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The Impacts of Global Trade Wars on Wind Turbine Production and the Renewable Energy Sector: Case Study of Goldwind and GE Renewable Energy

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Abstract: This study employs a comparative analysis approach to examine the effects of global trade wars on the renewable energy sector, with a specific focus on comparing the experiences of leading wind turbine manufacturers, Goldwind and GE Renewable Energy. In recent years, escalating trade tensions and protectionist trade policies have had the potential for significant repercussions on the growth of the renewable energy industry.

This research explores the direct impacts of trade wars on wind turbine production and their effects on supply chains from a comparative perspective. Additionally, it analyzes how major players in wind turbine production and the renewable energy sector have coped with and adapted to these challenging circumstances through a comparative lens.

The findings indicate that global trade wars can potentially slow down the growth of the renewable energy sector and increase costs. However, it is essential to note that these wars have also encouraged renewable energy producers to strengthen local supply chains and transition towards more sustainable production models.

By utilizing a comparative analysis approach, this study provides valuable insights into the complex effects of global trade wars on the renewable energy sector and how the industry can adapt to future challenges.

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1. Introduction

Global trade wars have emerged as a significant geopolitical and economic challenge in recent years, casting a shadow of uncertainty over various industries worldwide. This study delves into the profound impacts of these trade conflicts on wind turbine production and the renewable energy sector, with a specific focus on two prominent players in the field: Goldwind and GE Renewable Energy. As the world increasingly turns to renewable energy sources to combat climate change and reduce reliance on fossil fuels, understanding the repercussions of trade wars on this critical sector is of paramount importance.

The 21st century has witnessed a growing global consensus on the need to transition towards clean and sustainable energy sources. Renewable energy, which includes wind power, has emerged as a frontrunner in this transition. Wind turbines, in particular, have become symbols of green energy production, offering an environmentally friendly alternative to traditional fossil fuel-based power generation. Wind turbines are central to harnessing the power of wind to generate electricity. They consist of complex components and technologies, and their production and deployment have witnessed exponential growth over the past decades. This growth is driven by various factors, including climate change concerns, energy security, and the decreasing cost of renewable energy technologies. However, the globalization of supply chains and trade relations has exposed industries like wind turbine production to the consequences of global trade disputes. The early 21st century has seen a surge in trade tensions between major economic powers, such as the United States, China, and the European Union, leading to tariffs, trade barriers, and retaliatory measures. These conflicts have injected uncertainty into the global economic environment and have the potential to disrupt industries dependent on international trade. Goldwind, a Chinese company, and GE Renewable Energy, a subsidiary of the American conglomerate General Electric, are two significant players in the global wind turbine industry. They represent different facets of the sector, with Goldwind being one of the largest manufacturers globally and GE Renewable Energy encompassing a diverse portfolio of renewable energy solutions. Analyzing their experiences amid global trade wars provides valuable insights into how this complex geopolitical landscape impacts the renewable energy sector.

The rest of this study is organized as follows: Section 2 discusses "Fundamental Understanding of Trade Wars," Section 3 presents the "Profiles of Goldwind and GE Renewable Energy," Section 4 examines the "Effects of Global Trade Wars on Wind Turbine Production," and Section 5 focuses on "Goldwind and GE Renewable Energy's Strategies to Deal with Trade Wars." Finally, a conclusion section will be provided.

In a world where combating climate change is an urgent priority, understanding the dynamics of global trade wars and their influence on wind turbine production and the renewable energy sector is essential. This study aims to shed light on the challenges faced by industry leaders like Goldwind and GE Renewable Energy, providing valuable insights for policymakers, industry stakeholders, and anyone concerned with the future of clean energy production.

1.1. Problem Statement

The impact of global trade wars on the renewable energy sector, particularly wind turbine production, has become a growing source of concern in recent years. The uncertainty and trade restrictions brought about by trade wars have affected the operations and growth strategies of companies such as wind turbine manufacturers. This has become a significant issue, especially for major players like Goldwind and GE Renewable Energy.

1.2. Research questions

Leading companies such as Goldwind and GE Renewable Energy have been investigated for how they have dealt with the effects of global trade wars and sustained sustainable growth in the renewable energy sector. The research question can be formulated as follows: "How have companies like Goldwind

and GE Renewable Energy overcome the challenges posed by global trade wars and ensured sustainable growth in wind turbine production?"

2. Literature Review

2.1. Definition

A trade war refers to countries taking retaliatory measures against each other by implementing protectionist measures such as customs tariffs, quotas, and bans to restrict international trade and protect their own industries. When one country imposes protectionist measures like customs tariffs or quotas on imports from another country, other countries respond by taking similar protectionist measures, leading to trade wars. The proliferation of such protectionist measures reduces the volume of international trade. The main objective of a trade war is to correct the balance of foreign trade, protect the domestic industry from foreign competition as much as possible, and create new job opportunities and employment. A trade war is a potential outcome of protectionist policies. In the short term, protectionist measures may have positive effects on the economy. However, it is certain that due to retaliatory measures and counteractions by other countries, international trade will contract, nullifying the short-term benefits. In the long term, trade wars increase unemployment and hurt economic growth. Additionally, the increase in prices of imported products due to customs tariffs and quotas leads to a general rise in price levels (Çatalbaş, 2019). These trade wars can arise to protect national interests or enhance competitive advantages. In this context, the renewable energy sector, especially wind energy production, has become a significant area affected by such trade wars. The renewable energy sector is rapidly growing due to increasing global demand for environmental sustainability and energy independence. Wind energy is a crucial component of this growth, and wind turbines are among the fundamental products of this sector. Major players like Goldwind and GE Renewable Energy hold a leading position in this sector and closely experience the impacts of global trade wars.

