The SWOT Analysis and Countermeasure Research on the Development of Wind Power Industry in China

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Abstract. Under the dual pressures of conventional energy emergency and deterioration of the ecological environment, wind energy as a renewable clean energy is valued. Wind power has developed rapidly, and economic advantages have gradually become prominent. This paper analyses the development status of wind power industry in China, and the internal and external factors that affect the development of wind power industry are analyzed by using SWOT model. Research shows that the development of wind power industry is facing the bottleneck of independent research and development, technical barriers, benchmarking difficulties. This paper puts forward four strategies to get rid of the current dilemma and promote the healthy development of this industry, which is SO strategy— intensify the development, ST strategy— optimize the adjustment, WO strategy— handle the solutions to the toughest problems, WT strategy— strengthen the industrial development.

1. Introduction
With the severe situations of global warming, sharp decline and short supply of the fossil fuels, many countries have realized the necessity of developing renewable energy. Wind energy, as an alternative of burning fossil fuels, is clean, renewable and widely distributed and gets a rapid development in recent years. Wind energy refers to the kinetic energy of air flow which is derived from solar radiation and the earth’s rotation. [1] It can be transformed into mechanical energy or electricity through wind energy conversion system. The utilization of wind energy in China is focused on four aspects: wind power generation, wind assisted shipping, wind power pumping water and wind power heating. The major utility form of wind energy is wind power.

Since the reform and opening up, wind power industry has been developing rapidly in China. By 2020, the total installed capacity is 281 GW, ranking the first in the world. Among them, the total installed capacity of onshore wind power is 271 GW, and that of offshore wind power is about 9 GW. [2] By 2050, China will have 2525 GW of wind power installed capacity (including onshore and offshore wind power), accounting for about 42% of the global total installed capacity. [3] In conclusion, this industry has embarked on a fast track of scale, industrialization and maturity development. With the expansion of wind power industry, there are some problems and challenges, which are manifested in four ways. First, a fierce competition in power energy industry leads to some problems, like low level excess capacity and lack of high-end capacity. Second, power grid construction isn’t coordinated with the process of wind power energy, which results in serious issues about wind power, like insufficient consumption in local areas, difficult power integration and wind power curtailment. [4-5] Third, we need to rely on foreign advanced technology because of the hollowing out of core technology and lack of innovation. [6-7] Finally, the related laws and
regulations are not sound, policies are not implemented properly, and market supervisions are not adequate. In order to effectively solve dilemma in the process of the wind power industry development, this paper expounds the internal and external factors that influence the wind power development by using the SWOT model, based on an analysis to the status quo of the wind power industry. Meanwhile, there are four development strategies that have been come up to forward the healthy and orderly development of wind power industry.

2. The SWOT Analysis on the Development Wind Power Industry in China

In order to promote the healthy and sustainable development of Chinese wind power industry, SWOT methodology has been adopted to investigate its internal and external factors. After a detailed analysis of the strength and weakness of Chinese wind power industry, some strategies are proposed to balance the opportunity and threat of Chinese wind power industry. [8]

2.1. Strengths

(1) Abundant wind energy. China has a vast area and a long border line of coastline. It has rich wind energy resources which can be developed. According to the results from the China Academy of Meteorological Sciences, the amount of the wind energy storage and development in China is 4350 GW and 297 GW. However, wind resources in China are not evenly distributed. Wind resources are rich in three-north areas—the north, northeast and northwest China, and southeast China.

(2) Modest Cost. With the improvement of the equipment manufacturing technology, perfection of the wind turbines generators, and enlargement of the unit capacity causes production cost of per-kilowatt electricity to fall, accompanied with the drop of the construction cost of the wind farms. In addition, the improvement in the quality and maintenance, optimization of the wind farms location, and increasing of the wind farms operational efficiency have played a role of dropping the cost. In the short term, the cost of the wind is nearly equal to other regular clean energy. The decreasing of the equipment cost improves the enthusiasm of the investors and promotes to decline the cost deeply. In the long run, considering the prices move and improvement of the regular clean energy, the cost of the wind power will continue to decline and become the restitution of the fossil fuels.

(3) Advanced information technology. Driven by a new round of technological revolution and industrial change, intelligent technology has been widely used in wind power energy management, and intelligent wind turbine is gradually changing from concept to reality. [12] Compared to the occident, the focus of the smart grid is different in China. The west concentrates on the distribution network construction while China stresses on coordinated development of multi-level electricity network in electrical system in order to set up strong and smart grid. On the one hand, this kind of grid could ensure the secure and stable operation when grid integrates wind power and enhances the power grid capacity. On the other hand, it is conducive to develop large-scale wind energy so that the block of the wind power is avoided because of the long distance to the load center.

