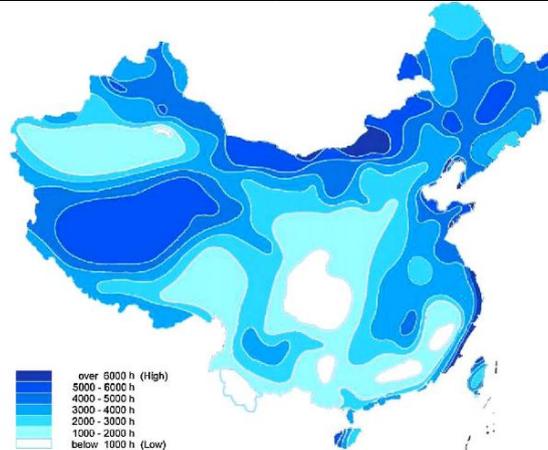


Fig. 1. Hours with wind speed over 3 m/s in different areas

2.2 Current state of wind energy

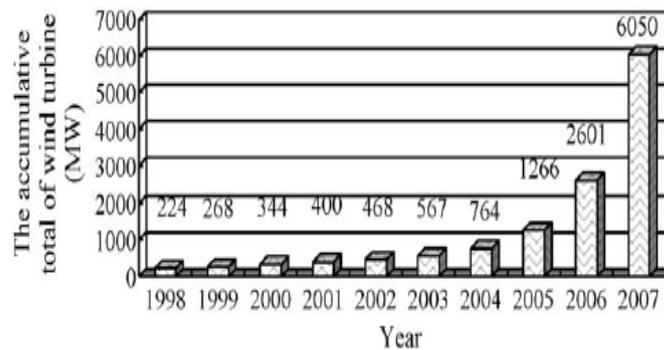


Fig. 2. The accumulative total of wind energy generating system in the past 10 years (source: CWEA and news, 2008).

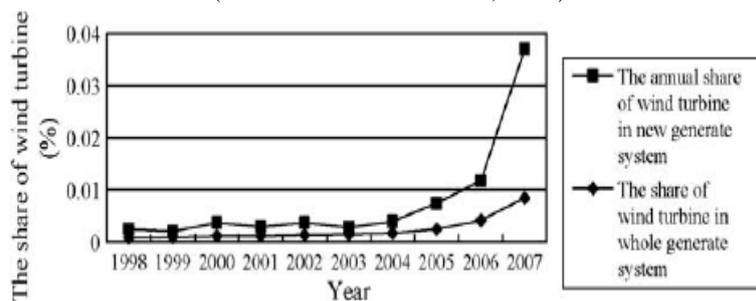


Fig.3. The wind energy shares in the whole generate electricity system and new generate electricity system (source: CWEA and news, 2005).

China has spent enormous money and energy in the wind sources domain, the wind capacity has doubled approximately every year in the past 5 years. Based on the data of Chinese Wind Energy Association (CWEA)

and news, Fig. 2 shows the accumulative total of wind energy generating system in the past 10 years. Fig. 3 shows the wind energy shares in the whole generate electricity system and new generate electricity system.

3 SOLAR ENERGY

3.1 Solar energy resources distribution

It is well known that China has abundant solar energy resources in large country. Thousands of years ago, the solar energy was used to insulate the corn and salt and clothing by Chinese ancestor. The easy application is used to improve the life quality of ordinary people until recently, such as solar energy street lamp, solar water pump, solar heater and solar energy charger. At present, the PV industry of China has a huge development in past 10 years. For example, the yield of Chinese PV in 2007 is more than 1200 MW, and which has share of 35% in whole world, which ranks the first in the world. Various actual applications have been used to improve the daily life of common people.

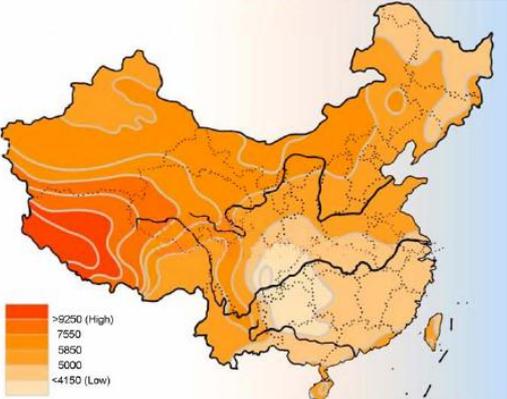


Fig. 4. The statistics of solar energy density in 2008 (source: CWB, 2008).