2.2 Trade Wars from the Past to the Present

To examine the effects of trade wars and understand the potential outcomes of such policies, it is important to take a close look at the results of the Smoot-Hawley Tariff Act passed by the United States in the 1930s. This law was primarily enacted to support American farmers who were facing significant income losses due to adverse climatic conditions known as the "Dust Bowl" in the early 1930s. Under this legislation, tariffs were increased by an average of 40% to 48% for approximately 900 different products (Amadeo, 2021). The significant increase in tariffs by the United States prompted other countries to retaliate, leading to the onset of new trade wars, and international trade volume contracted by 65% between 1929 and 1932. Most importantly, these trade wars exacerbated the impact of the Great Depression of 1929, making its effects even more pronounced (Little, 2018). Shortly; The trade war initiated by the United States, known as the Hawley Tariff and considered the first modern trade war, began with the imposition of additional taxes on the import of numerous agricultural and industrial products, resulting in a 60% reduction in exports and imports (Desjardins, 2018). In international trade, quotas, tariffs, and additional taxes, while they may yield short-term benefits, are ultimately detrimental in the long run for both exports and imports.

2.3 Literature Review

When we examine the theoretical explanation of the concept of trade wars, the first case that comes to mind is the Johnson case (Bouët & Debucquet, 2018). In his 1953 study, Johnson theoretically proposed that in the event of a trade war, large countries could increase their welfare by achieving the correct tariff balance, while small countries would always lose, resulting in a decrease in their welfare levels (Johnson, 1953). In a study conducted by Brander and Spencer in 1985, they examined an export subsidy war between two countries (Brander & Spencer, 1985). In this scenario, the objective was to

facilitate greater profit accumulation by domestic firms in both countries within an industry characterized by imperfect competition.

In 1986, Eaton and Grossman analyzed the equilibrium of policies between two countries, which involved Bertrand competition and the taxation of exports by oligopolistic companies. In a study conducted by Ossa in 2012, welfare changes associated with the application of Nash tariffs were formulated using Krugman's "new trade" model.

Ossa provides backing for the notion that a production relocation externality can serve as a motivation for trade policy (Başbuğa, 2022). Furthermore, this externality can lead to further ripple effects that can be incorporated into trade agreements among trading partners. To put it differently, this externality arises from an import tariff that encourages entry into the domestic manufacturing sector and exit from foreign manufacturing sectors. These types of production relocations will contribute to an increase in domestic welfare (Ossa, 2011).

If we delve into the empirical side of the literature, Conybeare characterizes trade wars as a high-intensity category of international conflict where states engage, negotiate, retaliate, and employ interlinked instruments that directly influence their economic objectives related to the traded goods or service sectors of their economies. All these studies (Johnson's study 1953, the study by Brander and Spencer in 1985, the study by Eaton and Grossman in 1986, Ossa's study in 2012 and 2011) have made significant contributions to the literature and have provided guidance for much of the ongoing research in today's context (Conybeare, 1987).

The literature reviewed in the preceding sections leads to three overarching conclusions. Firstly, global tariff wars can cause substantial damage to all nations and, more broadly, to the world economy. Secondly, in bilateral trade wars, two potential outcomes emerge: typically, both countries experience losses compared to their starting point in free trade. However, in certain situations reminiscent of the Johnson cases, while a large country may enhance its welfare, the welfare of the smaller country diminishes. The third conclusion is that even in cases centered around balanced tariff policies, global welfare has declined.

3. Research Data and Methodology

Data Collection: Secondary Data: Existing data related to global trade wars, renewable energy, wind turbine production, Goldwind, and GE Renewable Energy will be collected. These sources may include academic articles, industry reports, government publications, and news articles.

Research Design: Case Study Approach: A case study methodology will be used to analyze the impact of global trade wars on Goldwind and GE Renewable Energy. The focus will be on specific events, and their adopted strategies to cope with these challenges.

Data Analysis: Qualitative and quantitative analysis methods will be employed to assess the collected data.

Qualitative analysis may involve examining the content of documents and reports to identify main themes, challenges, and strategies. Quantitative analysis may include statistically evaluating market trends and financial data if available.

Case Selection: Goldwind and GE Renewable Energy will be selected as case studies.

Data Sources: Various data sources will be utilized, such as financial reports, annual statements, industry reports, government energy data, and company publications.

Comparative Analysis: By comparing the experiences of Goldwind and GE Renewable Energy, similarities, differences, and successful strategies in dealing with trade wars will be identified.

Reporting and Conclusion: The findings of the research will be presented in a clear and structured manner, drawing conclusions about the impact of global trade wars on wind turbine production and the strategies adopted by Goldwind and GE Renewable Energy. Insights from policymakers, industry stakeholders, and experts in renewable energy and trade have been considered.

4. The Impacts of Global Trade Wars on Wind Turbine Production and the Renewable Energy Sector: Case Study of Goldwind and GE Renewable Energy

4.1. Fundamental Understanding of Trade Wars

The fundamental concept of trade wars is to intervene in favor of state interests based on protectionist policies. Governments employ mechanisms like "tariffs, quotas, subsidies, and currency manipulation" when enacting their protectionist policies (Kimberly, 2022). There are various justifications for why states employ protectionist policies in international trade. The primary drivers encompass considerations such as "National Defense, Trade Deficits, Employment, Supporting Emerging Industries, and Promoting Equitable Trade (Abboushi, 2010)."

4.2. Profiles of Goldwind and GE Renewable Energy

Profile of Goldwind Renewable Energy: In today's rapidly changing energy landscape, the importance of renewable energy is steadily increasing. Goldwind Wind Energy is recognized as one of the pioneers of this change and is leading the growth of the renewable energy sector. Goldwind, a company with its roots in China, has established an impressive presence internationally. Currently, Goldwind's operations span 38 countries across six continents, with eight research and development centers worldwide. These R&D centers play a crucial role in supporting Goldwind's commitment to advanced technology and maintaining its leadership position. With approximately 11,200 employees, Goldwind houses over 3,455 research and development experts worldwide. The company's global cumulative installed capacity has surpassed 100 GW, and its operation and maintenance (O&M) service capacity exceeds 60 GW, signifying the successful deployment of over 47,000 wind turbines worldwide. Goldwind continues to support the global energy transformation by integrating renewable energy and digital technology. The company develops zero-carbon solutions for new energy systems and contributes to the construction of a smarter Energy Internet by optimizing and restructuring energy assets, a significant step towards achieving carbon neutrality. Goldwind also plays a significant role not only in the energy sector but also in water purification and environmental protection. Their scope of activities ranges from municipal water supply to industrial wastewater treatment and the reuse of treated water. Goldwind's subsidiary, Goldwind EP, has invested in and operates 65 water projects with a daily water treatment capacity exceeding 2.83 million tons. Goldwind Wind Energy is a pioneer not only in the energy sector but also in environmental sustainability and technological innovations. This leading company continues to shape the future of renewable energy and serves as a driving force behind the global energy transformation (goldwind).

