SWOT Analysis of Offshore Wind Power Development in Guangdong Province

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Abstract. This paper starts with the current development situation of offshore wind power industry in Guangdong province, and uses SWOT analysis to explore the advantages, disadvantages, opportunities and threats of the offshore wind power industry in the Guangdong province. Based on the analysis, this paper gives some suggestions for the policy makers: firstly, it is necessary to create a proper management system for offshore wind power; secondly, Guangdong should enhance its own equipment manufacturing and scientific research capabilities which would benefit the offshore wind power industry; finally, an effective typhoon-damage prevention system is required.

1. Introduction

Guangdong province has achieved world-renowned economic development achievements since the reform and opening up 40 years ago. According to statistic data[1], the gross domestic product (GDP) in 2017 reached 8980 billion RMB, nearly 12 times of the number from 1997. Along with the rapid economic growth, the electricity consumption of Guangdong province has been increased significantly. The same trend also exists in the consumption of fossil fuel energy. In 2018, the cumulative electricity consumption of Guangdong province was about 632 tera watt-hour (TWh). That was 8% of the total consumption nationwide, the biggest when compared to other administrative units of the country [2]. However, the gap between electricity generation and consumption of Guangdong province has been increased year by year (figure 1). The growth of power generation is unable to keep up with economic development. Electricity generated from fossil-fuel plays a major part in Guangdong’s electricity supply by taking up more than 70% of the total power generation in 2018[2]. This has increased the concerns of environmental problems.

In 2018, General Secretary of the Communist Party of China (CPC) Xi Jinping pointed out that Guangdong has not yet formed a ‘green’ production and lifestyle. It is still under great pressure of reducing energy consumption and pollution. It was also proposed by Xi Jinping that it is necessary to promote a high quality ‘green development mechanism’ to ensure low-carbon circular economy growth. As the global energy and environmental issues have become increasingly prominent, it sees an inevitable trend to develop green and renewable energy[3]. As the most fast-growing and most widely used renewable power generation technology, wind power is rapidly rising around the world[4]. Guangdong province has a long coastline and abundant wind energy resources. It has the natural advantages of developing offshore wind power. Developing offshore wind power could help
Guangdong province with minimizing the electricity shortage, transforming energy generation structure and promoting high-quality economic development.

2. Current Development of Offshore Wind Power in Guangdong Province

In 2017, 319 offshore wind power generators were installed in China, with 1.16 gigawatts (GW) capacity which is 40% of the total increase amount worldwide (figure 2). The cumulative installed capacity of offshore wind power in China reached 2.79 GW [5]. The cumulative installed capacity of offshore wind power in coastal provinces is shown in table 1, showing a regional imbalance of power supply. 77.9% of the installed capacity is from Jiangsu province. The cumulative capacity in Guangdong province ranked 4th, which was only 1.7% of the total amount[6].
Table 1. The cumulative installed capacity of offshore wind power in China’s coastal provinces by the end of 2017

| No. | Province | Cumulative Installed Capacity (MW) |
|-----|----------|-----------------------------------|
| 1   | Jiangsu  | 2170                              |
| 2   | Shanghai | 305                               |
| 3   | Fujian   | 136                               |
| 4   | Guangdong| 46.5                              |
| 5   | Zhejiang | 44                                |
| 6   | Hebei    | 36                                |
| 7   | Tianjin  | 27                                |
| 8   | Shandong | 15                                |
| 9   | Liaoning | 6.5                               |

Currently, the west and east part of Guangdong and the Pearl River Delta region are the 3 major areas of where offshore wind power stations located. The government of Guangdong Province plans to build 23 offshore wind farm sites with a total installed capacity of 66.85 GW. 16 coastline-closed projects are expected to be accomplished between 2017 and 2030, mainly in the west and east part of Guangdong. The first offshore wind power project in Guangdong Province, the Zhuhai Guishan Phase I project, has been operating since April 2018. So far, 31 wind turbines have been hoisted, of which 15 are in operation. The plant of the Three Gorges Wind Power Cooperation project, which is located in Yangjiang Industrial Transfer Park has been put into operation since the first half of 2018. The first-phase construction investment was about 200 million RMB[7].

In 2017, 10.4% of the total energy consumption in Guangdong was provided by renewable energy. The non-hydro electricity accounted for 3.5% of the total electricity consumption. It was estimated that by 2020, 14% of the total energy consumption in Guangdong would be supplied by renewable energy. According to the development goals set out in the Guangdong Offshore Wind Power Development Plan (2017-2030), by 2020, Guangdong should start to increase more than 12 GW offshore wind power capacities. By 2030, wind power stations with a capacity of 30 GW would be built and start operating. In the meanwhile, Guangdong was planning to establish an entire offshore wind power industry, including equipment manufacturing, engineering design, power plant construction, power generator installation, power station operation and maintenance.

3. SWOT analysis of developing offshore wind power in Guangdong

This paper uses SWOT analysis to evaluate the strengths, the weakness, the opportunities and the threats of Guangdong province developing its own offshore wind power industry.

3.1. Strengths

Guangdong province has rich wind energy resources. Located in the subtropical and southern subtropical maritime monsoon climate zone, with 4,114 kilometers (km) coastline and 419,300 square kilometers (km²) sea area, Guangdong province has a relatively high average flow rate of coastal wind, which leads to high wind power density. The annual average wind flow rate at a height of 100 m along the coast can reach more than 7 meters per second (m/s), allowing a large effective wind energy density[8]. The wind power density level in the eastern Guangdong sea area can reach 5-6. The theoretical total wind energy resource in the offshore area is about 100 GW. Therefore, Guangdong has a unique geographical advantage to develop offshore wind power. Figure 3 shows the wind power resource distribution in Guangdong.

