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Wind Power Development in China

— Case in Qinghai-Tibet Plateau

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Abstract: As the technology develops, coal becomes the most popular energy source with its low price. The burning of the coal produces greenhouse gas which can severely polluted the environment. Policies were made for countries to reach their fore emission reduction. Wind power is a good replacement for coal burning to China, one of the largest consumer countries for coal. China been through 3 stages in developing wind energy, from 1986-2005, China mainly focuses on introducing foreign technology; From 2005-2010, Chinese government begins to develop its own wind energy technology. Since 2010 China has developed of a complete wind energy industry chain. Till today, China already has mature wind energy technology and is starting to implement it, after. et al. investigation, the Tibetan Plateau is a very suitable area for building wind energy, they have higher altitude areas, and the wind speed can be as high as 14m/s, the local area also possesses environmental pollution problems due to the burning of cow dung in winter as fuel. DFIGs and DDPMGs are two models that leading team found capable of working in the wind speed instability area. With Zhang et als' research shows the construction of the wind power factory to reach zero emission needs twos times copper and nickel materials that earth has. The environmental impact of constructing wind factories and the availability of different metals will also be a concern in the future.

Keywords: wind power, zero emissions, carbon emissions, Qinghai-Tibet Plateau

1. Introduction

1.1. Background

pment of technology, coal, with the low price, has made itself the most popular energy source for developing countries; even today, it is still the most important power source for countries such as China and India. The environment is polluted because of coal combustion. Coal burning will produce greenhouse gases, which directly lead to climate change. This phenomenon has started to impact people's lives gradually. Global warming and rising sea levels are major concerns for people and can have an impact on many coastal cities. The animals in the natural world have started to be affected, and it is certain that the next to be affected is the human group. Therefore, many countries have signed agreements to restrict carbon emissions, such as the Kyoto Protocol and the Paris Agreement. In this era of emission reduction, it is important to focus on green energy, in addition to emission reduction itself. How to achieve emission reductions has become a common challenge for many countries. The

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search for new renewable and green energy sources is seen as the only hope to reach zero emissions by 2050.

1.2. Related Research

Wind energy, as a technologically mature and non-polluting energy source, is seen as one of the ways out after the abandonment of fossil energy sources. As discussed in the article written by Li, Jiachun, and Dexin "Vision of China's Wind Power Industry "; China, as a major carbon demand country, is also shifting its path to new energy source development, and wind energy is a perfect alternative.

1.3. The Objective

Qinghai-Tibet Plateau, the province with abundant wind resources, is one of the major wind power development cities in China. The article written by Xu, Qingyang, etc. give a lot of data and details on wind energy development in the Qinghai-Tibet Plateau. The article will focus on wind power growth in China's Qinghai-Tibet Plateau province in the face of carbon-neutral obligations. In Qinghai-Tibet Plateau, there is intrinsic problems with burning dung as fuel in the winter. Constructing wind power farm can give enough power for electricity for the local Qinghai-Tibet people.

2. Historical Development of Wind Power in China

In the past 30 years, China has seen explosive growth in the use and construction of wind energy, which has sparked global attention and even influenced the development of wind energy globally in 2019. In fact, as early as the twentieth and eighteenth centuries, wind energy has been rapidly developing in European societies, which has led to the maturity of this technology. China's current wind energy industry has completed different stages, from the introduction of the market, technology introduction as well as demonstration, independent research and development as well as industrialization, to today's self-out innovation. During the technology introduction phase, from 1986 to 2004, China was exploring wind energy; In 1986, China had its first wind farm (Malan Wind Farm) in Shandong with a European community. At this time, most of the worldwide development area of wind power is located in Europe, especially Denmark and Germany, which can be seen as the keystone of the global wind turbine industry today [1] . China then sought loans from other countries to build new wind farms in different provinces, including Xinjiang (Xinjiang Dabancheng Wind Farms I and II). At the same time, the Chinese Ministry of Science and Technology wanted to introduce and absorb foreign technology to give the Chinese the technology to build and develop wind farms earlier. This process includes "100 KW wind turbine development" and "750 KW wind turbine development and industrialization " which are co-operated by Xinjiang Goldwind Science & Technology Co., Ltd. and Zhejiang Windey Wind Power Co [2]. This phrase can also be concluded with fragmented technology and development through piecemeal and fragmented experimentation [3].

