

# The Current Status and Development Trend of Wind Power Generation

Zhang Xingguo, Liu Shuhua, Huang Liang, Wu Hui

Nanchang Institute of Science and Technology, Nanchang, China

**Keywords:** wind power generation; current status; development trend; research

**Abstract:** Due to the global environmental pollution and energy crisis, the development and application of low-carbon, clean and green renewable resources has gradually been focused on and become the trend. As one of clean and green renewable resources, the development and application of wind power has attracted the attention from various countries in the world. Wind power generation is an important part, and the current status and development trend are prosperous. This paper, firstly analyzes the principle, characteristics, advantages and disadvantages of wind power generation, then elaborates its current status, and finally expects its development trend. It is hoped that this paper can play a positive role in the development of wind power generation with a certain reference value.

Nowadays, with the rapid increase of global economy, the demand of people for various energy resources is also increasing. The subsistence of human being is closely related to the usage and development of energy resources, and sufficient energy resources is the necessary foundation to guarantee people's life and work [1]. At present, global science and technology develops greatly, however, it also results in the excessive consumption of non-renewable resources, such as natural gas, petroleum, and coal. The serious environmental pollution and shortage of various energy resources have been the important problems constraining the further development of nations and regions. In order to solve these problems, it is necessary to develop and make use of new energy resources, which can not only complement non-renewable resources, also effectively reduce environmental pollution and further realize the sustainable development [2]. In the development of new energy resources, by virtue of high utilization, rich reserves, lower environmental requirement and short construction cycle, wind power has gradually widely applied and developed in the whole world. Besides, due to the characteristics of less pollution and emission, wind power generation has become a significant strategy to realize the sustainable development of electric energy.

## 1. The Principle of Wind Power Generation

The principle of wind power generation is to apply the kinetic energy produced by wind power in movement to drive the vanes of windmill to rotate, and to enhance the rotational speed of windmill with corresponding booster engine, and lastly transform kinetic energy to electric energy through electromagnetic effect [3]. In terms of current wind power generation technology, the goal of power generation can be reached as long as the wind speed reaches three meters each second. To transform wind power to electric energy is one of basic methods applied in current wind power utilization. In general, wind-driven generator is mainly composed of energy storage device, empennage direction adjuster, tower, electric generator, wind wheel, etc. The wind contains giant energy. Related studies show that when the wind speed is 10 meters per second, it will have an acting force about 10kg on the surface of the object when it is about 5-level; when the wind speed is 20 meters per second, it will have an acting force about 50kg on the surface of the object when it is about 9-level; if the wind speed reaches 50 meters per second, it will become typhoon or hurricane, and it will have an acting force about 200kg [4]. Therefore, the energy of wind is much higher than the energy that currently controlled by people. The further development and utilization of wind power can bring greater convenience for people's life and work.

## **2. The Characteristics of Wind Power Generation**

Wind power is inexhaustible, cheap, clean and energy-saving renewable resource spreading in the whole world. In 1979, a Denmark company developed the first wind turbine generator system, and successfully established the first wind turbine. According to the 12<sup>th</sup> Five-year development plan of energy resource, until 2020, wind power will become the third conventional energy resource following hydroelectricity and thermal power, and the nation will further increase the goal to 150 million KW, trying to realize the goal of 200 million KW at the same time [5]. The goal of 300 million KW and 500 million KW will be realized in 2030 and 2050 respectively. At that time, the generating capacity and install power-generating capacity will be higher than 10% and 20% respectively, which can realize the high-quality sustainable development. As for the causes, firstly, compared with nuclear power station, thermal power station and hydropower station, wind power generation has advantages of lower costs, easy operation, simple maintenance and flexible investment; secondly, wind power brings less negative impact to ecological environment and is constrained by less factors, which greatly enhance the convenience; thirdly, it has advantages of efficient income from investment, short construction cycle, easy and simple construction and less demonstration area; fourthly, faced by exhausted non-renewable resources, it is urgent to replace it with new-type energy resources, and wind power can effectively solve the problem of insufficient environmental energy resources [6].