Guangdong has strong innovative potentials. By the end of 2016, there were 18 nation-recognized engineering technology research centers, 24 nation-recognized enterprise technology centers, and 19 national key laboratories located in Guangdong. Also, there were 658 engineering technology research centers recognized by province government and 1,734 enterprise R&D institutions recognized by municipal governments[9]. The landing of these scientific research centers at the forefront of science
and technology is conducive to the development of energy, especially renewable energy science and technology in Guangdong.

![Wind power resource distribution in Guangdong province.](image)

**Figure 3. Wind power resource distribution in Guangdong province.**

3.2. **Weakness**

Compared to industrialized counties, China started its own offshore wind power industry late, which was not earlier than the end of the 11th 5-Year Plan period. Guangdong started to construct offshore wind power plants in 2015. By the end of 2017, there was only one wind power generator manufacturing enterprise in Guangdong, called Mingyang Smart Energy Group. This failed to meet the needs of construction, research and development of offshore wind power industry in Guangdong. Therefore, offshore wind power operators were more willing to choose imported equipment in order to ensure the quality of wind turbines and reduce operation and maintenance costs.

Regarding the development and supervision of wind power industry in Guangdong, there are many government departments and authorities, which functions are usually overlapping, making it difficult to have uniformed policies[10]. Especially when it comes to the approval of offshore wind power projects, the process involves many departments, including environmental protection, marine, military, and fishery. Due to the lack of supporting laws, regulations and industrial standards, the government did not have a strong control when supervising the industry, and lacks measurement standards when reviewing and approving projects, which leads to inefficient management results.

3.3. **Opportunities**

With the explosive growth of China’s offshore wind power industry in 2014, the support from government has gradually been increased. From the policy’s aspect, it is gradually subdivided from wind power policy to offshore wind power policy. After 2016, the offshore wind power industry entered a full-acceleration phase, and the release of related policies was more intensive and detailed. In 2019, National Energy Administration (NEA) released 13rd 5-year Plan for Wind Power, which indicated that the installed capacity of offshore wind power shall reach 5 GW by the end of 2020. Besides, some regional governments also released their timetable for offshore wind development, like Guangdong, Guangxi, Jiangsu, etc[11].

As China’s economic transformation requires the emergence of innovative development models and the construction of an open platform, Chinese government promoted to develop The Guangdong-Hong Kong-Macao Greater Bay Area (GBA) and Belt and Road Initiate (BRI). This offers Guangdong a great opportunity to develop its own offshore wind power industry. In response to the central government’s strategy, Guangdong government released a 3-year action plan to promote GBA. In this plan, Guangdong will focus on the development of offshore wind power, marine high-end intelligent equipment and marine renewable energy.
3.4. Threats
Among all provinces of China, Guangdong is one of the most frequently affected provinces by tropical cyclones, with more than 40% tropical cyclones landing in its range. When wind flow rate is high, it will impact the operation of wind turbine to a certain extent. The extreme wind flow rate, rapid-changing wind direction and unusual turbulence of a typhoon, alone or together, can cause damage to wind turbines and hence, causing severe economic loss to wind farms[12]. Besides, the power cables of many offshore wind farms in Guangdong province lay across the Marine Ecological Red Line. Before construction of the submarine cable, the sea area needs to be cleared from obstacles, which will cause the increased sand content, sand suspension, and sand diffusion problems in the sea area.

On the other hand, the pattern of "one country, two systems, three customs zones, and four core cities" is the biggest feature of the GBA. This pattern has brought about differences in economic systems, legal systems, and administrative systems, which has made it difficult for resources sharing within the GBA. Nowadays, the integration within GBA is relatively inadequate and the development synergy has not yet fully manifested. This will also bring unexpected uncertainty to the development of offshore wind power development in Guangdong.

4. Policy recommendations

4.1. Speeding up the establishment of offshore wind power management system
The sustainable development of Guangdong's offshore wind power industry requires an efficient management system. The administrative process of offshore wind power projects involves many government departments. The long administrative processing time and complex procedures will increase investment costs. Therefore, it is essential to improve the engagement between relevant government departments and streamlining the approval process. The province government can designate one leading department to be responsible in leading and executing the programme among all other relevant government departments.

4.2. Enhancing equipment manufacturing and scientific research capabilities
It is important to establish a high-end offshore wind power equipment manufacturing industrial area in west part of Guangdong and attract more wind power equipment manufacturing companies to establish factories in Guangdong through policy preferences. The company will focus on offshore wind power equipment manufacturing, integrating offshore wind power testing and certification, equipment manufacturing, port services, and operations. Besides, Guangdong should build a Pearl River Delta offshore wind power science and technology research and development base, making full use of its regional innovation genes, leverage talent advantages, promoting industry collaborated academic research, and driving technological innovation.

4.3. Establishing a typhoon-damage prevention system
In order to minimize the loss caused by typhoons to the offshore wind farms, Guangdong should speed up the establishment of offshore wind power defence systems. It is necessary to increase investment of typhoon-damage prevention projects for offshore wind power, and pay more attention to the site selection of offshore wind farms. In addition, it is essential to speed up the establishment of offshore wind power insurance system and reduce the loss of offshore wind farms in typhoon-prone areas.

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