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Coping with climate change and China's wind energy sustainable development

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Abstract

Greenhouse gas emissions are the main cause of today's climate change. To address this problem, the world is in an era of new round energy transformation, and the existing energy structure is being reformed. In this paper, according to the Chinese government's action plan for coping with climate change, the China's wind energy sustainable development goals and development route are discussed, and the countermeasures and suggestions are put forward. Wind energy is currently a kind of important renewable energy with matured technology which can be scale-up developed and put into commercial application, and in this transformation, wind energy will play a key role with other non-fossil energy sources. The development and utilization of wind energy is a systematic project, which needs to be solved from the aspects of policy, technology and management. At present, China is in the stage of transferring from "large wind power country" to "strong wind power country", opportunities and challenges coexist, and the advantages of China's socialist system could be fully used, which can concentrate power to do big things and make contribution in the process of realizing global energy transformation.

Keywords: Climate change; Energy transformation; Wind energy; Sustainable development

1. Introduction

The Chinese government believes that combating climate change is a significant approach toward promoting national economic and social development and incorporating green and low-carbon development into ecological civilization building.

Greenhouse gas emissions from energy production and consumption are the main cause of climate change (IPCC, 2014). To address this problem, important energy transformations characterized by upgrading of the existing energy mix, improving energy efficiency, accelerating the development of non-fossil energy sources, and increasing the contributions of non-fossil energy in the energy mix are being implemented worldwide; these transformations aim to eliminate the current dependence on fossil fuels and achieve a clean, low-carbon, safe, and highly efficient modern energy system where non-fossil energy plays a dominant role. After more than 10 years development, in 2015, the non-fossil energy consumption occupies 11.8% of the primary energy consumption in China, which is 2.9% higher than 2010.

Wind energy is an important renewable energy that makes use of sophisticated technologies with the potential for large-scale development and commercialization. The sustainable development of wind and other non-fossil energies plays an essential role in ecological civilization building and energy mix transformation. Wind energy has witnessed rapid developments in recent years; however, several opportunities and challenges continue to co-exist in the process of sustainable development.

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This paper mainly discusses the role of wind energy in the process of realizing the government's goals to cope with climate change, analyzing the main constraints of wind energy development, and proposing countermeasures to address identified issues.

2. Overview of wind energy development

2.1. Overview of global wind energy development

The oil crisis in the 1970s promoted global wind energy development. Governments worldwide have reached a consensus on the strategic status of wind power and identified wind power as a significant contributor to their future energy supply. At present, over 100 countries are developing and using wind energy. In 2015, the newly installed wind power capacity stood at 63 GW and the total installed wind power capacity exceeded 400 GW (GWEC, 2016). The EU leads the world in the large-scale development of wind power. In recent years, Asia has turned to the core of large-scale developments in wind power, benefits from the rapid growth of China's and India's wind power sector. However, in terms of the shares of electricity generation from wind power and wind energy technologies, EU continues to rank first in the world.

In 2015, Germany's total installed wind power capacity amounted to 44.95 GW, contributing 10.4% of its total installed power capacity. The share of electricity generation from wind power in total power generation reached 35.2%. As the largest offshore wind power market, Britain's total installed offshore wind power capacity exceeded 5.06 GW in 2015, thereby allowing the country to rank first in the world. Electricity generation from wind power contributed 42.1% of the total power generated in Denmark. Eight-megawatt wind turbines developed by Vestas, which is based in Denmark, have been put in trial operation. Since 2005, the wind power industry in the U.S. has experienced rapid development because of the continuous enforcement of the Wind Power Production Credit Tax (PTC). With an annual newly installed capacity of over 5 GW, the U.S.' total installed wind power capacity reached 74.47 GW in 2015 and its power generation increased to 186.3 TW h; these figures allowed U.S. to become one of the largest producers of wind energy across the world.

One reason for the success of these countries in developing wind power is their stable policies. The governments of these countries introduced a market-based operation mechanism and paid great attention to innovations in wind energy technologies, thereby providing technological guarantee for the sound and sustained development of the wind power market and industry.

2.2. Overview of China's wind energy development

Since the implementation of the Renewable Energy Law in 2006 (PRC, 2006), there has been rapid growth in the wind power industry in China. In 2015, China's newly installed wind power capacity exceeded 30 GW, and its total installed wind power capacity was 145 GW or 8.6% of the national total power capacity (Fig. 1). Power generation in the whole year climbed to 186.3 TW h or 3.3% of the total energy produced. Wind energy has become an important part of China's energy portfolio. In 2015, China's newly installed wind power capacity made up 48% of the global wind power market, and China became a large user of wind energy.

As the scale development of the wind power market continues, China has established a wind power industry system and implemented the manufacturing technology of megawatt-grade wind turbines. Today, 1.5−2.0 MW wind turbines are major products in China's market, among which products manufactured by Chinese wind turbine manufacturers account for 80%.

As the wind power industry is developed, wind energy technologies have also seen increased activity. National achievements have been made in wind resource projection and assessment, wind farm location selection and construction, serialization design of low-speed wind turbines, construction of Ultra High Voltage alternating current (UHV AC) and direct current (DC) transmission lines, application of multi-energy complementation, and improvement of the quality of electricity generated from wind power and the security of grid operations. Great progress has also been achieved in wind energy research through key technology breakthroughs and capacity building with the support of the Major State Basic Research Development Program (973 Program), National High-tech R&D Program of China (863 Program), National Key Technology R&D Program, and National Natural Science Foundation; China's active engagement in international technological and scientific exchange and cooperation projects has also supported the growth of this industry. Six-megawatt wind turbines are at the R&D and demonstration stage. Offshore wind energy development and construction are accelerating. China has even embarked on an Internet Plus Wind Power Program, established a group of national key laboratories and engineering development centers, and set up domestic wind power standards, as well as testing and certification systems. Moreover, major fields of study related to wind power have been implemented in Chinese colleges and universities. These initiatives have cultivated a number of wind power professionals and a mindset where the advancement of wind power technology is believed to lay a good foundation for China's sustainable wind energy development.

3. Constraints in China's wind energy development

3.1. Wind power curtailment

In 2015, China's total installed wind power capacity accounted for 33.5% of the world's total; thus, the country was ranked first in the world in terms of wind power capacity. However, in the same year, electricity generation from grids connected to wind power was only 186.3 TW h, which is about 3.7 TW h less than that produced by the U.S. One of the most important reasons for the gap is wind power curtailment. Fig. 2 shows wind power curtailments in China from 2011 to 2015.