## **3. The Advantages and Disadvantages of Wind Power Generation**

### **3.1 The advantages of wind power generation**

With the continuous development of market economy, wind power, as a clean energy resource, plays a significant role in China's wind power generation. Relative wind power equipment has been further developed, so cost of production also constantly decreases. Wind power generation is renewable, without causing environmental pollution. On the one hand, it can make great contribution to the economic growth. On the other hand, it can significantly alleviate the problem of air pollution and help the energy conservation and emission reduction by virtue of gradual mature related technologies [7]. Therefore, wind power is a new-type clean renewable resources with prosperous development prospect

### **3.2 The disadvantages of wind power generation**

First of all, there is shortage of scientific and technological talents who conduct research on wind power generation, there is not sufficient capability of independent innovation, operation of infrastructure, and education on wind power generation, and many wind power generation still rely on national rewards and subsidies [8]. Secondly, relative Chinese producers do not have better technologies, depending on foreign technologies for production, with small single rated power and insufficient capabilities, so the waste of land and wind power is serious. In addition, wind power generation produces noise and occupies large land area, with instability and uncontrollability. It requires a lot in geographic location, it will have interference on birds. And the imperfect social security system and equipment also limits the further development of wind power generation [9].

## **4. The Current Status of Wind Power Generation**

After the appearance of wind power installed capacity of 32GW in 2015, it has been falling back for two consecutive years. It is expected that the new wind power installed capacity will increase by 15% this year on year-on-year basis. The main reasons include the promotion of offshore wind power installation, the expectation of lowering electricity prices and the improvement of wind-abandoning and electricity-limiting. The launch of offshore wind power generation expands new market space for its growth; the lowering electricity price stipulates that the original electricity price shall be performed in projects constructed before the end of 2019, so developers are promoted

to install the wind power; for wind-abandoning and electricity-limiting, after the power limiting rate reached 26% in the first quarter of 2016, there was a significant improvement, which reaches 13.62% in the first half of 2017 [10].



Figure 1 China's wind power newly installed capacity

In the first quarter of 2016, China's wind abandoning rate has reached 26%, creating a record high. Among them, in areas with severe electricity limiting such as Gansu and Xinjiang, the wind abandoning rate has even reached 35%. Subsequently, the National Energy Administration and the National Development and Reform Commission issued a number of policies and measures to alleviate the wind abandoning and electricity limiting. The State Grid also clearly stated to solve electricity limiting from various aspects such as technology and policy [11]. From Figure 2, national wind abandoning rate gradually declines since 2016, and it has declines to 13.62% in the first half year of 2017. It obviously reduces from 16.4% in the first quarter of 2017, and it has declines to 11.1% in the second quarter.

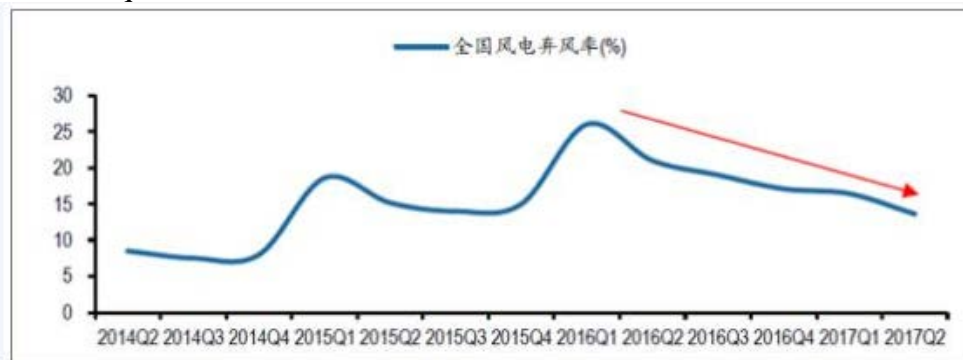


Figure 2 National wind abandoning rate (%)