Profile of Ge Renewable Energy: With a business worth 15 billion dollars, GE Renewable Energy offers comprehensive solutions to meet the demand for reliable and cost-effective green energy. These solutions encompass various fields such as onshore and offshore wind, wind turbines, hydroelectric power, energy storage, large-scale solar energy, grid infrastructure, hybrid renewable energy sources, and digital services. The company has installed over 400 gigawatts of renewable energy capacity to date and has provided grid solutions to more than 90% of energy service providers worldwide. GE Renewable Energy employs approximately 40,000 people operating in over 80 countries worldwide (Windeurope).

4.3. Effects of Global Trade Wars on Wind Turbine Production

The rising threats of trade disputes and protectionism are driving up the expenses associated with renewable energy sources, despite a worldwide effort that had previously enhanced the competitiveness of wind and solar power over fossil fuels and nuclear energy. Key figures in the industry have urged governments not to implement trade restrictions affecting wind turbine equipment and to maintain an open and favorable investment environment for companies supporting the worldwide shift to clean energy. The most significant impact of trade wars on the wind turbine industry is economic. During this

period, manufacturing companies have suffered substantial losses. Companies such as Goldwind, GE Renewable, and Vestas have reported losses, with Siemens Energy disclosing approximately 1 billion dollars in losses (Woods, 2023).

Another significant aspect of trade wars is patent wars, which can have a tremendously negative impact on wind turbines. These patent wars not only reduce profit margins but also threaten sales prices. For example, the largest wind turbine OEM reported a loss of 1.3 billion euros in 2018, which increased to 5.7 billion euros in 2022. If patent wars continue, it is estimated that this financial loss could reach 100 billion euros within the next decade (Barla, 2023). For a concrete example, there has been a patent dispute between Siemens Gamesa Renewable Energy and GE Renewable Energy: The UK High Court ruled in favor of GE Renewable Energy in a patent dispute over the design of offshore wind turbines with Siemens Gamesa Renewable Energy (SGRE or Siemens Gamesa) (Russell, 2022). Trade wars have increased costs while there has been an increase in the workforce. In the global onshore and offshore wind turbine industry, employment rose from 1.25 million in 2020 to 1.4 million in 2021. (IRENA, 2022). The employment situation indicates that if buyers and sellers have reached an agreement, production will occur without delays caused by employment.

The other facets where trade wars may have potential adverse effects on wind turbine beyond "material costs" and "patent wars" are as follows: "supply chain disruptions," "market uncertainty," "export markets," and "innovation and collaboration." In the context of market uncertainty, investors and companies may struggle to predict future trade policies. Trade wars can lead to issues concerning export markets for wind energy technology, as customs duties and trade barriers can hinder exports and limit market access. Regarding innovation and collaboration, the wind energy industry relies on international cooperation and technology transfer. Trade wars can make such collaborations more challenging and impede innovations.

The energy capacities, market revenues, and growth statistics of Goldwind and GE Renewable Energy in recent years are displayed in the figure below:

Leading wind turbine suppliers globally based on market share in 2019

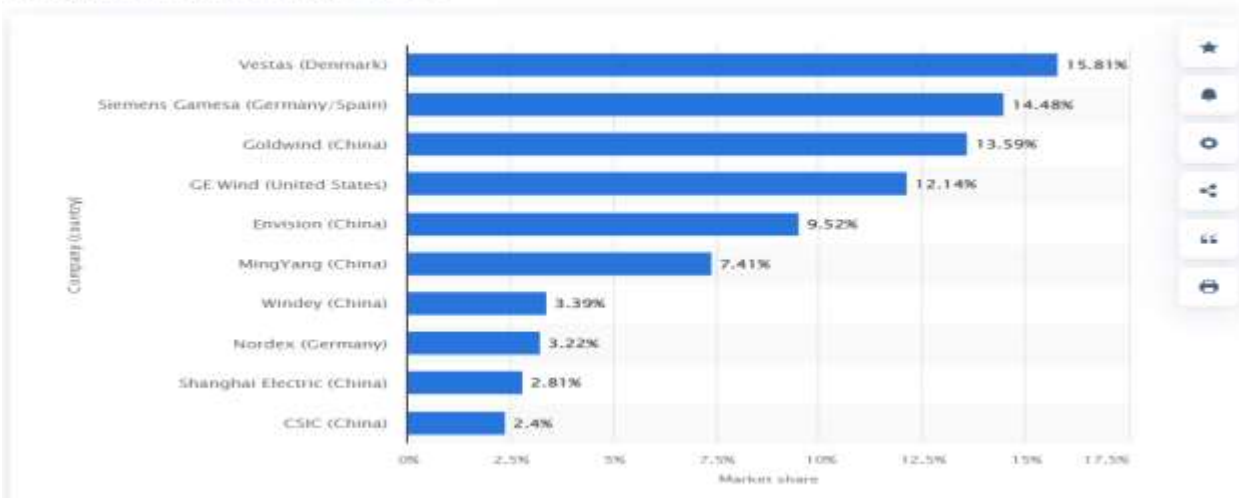


Figure 1: Leading wind turbine suppliers globally based on market share in 2019 (Source: <https://www.statista.com/statistics/554377/wind-turbine-suppliers-globally-based-on-market-share/>)

The global market shares of the United States and China in wind energy for the year 2019 are provided in Figure 1. When looking at the renewable energy sector market on a country-by-country basis, it is clear that China is far ahead. The total market share for the companies shown in the figure is indicated

as 84.77%. The total market shares owned by Chinese companies stand at 39.12%. Chinese companies hold almost half of the global wind energy market. The only US company on the list, "GE Wind", accounts for 12.14% of the shown capacity. When comparing the US's largest wind energy supplier "GE Wind" with China's largest, "Goldwind", the Chinese company has a larger market share at 13.59%, compared to the US company's 12.14%. The wind turbine market, which has become one of the most important issues of national security, has pitted the USA against China. The trade wars that started between the two countries have slowed and limited trade on this delicate issue, leading to increased taxes and adversely affecting the entire world.