2.2. Weaknesses

(1) The drawback of the wind. It is hard to make the use of the wind, for wind energy is easily influenced by many factors, such as climates, seasons, and locations. First, wind power generation is stochastic and non-scheduled. Relatively weak grid configuration constrains the consumption, so random wind power could not be used efficiently. Second, because of the intermittence, load forecasting of power network will be less precise. Therefore, there is a big waste, for the electricity produced in the wind farms could not be transported in time, which impacts greatly on the economy and stability of the large-scale transmission.

(2) Poor ability on research and develop. The ability of equipment innovation is weak and there is a gap in the core technology compared with the foreign countries. The enterprises in China put emphasis on the production and market, regardless of the design, research and development. Until now, China has not formed high-level teams that are outstanding in researching turbines and control system. Otherwise, China relies greatly on foreign core technology so that independent large-scale production
cannot be achieved for Chinese enterprises. Moreover, for some wind turbine generators, the enterprises first introduce the technology from abroad, and then the local production can be realized on the basis of studying and discovering. However, secondary innovation is limited in the part of material selection and simple technology improvement. A few companies are constrained because of being stuck in redundancy of low-level development.

(3) Slow process of power grid construction. The power grid construction has been slow in a number of regions, and cannot keep up with the wind power development. The grid construction has the characters of long construction period, across large regions, difficulty of coordination. As for construction period, it usually takes at least one year to complete a transmission project over 220 KV. However, compared to the transmission project, the period of wind power project is shorter, and the first power grid could be built in 6 months, and could be put into the use in 1 year. The large-scale development of the wind power could not match well with construction of the power grid, which causes the problem of the peaking capability in the power system were serious. Moreover, the difficulty of wind power integration, the phenomena of curtailment and poor power transmission have all emerged.

2.3. Opportunities

(1) Policy support. Inexhaustible impetus of wind power industry development is provided by the introduction of supporting and encouraging national policies. In the Renewable Energy Law implemented since 2006, there are some incentives: set up special funds for renewable energy development, the projects which are listed on the guidelines on the development of renewable energy can be provided with the economic incentives that promote the development and utilization of energy. The publishment of the notice on the adjustment of onshore wind power benchmark price in 2014 is aimed to set a reasonable price to reduce the cost differences between wind power generation and conventional power generation and the wind power industry could be developed rapidly. The publishment of the notice on construction of wind power and photovoltaic power generation projects in 2019 clearly requires to actively promote and give priority to the construction of wind power projects which will achieve grid parity, and strictly regulate wind power subsidy projects.

(2) Optimization of energy structure. Energy consumption is increased sharply in China to bring the issue that the contradiction between demand and supply becomes worsening, energy structure becomes unreasonable, and the utilization efficiency is low. Based on the national policy of developing energy: develop hydropower actively, optimize the thermal power, promote the development of the nuclear power station, and drive to develop renewable energy, the government accelerates the adjustment of the power structure and strives to develop the clean energy, such as hydropower, wind power and solar energy to take place of the fossil fuels. It is no doubt that wind power will be the focus of the power construction in China.

(3) The environmental consideration. Environment issues, global warming, the rise in oil prices, energy security and some other problems have raised a lot of strong concerns from the international communities. Among a variety of new energy power generation technology, wind power, as one of the most significant means to alleviate the environment problems which are caused by the consumption of the fossil fuels, whose advantages are manifested in several ways. On the one hand, abundant reserves, mature technology and short period are of great importance. On the other hand, low production costs, reliable security, and little pollution are also vital. Hence, promoting rapid development of wind power is beneficial to reduce the reliance of the consumption of the fossil fuels in order to mitigate the environment pressure.

2.4. Threats

(1) The substitutes take up the energy markets. Compared to other clean energy generation, like hydropower, nuclear power, photovoltaic power, it does not have the obvious advantages in the market competition and is threatened by above-mentioned energy in the market. For example, the advantages of hydropower are mature technology, large scale and high efficiency while less pollution to the
environment, convenient transportation and low cost are the strengths of the nuclear energy. In addition, solar energy is convenient to obtain and the cost of the operation and the maintenance are lower. These three kinds of energy generation take up the energy markets to threat the development of the wind power.