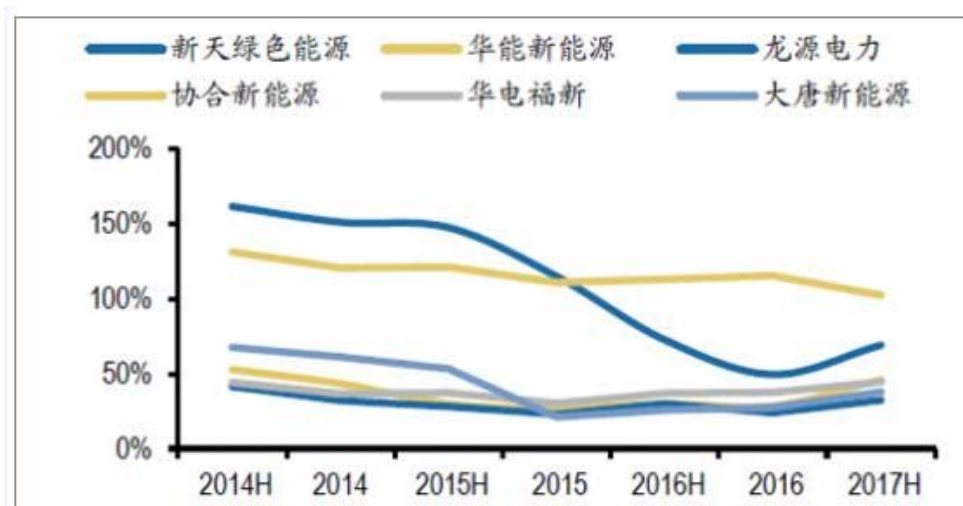


Figure 3 The liquidity ratio of wind power operators (unit: times)

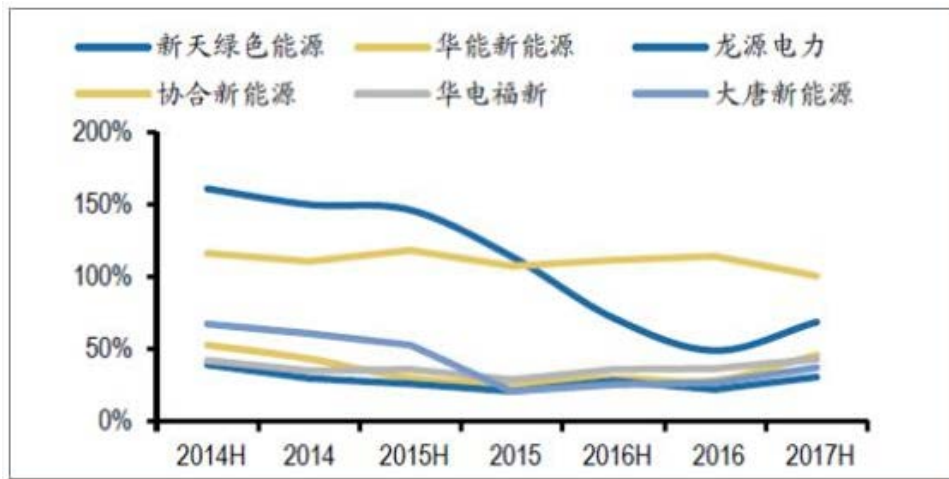


Figure 4 The quick ratio of wind power operators (unit: times)

