

SWOT Analysis of Us Wind Energy: Implications for Future Industrial Development

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Abstract. Along with environmental deterioration and scarce of traditional energy sources, clean and renewable energies are becoming more and more important. As the second largest clean energy source, wind energy account for a big proportion of renewable energy. However, current wind energy production is not enough for us to promote energy transition. Traditional energy, fossil fuels, still dominate the energy market. We urgently need further development in the wind energy industry to meet our demand of renewable energy. US wind production has huge investment support and significant development these years, but the supply chain is very weak, and the policy is unstable. This paper introduces US current situation of the wind energy and describes the further development prospect by using SWOT analysis.

Keywords: SWOT analysis, clean and re-newable energies, wind energy.

1. Instructions

The object of the paper is to analyses the US current situation of wind energy industry and make predictions about the industry 's future. The situation of an industry is an abstract concept, so this paper uses SWOT analysis which is very comprehensive and useful to have more valuable consideration. To do the analyze, we will research data about current situation, policies which are set by company or government, international relationships and supply chains, and professional people's attitude to the industry.

SWOT analysis include 4 parts which are strength, weakness, opportunity, and threat. These four parts include positive aspects and negative aspects, and lead to some predictions of the industry. Wind energy is the second largest renewable energy in US, only less than solar energy. US wind energy industry is the second largest in the world, but it only ten-point three percent of total US utility scale electricity generation (U.S. Energy Information Administration, 2023). If US want to generate electricity a hundred percent by renewable ways, it still needs a lot of contribution. By using SWOT analysis, it is vital to put meaningful messages into a single plot or a passage than organize them in a clear and accuracy way (Accounts, 2023).

Through reading this paper, the reader can gain valuable messages about status and the outlook of the wind energy industry in US. US is the world's largest economy and the one of the biggest renewable energy production countries. As an example of the world's renewable energy development and sustainability progress, it must be very valuable to be a model for other country. Then follow the model of the US, countries cooperate to reach a better live condition and further goals (Boretti & Castelletto, 2024).

2. Background

The first image about wind energy in US came out in 19th century. Then in 1850, the first wind engine company established. The first application in US of wind energy is in 1890, people use wind to pump water and electricity. The first large wind turbine farm was produced in 1990, which means US had a mature technology to produce wind turbine and generate wind energy. In 1992, production tax credit established focus on renewable energy (Office of Energy Efficiency & Renewable Energy, 2019). This is a very important policy to all renewable energy industries, include wind energy industry, of course. Establishment of a production tax credit (PTC) of \$0.015 per kWh for wind is really huge amount of subsidy (Energy Policy Act 1992 Incentives for Renewable Energy – Policies, n.d.). In 21st century, US continuously build more wind turbine farms and innovate the wind energy

generation technology. The electricity generation of onshore wind is persistently increasing, and the costs of the energy is persistently decreasing. The production of wind energy in 2023 are more than two times of 10 years before (Debnath, Shakur, Siraj, Bari, & Islam, 2023).

Since 2005, an average of three thousand onshore wind energy units have been produced in the United States each year (Energy Policy Act 1992 incentives for renewable energy – Policies, 2022). forty-one states take part in the project and build wind turbine and generate wind energy together. Texas, the leader state of the project, produces about twenty percent wind energy in this project and help other states about their technology difficulties and investments. Texas having two hundred thirty-nine active wind energy related projects that have produced more than fifteen thousand and three hundred wind turbine units to date (Accounts, 2023). As of 2023, offshore wind in the United States has a total capacity of fifty-two point six GW and this number will still increase according to professors' predictions. Although different states have different situation and lead to different cost of wind energy generation, costs generally hover around one million dollar per megawatt of capacity. Producing the average onshore commercial turbine ranges from two to four million dollars, typically with two to four megawatts capacity each (Duval, 2023). Offshore turbines tend to cost much more to produce and install as the installation process is more difficult and they must be made to withstand rougher conditions at sea (Office of Energy Efficiency & Renewable Energy, 2019). These can cost upwards of ten million dollars per unit to produce, having capacities ranging from six to twelve megawatts (Hannan et al., 2023).

Although the trend of the investment, cost, and the amount of energy generation is very optimistic, there are many weaknesses and threats that will slow down the development and innovation of wind energy industry (will mention later in SWOT analysis). As a result, US should continuously develop their strengths and deals with the problem which is their weakness of their industry (Office of Energy Efficiency & Renewable Energy, 2019).

3. Swot Analysis

3.1. Strength

We all know that US is the largest economy in this world, so a crucial renewable energy industry like wind energy production industry must have a huge amount of investment support from government and companies. US domestic production of wind energy has received one point nine-billion-dollar investment for its manufacturing facilities and components. Also, there is 10 potential facilities that are building which are supported by industrial investment. US wind energy industry not only include domestic manufacture, but also imports. Imported wind energy is also a important component of US renewable energy industry. There are 760 million dollars that are invested to develop the port and transport machine (Lightbody & Shane, 2023). Totally, the whole process of generate wind energy received investment of about 12 billion dollars (U.S. Department of Energy Projects Strong Growth in U.S. Wind Power Sector, 2023). This is really a huge amount of investment only less than China. Moreover, the market ecosystem is very mature. In this ecosystem, there are much competitiveness between each company. Such competitiveness will encourage those companies to innovate more products and methods, enabling more implementation of such innovations and new technologies. As a result, they are more likely to dominant the market. An example for this is technipFMC the vertiwind project have been continuously innovated since 2011. In 2024, this technology has acquired sixteen-point three stake in a kind of single wind energy X1 wind (Ramakrishnan et al., 2024).