In the past few years, wind turbines have generally cost about \$700,000 per megawatt globally, especially in Europe and the Americas. However, in Asia, the price stands at approximately \$400,000 per MW. This lower cost in Asia is primarily due to the benefits China has with raw material costs and their reduced overheads and margins, as explained by Philip Totaro, the CEO and founder of IntelStor, a consultancy specializing in renewable energy insights, in his conversation with The China Project. If Chinese manufacturers had been allowed access to Western markets, they would have profited every day due to their cost advantages. However, the US and Europe began to impose import duties on Chinese-made wind turbines and components that increased their costs. They do not want to accept turnkey projects offered by the Chinese with their equipment, labor, experience, and financing (WYK, 2023).

Energy & Environment > Energy

Revenue of General Electric energy segments from 2017 to 2022, by segment *(in million U.S. dollars)*

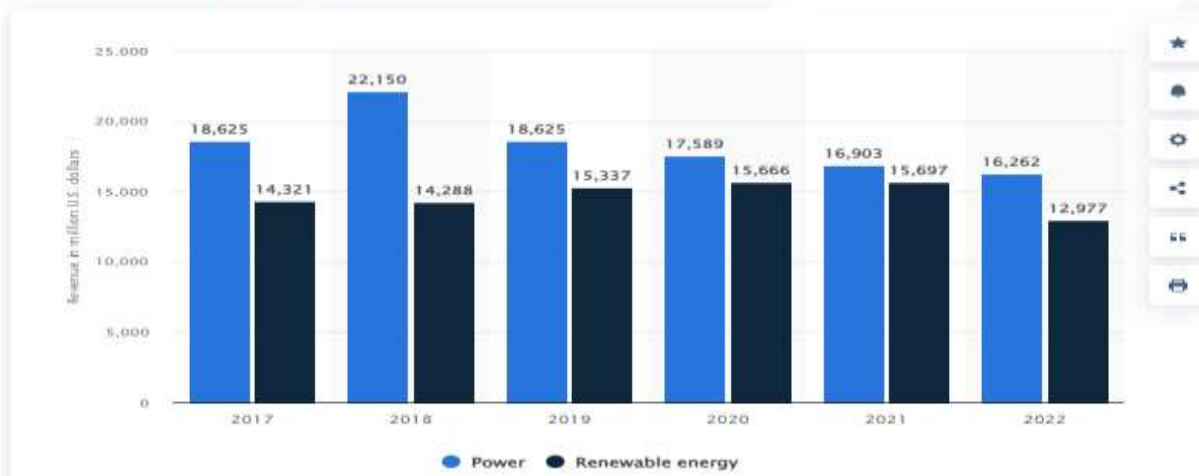


Figure 2: Revenue of General Electric energy segments from 2017 to 2022, by segment (Source: <https://www.statista.com/statistics/515652/revenue-for-general-electric-energy-management-segment/>)

Figure 2 displays the revenue figures for General Electric's energy segments from 2017 to 2022. When examining the figure, it is evident that even during the global trade wars, the renewable energy market did not contract; instead, it experienced growth. The contraction observed in 2022 was an exceptional situation due to delays in the product supply chain.

Leading countries in installed renewable energy capacity worldwide in 2022 *(in gigawatts)*

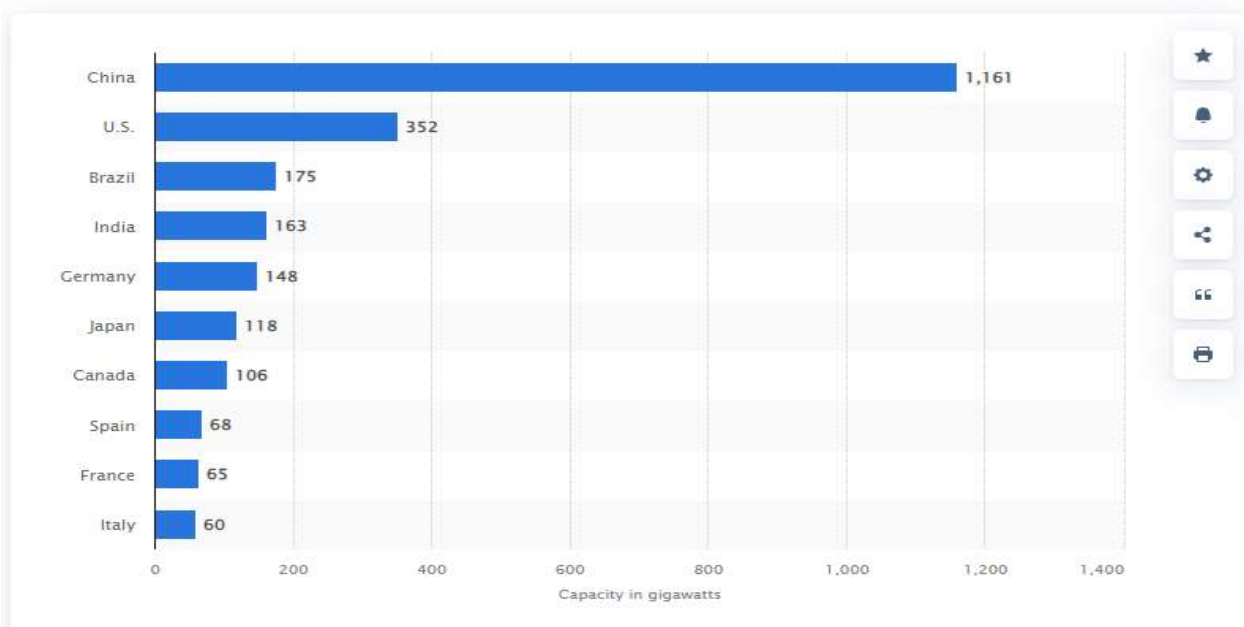


Figure 3: Leading countries in installed renewable energy capacity worldwide in 2022