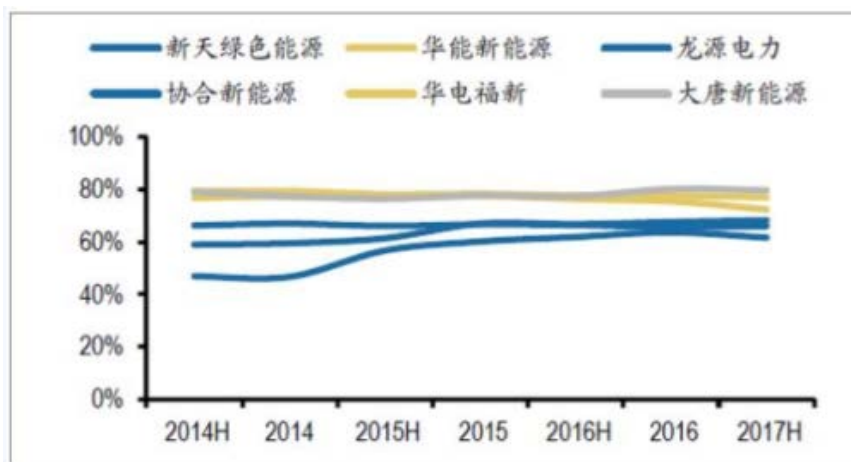


Figure 5 The asset-liability ratio of wind power operators (unit: times)

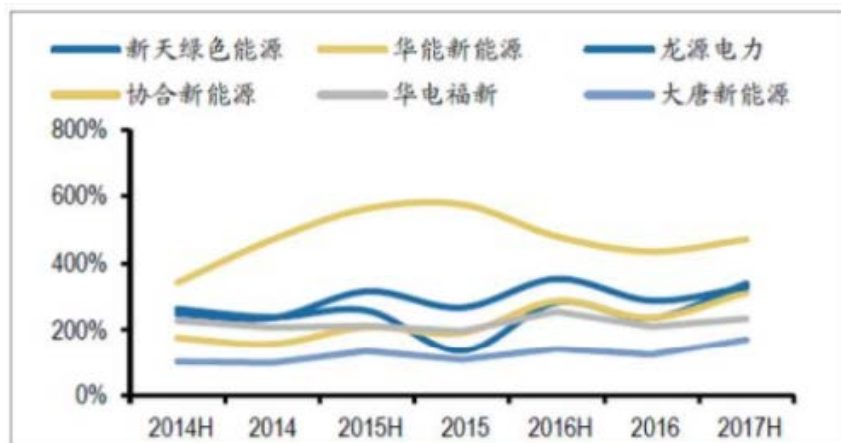


Figure 6 The interest coverage of wind power operators (unit: times)

As of the end of 2016, the total capacity of wind power projects approved but not under construction in China has reached 84GW. The National Energy Administration also released the *New Wind Power Project Scale Plan for 2017-2020* in 2017, and it clearly stated that the new construction scale in 2017 is 30.65GW. In the adjustment of electricity price, it is stipulated that the project approved before January of this year and built before the end of 2019 can get the on-grid price of 0.47-0.60 yuan/Kwh, otherwise the on-grid price will be adjusted to 0.40-0.57 yuan/Kwh [12]. If the above projects starting before 2020 can obtain relatively high electricity prices, wind power projects that cannot be built for various reasons will be excluded, and the annual average

project construction scale may exceed 25GW.