During the period from 2005 to 2010, China also introduced a series of policies and regulations to reduce carbon emissions. The Chinese government introduced "renewable energy Act" in 2005 laying the foundation stone for the subsequent development of wind energy. The release of such Act also is a response to the Kyoto Protocol of emission reduction. China issued policies corresponding to wind energy reform, adopted wind power concessions, decentralized the approval of wind farm construction projects under 50,000 kilowatts and other preferential policies, and it is because of the call of the Chinese government, many manufacturing industries It is also because of the call of the Chinese government that many manufacturing companies began to join the wind power equipment manufacturing industry, and in this process, advanced wind turbine development was completed by

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renewing foreign technology. With the release of the "Renewable Energy Act" and the encouragement of wind energy development, China's wind energy power has continued to grow by more than 100% in five years, and in 2010, the cumulative wind power generation was the first in the world [2]. The annual average GR of global and Chinese renewables since 2000 is 21.64% and 42.82%, respectively. The new wind power installed capacity of renewable energy in China is nearly twice as high as that of global wind power [1]. With Chinese government ‘s with the encouragement of the Chinese government, the figures for installed capacity in China also continue to rise. Figure 1 shows the Cumulative installed wind power capacity in China from 2014 to 2021, from 2013’s 91.41 gigawatts to 2021 328.48 gigawatts. Undoubtedly, China has had great success in contrstucting and developing wind energy, as shown in Figure 1.

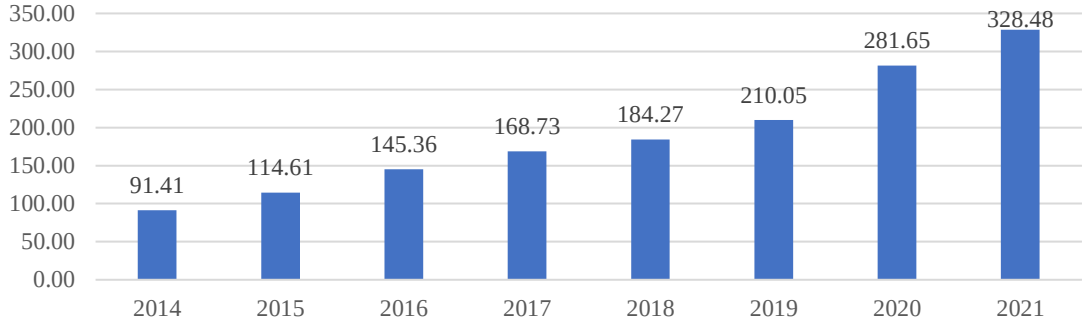

Figure 1: Cumulative installed wind power capacity in China from 2014 to 2021 [4].

China's localized wind energy industry is increasing faster than China's wind energy imports, with mostly local wind energy companies capturing the market, with wind energy imports falling from 90.74 to 77.40% from 2001 to 2005 [1].

Since 2011, China's wind energy has been in full development mode, with the proposal to build eight GW of wind power bases onshore and the opening of offshore wind power projects. With the state's impetus, the level of wind energy construction has grown rapidly, and the industrial system is becoming more robust. 5 MW and 6 MW wind turbines are coming into operation. China's innovation capacity has also increased, and the wind energy industry chain has been improved through continuous efforts [2].

Although China's local wind energy development has been a great success, its exports of wind energy have not done well, China's exports of renewable energy were less than 1% of the global market [2]. In 2018, China's total installed capacity was 206 gigawatts, making it the first market to exceed 200 gigawatts of total installed capacity [5].

China's wind energy development has achieved remarkable results. The article "Effect of the digital transformation of power system on renewable energy utilization in China" points out that further improvement of energy development relies on the digital transformation of the power system. Data measurement and equipment maintenance problems will be better solved by the digital transformation of power. Thus, improving the utilization rate of wind power energy in China [6].