(2) Problems of the security are gradually obvious. Some enterprises put some new MW-level wind turbines into business operation without sufficient proof and reliability test in order to occupy the market quickly, which brings lots of security risks on the quality and reliability of the wind turbines. In recent years, the accidents that the wind turbines collapsed have occurred frequently. For instance, the trouble of cable head emerged in the first wind power farm of the Jiuquan Wind Power Company in Gansu led to 598 wind turbines off-grid accidents in 16 farms on February 24th, 2010. Another example is the collapse of the wind turbine in Zhoujiajing wind power farm in Gansu Province on April 24th, 2019, which caused six maintenance personnel on the wind turbine to fall, resulting in four deaths and two injuries. Besides the quality of power grids and technology of the integration, it is also vital to manage and maintain the grids after developing the farms. The management of farms is poor, so the issue that the untimely change of the turbine components damages is also needed to focus on. On March 14, 2021, Gongzhuling wind power farm burned the engine room of No. 26 wind turbine due to the damage of wind turbine frequency converter.

(3) Competitions between domestic and foreign enterprises become more intense. The wind power generation is becoming the hotspot of the investment because of its excellent development. Winning the bid at a loss of the domestic and foreign enterprises for occupying the markets increases the earnings risks because of the low-price competition. It is mainly seen in some ways: first, the equipment giants of the wind power, such as General Electric, Siemens and Nordex is gradually occupying the markets by core technology, and their assembling factories and research centers were set up. Second, National Development and Reform Commission cancelled the clause that the localization rate of the wind power generation equipment is at least 70%. Meanwhile, some projects about wind power construction are lacking in the construction approval procedure about some projects. These two sides both result in situation that the capacity of the wind power equipment enterprises has exceeded the demand of the domestic market. There emerges the malign competition because some companies obtain the market share by the means of vicious price war.

Table 1. The Results of the SWOT analysis about the wind power industrial development.

| Condition | Strengths | Weaknesses |
|-----------|-----------|------------|
|           | ① Abundant reserve | ① The limits of wind |
|           | ② Appropriate cost | ② Weak independent research |
|           | ③ Development of information technology | ③ Slow progress of grid construction |

| Environment | Opportunities | Threats |
|-------------|---------------|---------|
|             | ① National policy support | ① Increasing market share of substitutes |
|             | ② Adjustment of Energy structure | ② Security and quality concern |
|             | ③ Severe environmental problems | ③ Fierce Competitions between domestic and |

3. The strategies and suggestions about wind power industrial development in China
Through above analysis about strengths, weaknesses, opportunities and threats, combining with the contexts of the wind power industrial development in China, this paper formulates 4 strategies of SO, ST, WO, and WT.
3.1. SO strategy— intensify the development

SO strategy is focused on the internal strengths and external chances to intensify the industrial development.

(1) Ensure the reasonable energy prices to avoid the harmful competition in the markets. Drawing on the foreign experience, it is better to adopt the policy that different areas vary in benchmark prices. When governments set up the policies about benchmark prices, they should consider the economic development and constructions of power grids in diverse districts to set the reasonable prices to keep the industry vitality and guarantee the economic profits. Meanwhile, with the maturity of wind power technology, reduction of production costs, governments should adjust the benchmark prices in time based on the development trends of the wind power to avert bad competitions and protect the market order.

(2) Increase the proportion of the wind power to promote structural transition of energy. The key to increase the proportion of the wind power is to decline the production costs, increase the development efficiency. For the sake of decreasing the costs, it is prior to choose the projects that with abundant energy, low risks and simple operation and maintenance, it is convenient to build the wind power farms, and easy to integrate, transform and consume. In terms of propelling up the efficiency of the equipment, first, wind turbines with high utilization rate and price-performance ratio should be firstly taken into the consideration to make the best use of the energy under the same situation to generate electricity. Second, give full play to the production of the wind farms to avoid the wind power curtailment.

(3) Identify the wind power industrial planning to ensure the market spaces in the future. Effect development of wind power depends on the national specific plans. The specific plans are the basis of instructing the development, guiding the resources allocation, determining the construction projects and arranging the government investments. Making the plans is conducive to identify the goals, strategies, major tasks, and government policies. In addition, it could help concentrate efforts and pool the resources in the society to promote the scale of this industry.

3.2. ST strategy— optimize the adjustment

ST strategy put the emphasis on using internal advantages and resolving external threats.

(1) Establish the sound rules to supervise the industry efficiently. The establishment of the sound rules should be embarked on the four aspects: first, perfect the systems of the development and utilization of the wind power that is about government domination, market controlling and public participation. Second, optimize the investment and financing system of the development and set up diversified system of the fund circulation. Third, perfect the system of fund management about development, utilization and supervision and build the socialization supervision mechanism. Finally, optimize a market access system and improve industry access standards. Promote harmonious development of wind power markets through above-mentioned optimization.