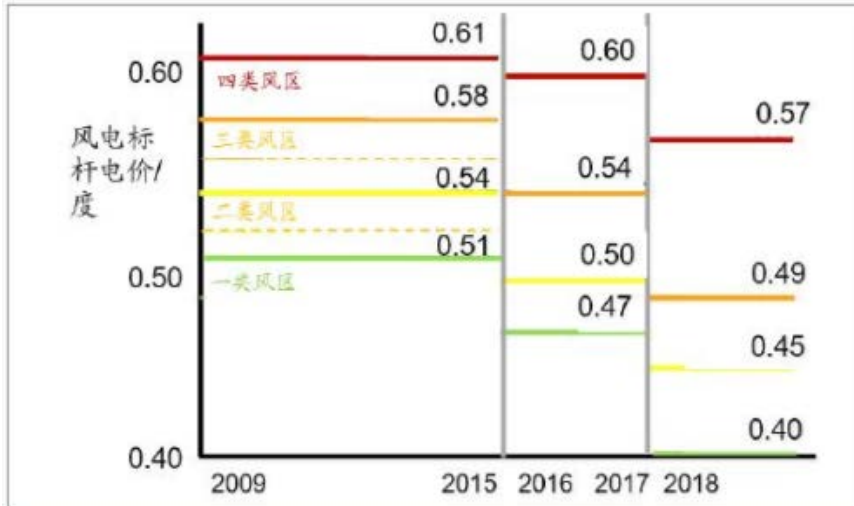


Figure 7 The reduction of benchmark electricity price of wind power



In the *New Wind Power Project Scale Plan for 2017-2020 in 2017* issued by the National Energy Administration, in addition to the 30.65 GW of new wind power project construction in 2017, the construction of new wind power projects in 2018-2020 will be 28.84 GW, 26.6 GW, and 24.31 GW, respectively. The sum will be 79.75GW, which effectively guarantees the scale of wind power installation [13].

## 5. The Development Trend of Wind Power Generation

With the constant utilization and development of wind power resources, the industry of wind power generation in countries develops rapidly, with increasing installation capacity, and improving related production technologies and control management technologies. Besides, the trend of offshore wind power generation also proves that the wind power generation realizes more stable development.

### 5.1 The light, flexible and compact structure design

Based on the increasing wind single turbine capacity, it is necessary to perform light, flexible and compact structure design for more convenient installation and transportation. Specifically, the direction adjusting system is placed at the bottom of tower, the direct drive system is adopted, high-tech composite materials are used to lengthen blades of wind fan, and the entire drive system is placed on the compact frame so that the loading force can be transferred from the wheel hub to tower [14].

## **5.2 The increasing slip casting of unit's standing-alone capacity**

When the unit's stand-alone capacity continues to increase, it can not only reduce the application of the wind farm's floor space, expand its scale effect, but also reduce the unit cost and improve the utilization efficiency of wind energy. Before 2005, the unit below 750KW is the mainstream unit, the unit of 750KW becomes the mainstream unit from 2005 to 2008. At the same time, the unit of 1.5MW gradually is developed and launched to the market, and from 2008 to now, the unit below 3MW is leading the market [15].

In addition, the development and utilization of offshore wind plant further promotes the development of wind turbine generator with large capacity, and the wind turbine unit with the stand-alone capacity of 5-6MW is already operated in the commercial field. The principle producers of wind turbine generator unit in the globe have conduct corresponding preparation for the construction of offshore wind plant with larger scale in the future.

## **5.3 The combination of operating unit and intelligent control technology**

According to characteristics of control system in wind power system and its operation features, various advanced intelligent control methods are put forward and applied in the control system of variable pitch, which solves the stochastic disturbance and non-linear problem of wind power generation system to a certain extent [16]. The fatigue load and limit load of the wind turbine will have a great impact on the life of the unit and the reliability of the components. The manufacturers can use intelligent control to effectively combine the design of the whole turbine to avoid and reduce the phenomenon of the wind turbine in fatigue load and limit load.

## **6. The Development Trend of Wind Power Generation in China**

According to current status, key task and development plan of wind power generation in China, it is essential to make efforts to grasp key and core technologies of large-scale wind turbine. The design, manufacturing technology, assembly technology, and body design of key parts, and such key components as electric appliance, the control and gear box of blades, motor and converter shall mainly developed domestically; the prototype and engine performance of key parts shall reach the advanced level with the same kinds of products internationally; the design certification of related departments shall be satisfied; the wind turbine of 2.5MW suitable for climate conditions of wind power plant shall be developed successfully.

In addition, as one of effective means of access to grid, micro-grid has attracted higher attention. the capacity of micro-grid is small, which cannot provide sufficient voltage on line side support, and its disturbance rejection and stability are lower than large grid. However, after the grid-connection of converter, the entire system will have characteristics of non-linearity, strong coupling and multiple parameters. Therefore, how to improve its dynamic and static performance and realize reliable and effective control has become one of important research directions to drive the development of distributed power generation.