3. Development of Wind Power in the Qinghai-Tibet Plateau

As a high-altitude region, the Qinghai-Tibet Plateau has rich wind resources in such an environment. According to initial calculations, generating less than 20% of the Qinghai-Tibet Plateau's wind-solar-hydro energy potential can satisfy China's carbon neutrality objective. Research has shown that 0.91 percent of the Qinghai-Tibet Plateau area is Suitable for building wind farms [7]. In addition to the abundant new energy resources that can be exploited, the Tibetan Plateau itself suffers from environmental pollution caused by the burning of cow dung for heating and cooking [8]. On the

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Tibetan Plateau, due to its high altitude, there are 11 months of cold winters and 20 hours of continuous heating every day. The heating needs brought about by this extreme environment cannot be underestimated. Due to the lack of fossil fuels in the region, most of the approximately 7 million people native to the Tibetan Plateau have been relying on the burning of cow dung, which is easily accessible and burns for a long time, to survive the winter. However, burning Dung could produce M2.5, OC, EC, ions, PAHs, VOCs, CO, and CO2, which enhance greenhouse gases [9]. Therefore, establishing wind energy in the Qinghai-Tibet Plateau region can provide China with the ability to reduce emissions to meet its goals, in addition to solving local air pollution [8].

China has grown to become the world's largest and fastest growing wind power market, with a cumulative installed capacity of 188 GW. The richest wind resources in China are in Inner Mongolia, which exploitable wind energy is 36034 megawatts by May 2022, closely followed by Xinjiang, which is a province part of the Qinghai-Tibet plateau, with an Exploitable wind energy of 43,555, as shown in Figure 2. By 2022 May, Xinjiang has already reached 22416 megawatts capacity of wind power farm proposed or under construction. In comparison, the Exploitable wind energy of Jiangsu province is 370. Xinjiang and Inner Mongolia have priority in installed capacity in China, with the five provinces in the package (Xinjiang and Inner Mongolia) contributing a total of 47.6% to China's installed wind power capacity.

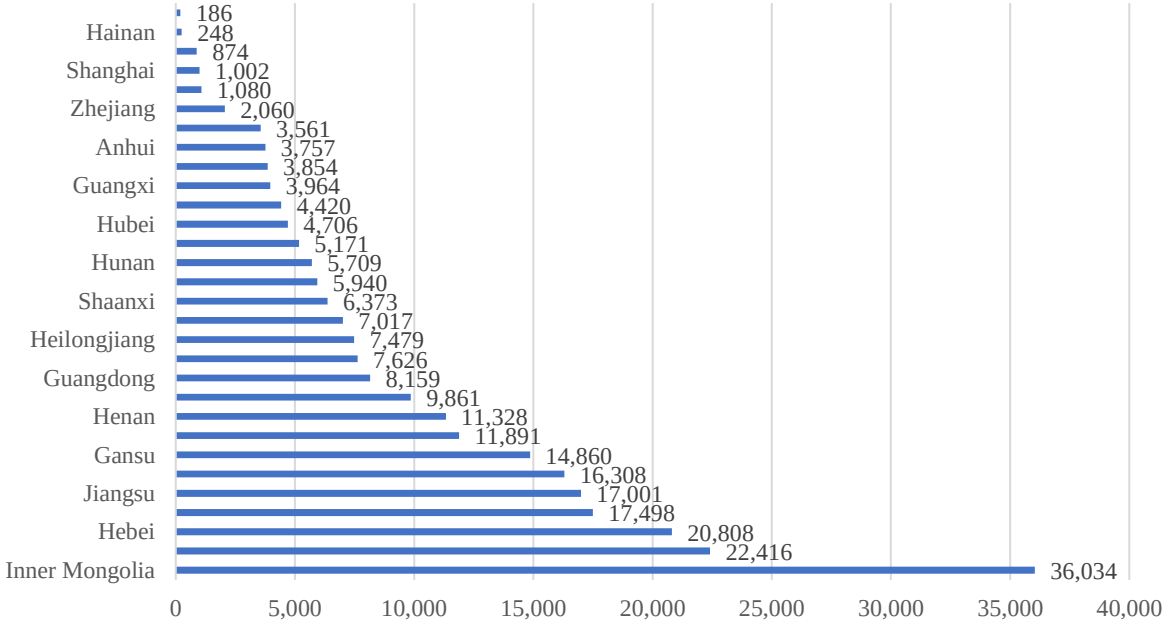

Figure 2: Capacity of wind power farms proposed or under construction in China as of May 2022, by province/municipality [10].