3.2 PV industry development in China

Table 2 Market shares of different PV applications in China

Classify	The accumulative total (MW)	Market share (%)
Electric energy supply of remote villages	33	41.3
Communication and industry	27	33.8
Solar energy manufacture	16	20
Architecture PGEP	3.8	4.8
Large-scale desert PGEP	0.2	0.3
Total	80	100

Note: (Source: Chinese Environmental Science Press)

At present, more and more Chinese enterprisers begin to invest the PV industry. Certainly, the PV industry of China faces some difficulties at present, such as the technology of produce, raw and processed materials and environmental pollution. The PV is produced in some factories, and the number is more than one hundred. But most of them are nothing more than assembling the subassembly of PV. There is no little technology, and the benefit of economy is bad. The essential reason is no pivotal technology, such as silicon material, incision, forging and polish, etc. It is well known that the produce of PV products has a lot of contamination, such as acidic and alkaline waste water, heavy metal waste residue, which have big effect to local environment.

4 PUPMED-STORAGE HYDROPOWER

4.1 Capacity of PHES and its distribution

Table 3 Data of PHEs capacity in each region of China (MW).

	North China	East China	Central China	Northeast China	West China	South China
Total MW capacity	5503	10,220	4992	2700	90	7280
Existing MW capacity	4303	4860	2892	300	90	4500
Number of existing plant	7	7	6	1	1	2
MW under construction	1200	5360	2100	2400	0	2780
Number in construction	1	5	3	2	0	3

Table 3 Planned capacity of PHEs in 2015 and 2020 (MW).

	Existing capacity(MW) in2010	Addition (GW)		Accumulation(GW)	
		2011–2015	2016–2020	2015	2020
North China	4303	2.88	3.03	7.18	10.21
East China	4860	6.3	4	11.16	15.16
Central China	2892	2.9	2.5	5.79	8.29
Northeast China	300	2.4	1.1	2.7	3.8
West China	90	0.75	1.62	0.84	2.46
South China	4500	1.5	4.1	6	10.1
Overall capacity	16945	16.72	16.35	33.67	50.02

4.2 Balancing the intermittent energy sources by pumped –storage hydropower in China

Large-scale development of wind power and other renewable energy should be coordinated and the ability of the power system to use wind and other clean energy sources will be improved. With the large scale development of renewable such as wind power, the appropriate capacity of pumped storage plants should exist in the electric power system to act as a complement to wind power. The extra wind power in electric power system can be stored by pumped storage plants, and the pumped storage plants can generate power when wind power is suddenly reduced to maintain the stability of the grid, especially for high-voltage transmission. Making use of the advantages of pumped storage plants can not only balance the disequilibrium of wind power generation but also participate in frequency regulation of the grid, reduce the impact of wind power on the grid and solve the current problems of wind power transmission.

5 CONCLUSION

The highly energy intensive economy and strong GDP growth in China will inevitably drive the continuous growth of the energy demand. These present key challenges to China to balance between rising energy demands and potential environmental issues. The developments of the renewable energy-especially wind and solar energy-will be put more attention in the future. With the potential development of pump hydro storage, more effect of balancing the intermittent energy sources would be showed up. It is benefited and necessary for us to promote the future development of renewable energy and pump hydro storage.

REFERENCES

- Deane, J.P., Gallachóir, B.P., McKeogh, E.J., 2010. Techno-economic review of existing and new pumped hydro energy storage plant. *Renewable and Sustainable Energy Reviews* 14 (4), 1293–1302.
- Demirbas A. Biomass resources for energy and chemical industry. *Energy Educ Sci Technol* 2000;5:21–45.
- Demirbas A, Demirbas AS, Demirbas AH. Global energy sources, energy usage, and future developments. Chen, Fu, Liwen, Zhao, Huiru, Guo, Sen, 2012. An analysis on the low-carbon benefits of smart grid of China. *Physics Procedia* 24(A), 328–336.
- Hepbasli A, Ozgener O. Turkey's renewable energy sources: Part 1. Historical development. *Energy Sources* 2004;26:961–9.
- H.S., Cong, T.N., Yang, W., et al., 2009. Progress in electrical energy storage system: a critical review. *Review Article Progress in Natural Science* 3 (19),291–312.
- Sadettanhand K, Kumar S. Renewable energy resources potential in Lao PDR. *Energy Sources* 2004;26:9–18.