Source: <https://www.statista.com/statistics/267233/renewable-energy-capacity-worldwide-bycountry/#:~:text=Renewable%20energy%20capacity%202022%20by%20country&text=The%20leading%20countries%20for%20installed,%2C%20the%20U.S.%2C%20and%20Brazil.>

When looking at Figure 3, it appears that China holds the top position globally in renewable energy capacity, while the United States is in second place. The reason for the significant gap between China and the United States is due to the size of China's domestic market.

The market size of the renewable energy sector for the upcoming decade between 2021 and 2030 is shown in the figure below:

Renewable energy market size worldwide in 2021, with a forecast for 2022 to 2030 (in billion U.S. dollars)

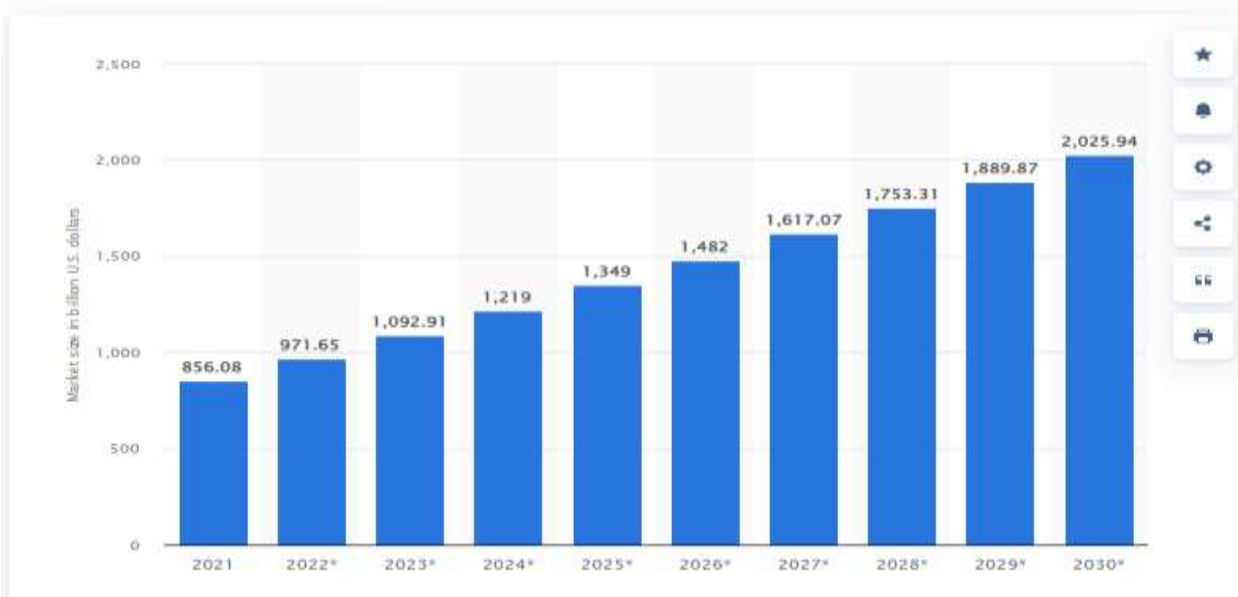


Figure 4: Renewable energy market size worldwide in 2021, with a forecast for 2022 to 2030 (Source: <https://www.statista.com/statistics/1094309/renewable-energy-market-size-global/>)

According to Statista, Figure 4 forecasts that the market size for renewable energy will steadily grow over the next decade, culminating in a 2 trillion-dollar volume by 2030. Given its current market volume of 1 trillion dollars, the realization of the 2030 scenario appears quite plausible. Statista's 2030 market size projection anticipates contributions from environmental concerns about fossil fuels, swift urbanization, and economic growth in emerging regions. This figure indicates a cleaner future by the year 2030.

The wind power capacity for the year 2022 in the United States, China, and worldwide is shown in the figure below:

Renewable energy: Wind capacity

Installed wind turbine capacity* Gigawatts											Growth rate per annum			
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2021	2011-21	Share 2021
US	45.7	58.1	60.0	64.2	72.6	81.3	87.6	94.5	104.1	118.7	132.7	12.1%	11.3%	16.1%
China	46.4	61.6	76.7	96.6	131.0	148.5	164.4	184.7	209.6	262.1	329.0	16.9%	21.6%	39.9%
Total World	220.1	286.9	299.8	349.3	418.2	488.9	514.2	569.5	621.3	731.8	824.9	13.0%	14.1%	100.0%

Source: IRENA (2022), Renewable Energy Statistics 2022, The International Renewable Energy Agency, Abu Dhabi.

*End of year.

†Less than 0.05.

Notes: Capacity figures in this table include both onshore and offshore wind and are on an AC basis.

Growth rates are adjusted for leap years.