## **7. Conclusion**

For various types of resources, wind power generation has become an important part of modern economic development. With the rapid development of science and technology, non-renewable resources are excessively consumed now, so the shortage of energy resources has become an important cause limiting economic development. Therefore, relative research staff is required to perform reasonable development plan, make full use of wind power, scientifically construct and plan grid, which requires so long time. However, with the constant improvement of national economy, the industry of wind power gradually enters a new stage of development. In order to realize the further improvement, it is necessary to continuously improve relative policies, encourage enterprises to innovate independently and promote the development of wind power generation.

## Acknowledgements

Fund Project: Scientific and technological project of Jiangxi Provincial Department of Education. Project Name: Research on Key Technologies of Variable-speed Constant-frequency Double-fed Independent Power Generation System. Project No. GJJ171100; Scientific and technological project of Nanchang Institute of Science and Technology. Project Name: Research on Key Technologies of Micro-grid. Project No. NGKJ-17-14.

## References

- [1] Zhang Tao. The Current Status and Development Trend of Wind Power Generation [J]. The Merchandise and Quality, 2017,40(35):57.
- [2] Li Kexin. The Current Status and Development Trend of Chinese Offshore Wind Power Generation [J]. Shenzhen, 2018,37(1):230.
- [3] Zhu Chengshun, Guo Zhiwei, Zhang Shengwen et al. Literature Review of Flexible Support of High-power Wind Turbine [J]. Machinery, 2018,33(4):1-5.
- [4] Ya Lun, Ding Jianguo. Present situation of wind power projects and development trend [J]. Northern Environmental, 2013,80(11):59-61.
- [5] Yang Yifei, Zhang Fuchun, Gu Lipeng et al. Development overview of rotor shaft component and control system of wind turbine [J]. Machine Design and Manufacturing Engineering, 2017,64(8):11-15.
- [6] Jin Xiaohang, Sun Yi, Shan Jihong et al. Fault diagnosis and prognosis for wind turbines: An overview [J]. Chinese Journal of Scientific Instrument, 2017,67(5):1041-1053.
- [7] Wang Xun, Zhu Huangqiu, Qian Yi, et al. Research and Development Status of Magnetic Suspension Wind Power Generator [J]. Micromotors, 2016,42(10):84-88.
- [8] Zheng Jiannong. The Current Status and Development Trend of Wind Power Generation [J]. Electric Power System Equipment, 2018,34(7):102-103.
- [9] Zhu Ruida. On Wind Power Generation and Its Technological Development [J]. Scientific and Technological Innovation, 2017,59(34):173-174.
- [10] Wang Yuan, Na Sen. Discussion on Current Status and Development Trend of Wind Power Generation [J]. Architectural Engineering Technology and Design, 2018,11(4):1698.
- [11] Xu Dajun, Zhang Jin, Gao Yunsheng et al. Status and trend analysis of wind power fire technology [J]. Fire Science and Technology, 2013,25,(12):1407-1410.
- [12] Yang Long. The Current Status and Development Trend of Wind Power and Solar Photovoltaic Power Generation [J]. Encyclopedia Form, 2018,36(2):571.
- [13] Wang Junmei. The Current Status and Key Problems of Wind Power Generation [J]. Architectural Engineering Technology and Design, 2018,39(8):3273.
- [14] Zhang Hongbo. On the Current Status and Prospect of Wind Power Generation [J]. Silk Road Vision, 2017,52(32):186.
- [15] Wu Xuqing. Analysis and Research on Current Status and Development Trend of Wind Power Generation [J]. Architectural Engineering Technology and Design, 2017,81(15):4278-4278.
- [16] Liu Deshun, Dai Juchuan, Hu Yanping, et al. Status and Development Trends of Modern Large-scale Wind Turbines [J]. China Mechanical Engineering, 2013,26(1):125-135.