(2) Integrate the industrial chain to decrease the cost of wind power generation. The links and integrations in the wind power industry are focused on the integration of the equipment manufacturing, production and construction. The integration of the equipment manufacturing chain is aimed to reduce intermediate links, promote the development of the production technology and thus reduce the production cost through parts manufacturing enterprises being dominated by the whole equipment manufacturers. The integration of the production and the construction chain intends to integrate the production and the construction, form scale effect and thus reduce the costs through equipment manufacturing enterprises being dominated by the developers.

(3) Perfect the mechanisms of the industrial development to solve the problem of capacity. On the one hand, governments should pursue the concept that progress and the security are both required to set up the compensation mechanism of the integration and energy limitation, improve the investment and development of the industry, and eliminate backward energy, so the problem of the overcapacity is partly solved. On the other hand, enterprises should pursue the concept that cultivate the innovation ability and improve the innovation strength and optimize 5 mechanisms: innovation platforms
establishment, innovation and technical breakthrough, resources control of the innovation, personalized service and professional supervision, so as to implement the strategy of innovation-driven development in order to deal with the overcapacity effectively.

3.3. WO strategy— handle the solutions to the toughest problems
WO strategy concentrates on utilizing the external opportunities and overcome internal weakness.

(1) More supports will be given to scientific research to cultivate talents in the field of wind power. It is encouraged to set up a scientific research institution relatively, so as to increase more independent research. In addition, there will emerge a platform for the talents in the field of wind power to put theories into the practice to make up the shortcoming of valuing theories more than practices by cooperating with enterprises. Besides, build a science park combining with the universities at home and abroad to cultivate needed talents for wind power industry. From the government aspect to the enterprise aspect and the scientific research institution, everyone is making efforts to build a solid foundation for the wind power long-term development.

(2) Construct the mechanism of technology innovation. According to the demands of the wind power development, it is active to make the most of the decisive role of the market in the allocation of the innovation resource, and set up a mechanism which is driven by the industry to achieve the technicalization of the advantageous subject knowledge and engineering of the core generic technology. At the same time, create atmosphere of encouraging and protecting innovation.

(3) Implement technical standardization strategies to drive the development of the industry. Advanced technology standard strategy drives the wind power industry to improve the process, make progress in the technology and upgrade the management. Moreover, the ability to innovate independently, and the core competitiveness of enterprises will be propped up to promote the rapid development of the industry. During the process of implementing technical standardization strategies, it is of great importance to pursue the concept that the standards are prior to everything, and guide the development, construction, operation of the wind industry on the basis of the uniform technology standards.

3.4. WT strategy— strengthen the industrial development
WT strategy concentrates on knowing external threats and overcoming the internal weakness to strengthen the industrial development.

(1) Depend on the electronic information technology to enhance the intelligent grid construction. Considering the characters of the intelligent grid, such as the self-healing, compatibility, interaction, optimization, integration, there are various ways to generate electricity. The information technology, which is being steadily improved on the aspect of the information and physics, supports the system technology by advanced sensing, surveying and mapping technology, equipment technology, controlling means, and decisions. These push the grids towards the digital, information, interaction and automatic.

(2) Speed up the process of the grid construction to increase the capacity of the system. What needs to be focused is that government should form a group to discover and deal with the affairs, take the grid planning into the urban planning to assure the connection between grid planning and the overall plan for land utilization, simplify the approval procedure, and when expedite the land requisition, the demands for land are reported in time to the department of land and resources.

(3) Optimize the supporting facilities to promote the wind power industry development. The optimization should be paid attention to the three-north areas where there is abundant energy, low development of economy, and weak construction of grid. Especially, government should put emphasis on the economic construction and integration planning. Regional energy supervisor should think highly of the efficient role of the wind power and the convenience that wind power could provide. Meanwhile, the grid enterprises should follow the step of the government to put more investment and hold the view that the basis is to promote the comprehensive benefits so as to perfect the supporting facilities.
4. The conclusion
This paper analyses the current situation of the wind power industry through SWOT model to identify
the strengths, weaknesses, opportunities and challenges. For now, the development of this industry
depends on the progress of technology, stable policy, the cost of the environment and some other
factors. There is a need to learn advanced international technology and experience, improve the ability
about independent research, tackle primary problems of the core technology, and cultivate more
professional talents in China. Thus, more breakthrough of scientific research could be done and less
dependence of the foreign technology and equipment could emerge.

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