Figure 5: Renewable Energy: Wind Capacity (Source: bp statistical review of world energy, 2022, 71 edition)

When looking at Figure 5, it provides information about the wind energy capacities and global market shares of the USA and China. According to the figure, China, which had a capacity of 45.7 gw in 2011, reached a capacity of 132.7 gw in 2021, growing at a rate of about threefold. The USA, on the other hand, had a capacity of 46.4 gw in 2011 and experienced approximately a sevenfold growth rate, reaching 329.0 gw in 2021. In 2011, the global wind energy capacity was 220.1 gw, and by 2021, it was 824.9 gw. Thus, based on the 2021 data, just the USA and China combined have a wind energy capacity of 461.7 gw. The remaining wind energy capacity for all other countries is 363.2 gw. In short, according to the 2021

data, the wind energy capacity of china and the usa is 27.1% greater than the rest of the world combined. Looking at the data for 2020-2021, the usa's annual growth rate is 12.1%, china's is 16.9%, and the rest of the world is at 13%. Over a decade, from 2011-2021, the usa's growth rate was 11.3%, china's was 21.6%, and the rest of the world grew by 14.1%. In terms of their shares in the global trade market, the usa's market share is 16.1%, china's is 39.9%, and the rest of the world's share is 44%. The combined global market share of just the usa and china's wind energy trade is 56%.

4.4. Goldwind and GE Renewable Energy's Strategies to Deal with Trade Wars

In the first quarter of 2022, wind turbine manufacturers faced significant financial setbacks, primarily attributed to rising production expenses and the downward pressure on pricing. The industry's profitability started declining in 2017 as governments shifted towards competitive contract bidding in response to changing tariffs, which forced companies to cut costs and led to shrinking profit margins (Cohen, 2022). These companies have adopted various strategies to minimize the impact of trade wars. For example;

Other strategies is "collaboration and partnership." For example, GE Renewable Energy company established a partnership with "Sanko Enerji" in 2019 in order to enter the Turkish market. This local partner may be familiar with local regulations and can help mitigate political risks (wind turbine, 2019). The renewable energy companies in the United States and China have been provided with all kinds of support by their respective governments to weather crisis periods.

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Goldwind's total assets from FY 2010 to FY 2015
(in million U.S. dollars)

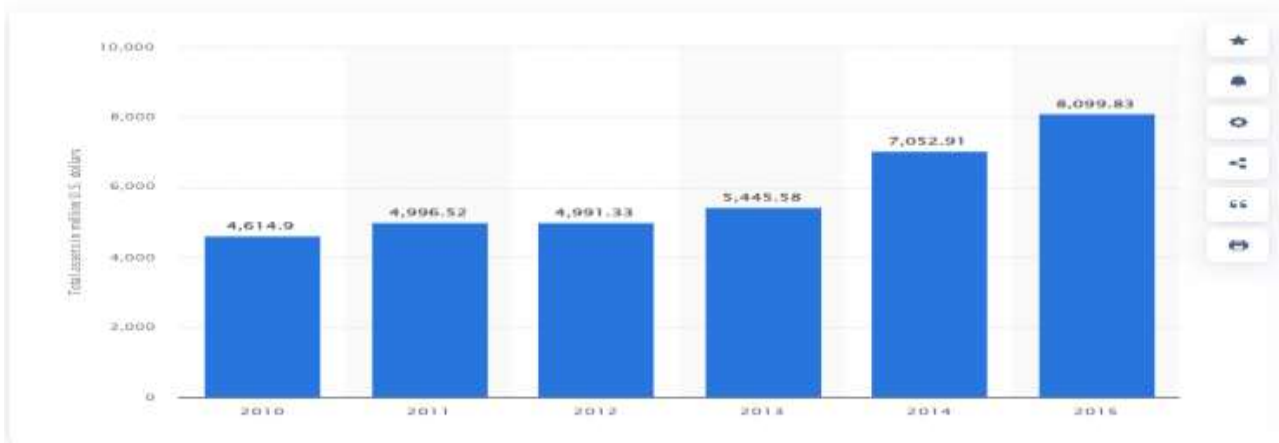


Figure 6: Goldwind Investment (Source: <http://www.statista.com/statistics/555108/goldwind-total-assets-worldwide/>)

Revenue of Xinjiang Goldwind Science & Technology Limited from financial year 2007 to 2020

(in million U.S. dollars)

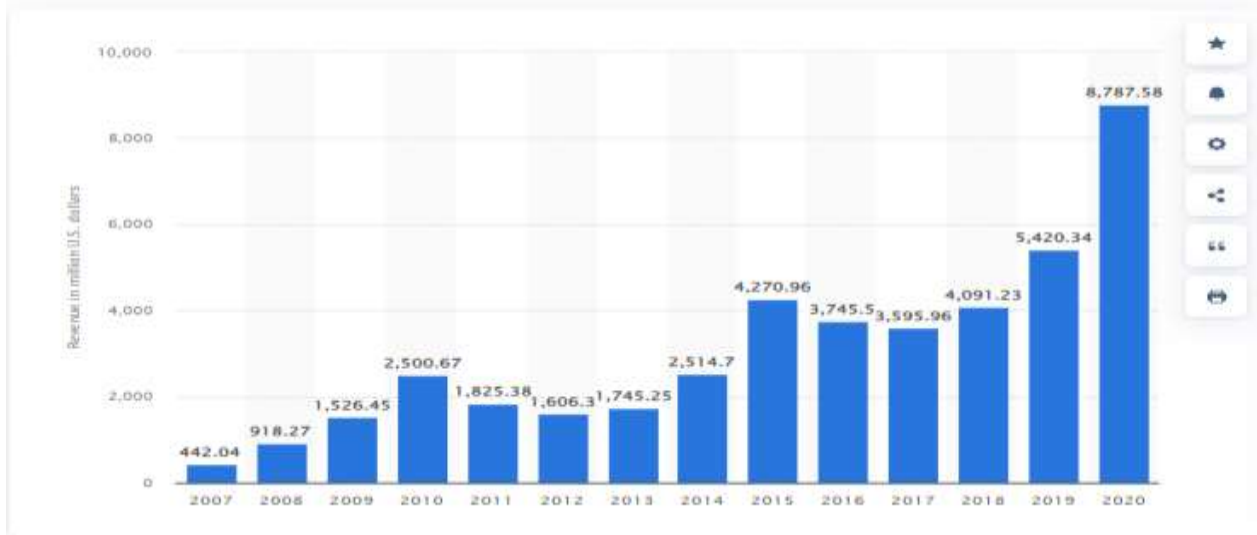


Figure 7: Goldwind Revenue (Source: <https://www.statista.com/statistics/278245/goldwind-revenue/>)