3.2. Weakness

China control nearly a hundred percent of rare earth metals market. It means US can hardly acquire these metals domestically. Base on the fact some components of wind turbines must need these metals to make, so it means US cannot produce wind turbine and wind energy on its own. Wind energy production in US is rely on some materials that must be imported, in another word, China's support

is crucial to US wind energy generation, so the supply chain of these materials must be very vulnerable. What makes this more difficult is that the US has a bad political relationship with China. It may not be that easy for China to sell their materials to the US. It is true that the US can import from other countries, but other countries' supply is not enough for US wind production. According to the US Department of Energy, eighty percent of rare earth metals used in the US are imported from China. In conclusion, the US must strengthen the supply chain of those metals, and have a relatively good cooperative relationship with China (Raza, Yousif, Hassan, Numan, & Kazmi, 2023).

3.3. Opportunities

In this era, the hole of the ozone layer is growing, the air condition is getting worse and worse. To solve these environmental problems, the world is advocating renewable energy and recyclable things. Wind energy is on the trend of the development of the whole world. From the perspective of global sustainable development, wind energy is a crucial component of further progress. With the current trend, wind energy will become much more important in the recent future. The industry's outlook is very good. So, more and more investment will be attracted to this industry to support the innovation and implementation of new technologies (Su et al., 2023). The US as one of the leaders of energy transition countries, it will have more opportunities to be successful and become a country that transformed under the condition of low cost. According to the estimated compounded annual growth rate from 2024 to 2032 in the US, there will be a 8.2% increase, from about 141.1 million dollars to 291.69 million. This data shows a huge potential developmental ability of the wind energy industry. Overall, the US has many opportunities for it to develop the wind energy industry successfully and innovatively (U.S. Energy Information Administration, 2023).

3.4. Threats

The new round of presidential election will be operated in November 5th. Nearly everyone considered the new president will be one of Trump and Biden, but Biden had dropped the presidential election in July. Although there are other people who will replace Biden to compete for the president, Trump is much more possible to be the president since Biden dropped the election. According to Trump's previous policies, we can find that he likes traditional energies like oil and gases very much and he does not like renewable energy. He pulled the United States out of the Paris Agreement and then rolled back hundreds of environmental policies; a large proportion of these policies are renewable energies. As wind energy is an important kind of renewable energy, those policies must also influence the production and importation of wind energy. Under his governs, there must be a substantial decrease of government support and investment (note that this does not represent the authors' political views, if any, in any way). Next, wind energy is a kind of energy which relies on the nature. We cannot ensure when, where, and how many wind energy will be produced in a single country. Although the technologies and innovations help people gather wind and produce wind energy more efficiently, wind energy is not a stable energy and could easily be disrupted. To meet these problems, the US should continuously do the innovation and implementations, persistent development of relative techniques (Wind Market Reports, 2023).

4. Suggestion

To improve the weaknesses and avoid threats, the US needs to put more effort into the industry and analyze these problems profoundly. The US should strengthen their rare earth metal supply chain. If they cannot avoid cooperation with China, they should set up a friendly business relationship. In the United States, the future outlook of the wind turbine industry is very much dependent on the result of the coming election. Biden has recently dropped out of the election, and the Democrats are still in the process of selecting a new candidate. On the other hand, if Trump is reelected, things could turn out quite differently. During his presidency, Trump primarily favored the fossil fuel industry over the renewable energy industry and advocated for the increased use of coal, oil, and natural gas. If Trump

is elected, we can expect policies in the United States to shift more towards favoring the fossil fuels industry. In addition to this, it's not unlikely that Trump would also take back existing tax reductions and other incentives to renewable energy companies, slowing the growth of the turbine industry as well. Politic counteract should not cause huge impact on their transaction relationship. Because China is the country which control most of the rare earth metals, US should be more active to seek for a good cooperate relationship. About the politics' influence, it is hard to overcome. However, within the accepted range, US can do a lot. US can still enhance their strengths. There is substantial investment in US wind energy industry, so although government investment will decline, companies' investment can still play an important role in this industry. Also, the era's trend is the renewable energies, the policy may be stricter to industry, but no one can stop develop it. In the short term, the industry should be waited for the result of the election, and after the result of election proposed, the industry should make some changes and adapt to these changes as fast as the industry can then develop in a new style.

5. Conclusion

The global wind turbine industry outlook still seems positive and bright, and the amount of energy will be nearly doubled as mentioned in the previous passage. China is still the leader of the renewable energy production, there are more and more countries are gotten into the team of environmentally friendly energy production. Generally, all countries want this world, this environment to be a better place for human being to live. The United State is no exception. Overall, although there are threats from the politics, inside the US, and from the environment itself, outside the US, the wind energy industry also seems bight in recent future. In the long term, according to the United Nations, the environmental condition will be better than it is now, so the production of renewable energies will receive more supports, and the process will be more efficient and successful.

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