The Qinghai-Tibet Plateau is one of the high-altitude regions in the world. Although the wind energy yield is high due to the geographical location factor, and the wind speed is 11 m/s during most of the winter, Zhang et al found the fluctuation is high due to the excessive temperature difference between seasons [11]. The ecological environment on the Tibetan plateau makes it very difficult to develop energy sources, and the long-term reliance of local residents on biomass energy sources such as cow dung also has a negative impact on the grassland environment, so the development of wind energy in the Tibetan plateau region could not only better influence the future of wind energy generation in China, but also improve the environmental pollution that may result from the long-term habits of local residents.

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China's installed capacity is showing an annual increase, with 3.81 GW of new capacity installed in 2020, and a significant increase in the Qinghai region, with 1.5 kW of new wind power capacity installed in the last five years, but wind speeds of 5-7m/s at the wind tower. DFIGs and DDPMGs use two different models of the Qinghai-Tibet Plateau, such as the day and night temperature difference, air density of the environment, to test the possibility of wind resource development. Under the side wind tower test, the seasonal temperature difference is large and the wind speed varies greatly in the morning and evening, with a large variation in wind speed in winter and a more moderate one in summer. Wind speeds on the Tibetan Plateau are also greatly influenced by solar radiation and weather conditions, with the team concluding that the Tibetan Plateau gradually grows from September to February, with an average wind speed of 14 m/s, and decreases from March to August. The total average wind speed throughout the year is 9.3/sec but fluctuates up and down due to the seasons, with a negative correlation between falling temperatures and rising wind speeds, while both wind turbines tested were able to operate in a complex climate. Wind resources and generation efficiency are generally better at ultra-high altitudes. According to Zhang's article, the research in Gong he County, Qinghai Province, shows that the wind farm produces a warming impact on the temperature of the land surface, and the warming effect is inversely proportional to distance, as well as wind direction and volume [11]. This could be a future obstacle to watch out for as China develops its wind power.

4. Future Obstacles and Solution

The target for 2050 is currently under investigation. According to the survey results, by 2050, the annual demand for wind power base metals in China will be 12 times that of 2018, and the overall demand will be 23 times that of 2019. The cumulative consumption of copper and nickel in the wind power industry accounts for 35-45.9% of China's copper reserves and 74-101% of China's nickel reserves [12]. This may be seen as an obstacle to future wind power growth. It is equally important to consider the pollution generated by mining.

5. Conclusion

This article summarizes the last 30 years of wind power generation in China. It draws conclusions from the different development situations, foreign technology introduction, self-development, and improvement of the industrial chain. It contains the different stages of development, and the results achieved. In addition, this article makes a summary of the case of the development of the Tibetan Plateau region, which, as a plateau region, has ten months of needing to rely on cow dung burning for heating, which has led to a sharp increase in air pollution in the region. So, the development of wind energy in the region is not only because of the abundance of local wind energy, which can accelerate the development of wind energy throughout China, but also to solve the demand for electricity to heat the local 7 million people. In the second paragraph, the initial research and development of the Tibetan Plateau and the future possibilities of the region are presented. The article shows an experimental report on the wind speed variation in the Tibetan Plateau region for different wind power generation due to seasonal temperature differences. The wind speed on the Tibetan Plateau is influenced by the weather's temperature. This leads to large fluctuations in the adaptation of different wind power generators. This paper reviews the development of wind power in China and the specific case of the Tibetan Plateau region and provides a basic summary of future wind energy development in the region. Specific references are made for future wind energy development in the region as well as for investments.

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