With the onset of trade wars, companies' budgets have been tightening due to declining revenues. Goldwind Renewable Energy company's ability to contend with the trade war and succeed can be attributed to the investments it made in previous years. Despite being negatively affected during the crisis period, the company has managed to continue growing, albeit to a limited extent. Graph 1 displays data related to Goldwind Renewable Energy, showcasing the assets the company possessed from 2010 to 2015. In Graph 2, the same company's revenue from 2007 to 2020 is depicted. Looking at the years of the trade wars in 2018-2019, it is evident that the company's revenue increased. There was an average growth rate of around 60% in previous years. During the years of the trade war, the growth rate dropped to approximately 25%. In summary, the most significant factor contributing to Goldwind Energy company's ability to combat trade wars is the investments it made in previous years.

Another strategy is 'diversification'. To bolster their security, two companies have expanded their operations across a vast geographic spread, thus reducing their dependency on any single country or region. For example, in 2021, 30 wind turbine manufacturers installed a collective total of 29,234 wind turbines. Vestas led the market with a 17.7% share, followed by Goldwind at 11.8%, Siemens Gamesa at 9.7%, Envision at 8.65%, and GE Renewable Energy rounding out the top five with 8.55%. Vestas and Siemens Gamesa had operations in 37 and 32 countries, respectively, while GE was present in 22, Goldwind in 7, and Envision in just 3 countries. To counter protectionist tendencies in international trade, the wind turbine industry showcased significant geographical diversity in 2021. Firms like Vestas and Siemens Gamesa actively supplied turbines in over 30 countries, amplifying global market diversification. Such diversity encourages a more balanced and mutually interdependent approach to international trade. This reduces risks associated with over-reliance on any single market or region and can mitigate protectionist inclinations (Backwell, 2022).

During trade wars and supply shortages, both China and the United States have extended significant support to domestic firms in the form of "financial and tax incentives," "favorable customs duties," "emergency credit assistance," "quality certification," and "research and development (Altuntaşoğlu, 2009)." In addition to the measures mentioned above, Goldwind and GE Renewable Energy companies have successfully navigated through crisis periods by adopting a sensitive approach in areas such as

"market analysis", "state subsidies", "risk management," "emergency action plans," "market diversification (i.e., avoiding dependency on local markets)," and "closely monitoring international customs tariff changes."

5. Empirical Findings

In our case study, Goldwind and GE Renewable Energy companies are compared in terms of dealing with global trade wars.

The top 5 wind turbine OEMs collectively captured almost 60% of the global market in 2022

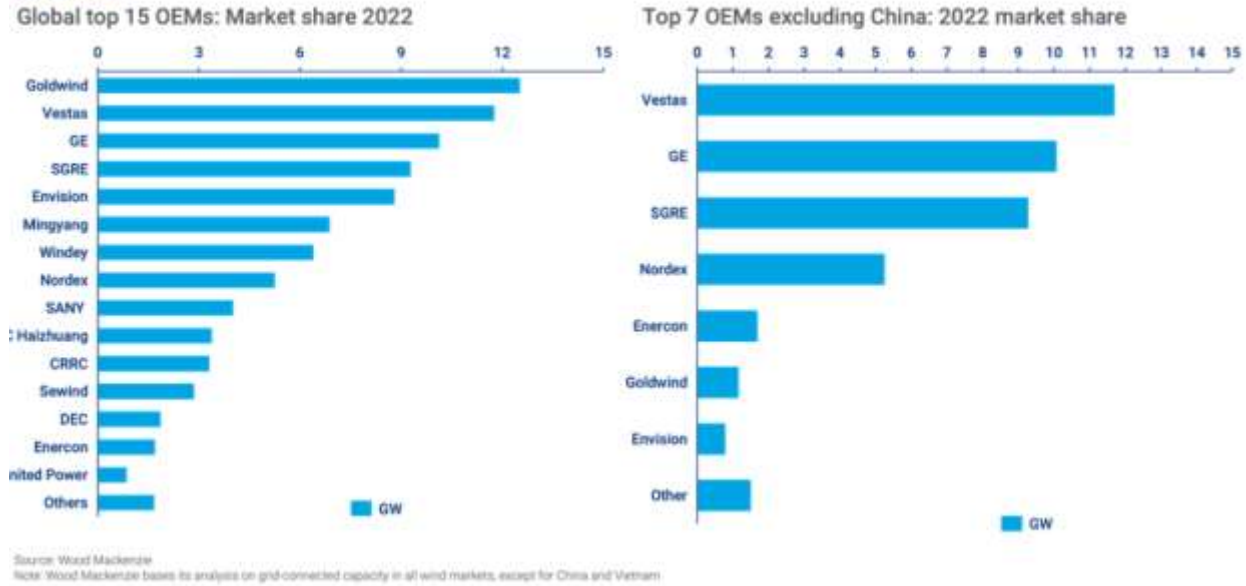


Figure 8: Wind turbine global market excluding China

Source: <https://www.woodmac.com/news/opinion/goldwind-captures-the-top-spot-for-global-wind-turbine-supply/>

In the figure on the left, companies are listed in order based on their installed capacity as OEM (Original Equipment Manufacturer). The Chinese OEM leads the global market share for the first time. Vestas, which lost its leadership for the first time since 2015, closely followed it with 11.8 GW. GE closed the top three with double-digit GW installations, following with 10.1 GW. Siemens Gamesa and Envision completed the top five OEMs (a group that collectively controls almost 60% of global markets) with 9.3 GW and 8.8 GW installed capacity, respectively. In the figure on the right, Vestas continues its leadership outside of China for the seventh consecutive time, followed by GE and SGRE. Nordex and Enercon are the remaining major Western OEMs shown. Western OEMs (Vestas, GE, SGRE, Nordex, and Enercon) dominate markets outside of China, concentrating 92% of new installations (Lico, 2023).

In our case study, Goldwind and GE Renewable Energy companies are compared in terms of dealing with global trade wars. According to the figure on the left, it is stated that the world's largest wind turbine company by market share is the Chinese company Goldwind. In the figure on the right, when looking at OEMs excluding China, it is shown that the largest companies are Vestas and GE, respectively. These data indicate that China's biggest market is its own country, while GE Renewable Energy has a large market outside the USA. In the relevant section of our study, recalling the information given about the two

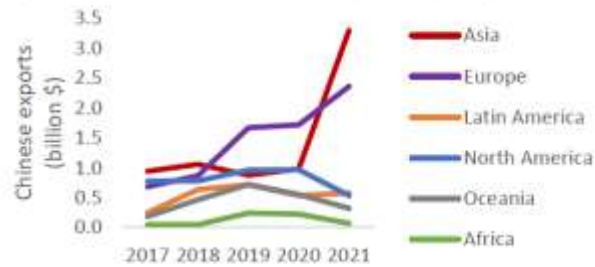
companies, it is mentioned that while the Goldwind OEM operates in 38 countries, including R&D and preparation studies, the American company GE is spread across 80 countries.

Figure 1: Chinese wind turbine exports



Source: IHS Markit, [Global Trade Atlas](#).

Figure 2: Chinese wind turbine exports by region



Source: IHS Markit, [Global Trade Atlas](#).

Figure 9: Chinese wind turbine export (Source: U.S. International Trade Commission Executive Briefings on Trade, March 2022)

Figure 9 presents a detailed distribution of China's exports by year and region. Referring to this figure, it can be observed that the total value of China's exports to the Asian and European markets in 2021 amounted to 7.2 billion dollars.



Figure 10: U.S. Wind Power Market (Source: <https://www.grandviewresearch.com/industry-analysis/wind-power-industry>)

Figure 9 provides a detailed representation of the US wind turbine market data by year. According to this figure, the trade volumes for the years 2020 and 2021 are recorded as 18.9 billion dollars and 12.5 billion dollars, respectively.

In summary, when comparing the wind turbine companies GE and Goldwind, it has been determined that Goldwind, based in China, possesses a larger financial structure. However, it is observed that Goldwind lags behind GE in terms of export performance. The primary reason for this is that

Goldwind's main market is its domestic market, China. A significant similarity between the two companies is their continued growth despite quotas and trade barriers. Within the context of trade wars, the strategic approaches adopted by both firms stand out in terms of the measures they take against trade obstacles. A common strategy can be identified as aiming for new markets and operating in broad geographies. GE, based in the US, has effectively implemented this strategy by expanding to 80 countries, whereas Goldwind operates in 38 countries in this respect. In the future, if China reduces its energy dependency on foreign sources, it is predicted that Goldwind's growth rate will decrease compared to GE due to the weaknesses it will experience in the external market. Lastly, both GE and Goldwind have adopted effective strategies to avoid being negatively affected by the trade wars experienced in international trade and have continued their growth.

6. Conclusion

In this empirical study, we have explored the profound impacts of global trade wars on wind turbine production and the renewable energy sector, with a specific focus on two major players, Goldwind and GE Renewable Energy. Through a comprehensive analysis of trade wars, the profiles of these companies, and the effects of trade disputes on wind turbine production, we have gained valuable insights into how these industry leaders have navigated this complex geopolitical landscape to ensure sustainable growth.

Our research has revealed several critical findings:

Trade Wars and Renewable Energy Growth: Despite the challenges posed by global trade wars, the renewable energy sector, including wind turbine production, has continued to grow. Trade wars have not led to a contraction of the renewable energy market, but rather, the sector has experienced significant growth during this period.

Market Leadership: China, with companies like Goldwind, has emerged as a global leader in renewable energy capacity, while the United States also plays a significant role. These two countries collectively account for a substantial portion of the world's wind energy capacity.

Impact on Wind Turbine Manufacturers: Global trade wars have led to one of the impacts on companies like Goldwind and GE Renewable Energy, which is the emergence of "patent wars." This situation has reduced profit margins for these companies and caused fluctuations in prices. Additionally, market uncertainty has had a negative effect on the wind turbine sector. As a result, countries have been reluctant to make short-term investment decisions, creating an unfavorable investment environment.

On the other hand, with the increase in customs and trade tariffs, both companies have shifted their focus to new regions. Consequently, they have not faced significant challenges regarding market and growth.

Strategies for Resilience: Goldwind and GE Renewable Energy have employed certain strategies to avoid losses during the trade war period. Among these strategies, the most crucial one is the investments they have made. The study illustrates the assets of these debt-free companies. Generating income from these assets signifies gains and profits. Therefore, despite facing losses during the crisis period, both companies have managed to achieve growth.

Another significant strategy is the adoption of a partnership and collaboration approach while expanding into different geographical regions. This move has enabled them to stay informed about trade policies adopted by countries and take preventive measures in case of a negative attitude towards foreign investment. This approach aims to grow with lower risk and does not prioritize growth without compliance with regulations.

Potential Threats: Beyond material costs and patent wars, trade wars have the potential to disrupt supply chains, create market uncertainty, hinder export markets, and impede innovation and collaboration in the wind energy industry.

In conclusion, the renewable energy sector, particularly wind turbine production, remains resilient in the face of global trade wars. Both China and the United States play pivotal roles in driving the growth

of this sector. Wind turbine manufacturers like Goldwind and GE Renewable Energy have strategically adapted to the challenges posed by trade wars, ensuring their continued participation in this vital industry.

As the world's demand for clean and sustainable energy continues to rise, it is essential for policymakers, industry stakeholders, and companies alike to closely monitor the dynamics of global trade wars and continue to develop strategies that promote the growth of renewable energy production. This empirical study provides valuable insights for addressing these challenges and shaping the future of clean energy.

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