

## Wind Power Development and Impact on the Local Economy: International Experience and Suggestions for Vietnam



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**ABSTRACT:** In the context of the global focus on renewable energy policies, wind power development plays a crucial role in the sustainable energy transition and enhancing local economies. This paper aims to explore and analyze international experiences in wind power development, especially from leading countries like the U.S. and China, and propose lessons applicable to Vietnam. We focus on how wind power can positively impact local economies through job creation, investment attraction, and promoting sustainable economic development, while suggesting necessary policies and technical support to boost the wind power sector in Vietnam.

**KEYWORDS:** Wind power, Economic impacts, Local economy

### I. INTRODUCTION

Climate change is currently a critical issue for humanity in this century. Therefore, the development of renewable energy has become a priority for many nations globally. Among various renewable energy sources, wind power has emerged as one of the most promising and rapidly growing sectors. This study aims to explore the development of wind power on an international scale, examining its impact on the local economy, with a particular focus on drawing lessons and making feasible policy suggestions for Vietnam.

Wind energy, characterized by its low emissions and sustainability, has witnessed significant technological advancements and cost reductions, making it a competitive alternative to traditional fossil fuels [1]. Leading countries in wind power development, such as China, the United States and Germany, have demonstrated the potential for wind energy to contribute significantly to national energy supply, stimulate economic growth, create jobs, and reduce carbon emissions [1].

This research paper consists of two main parts. The first part of this article discusses the economic benefits of wind power, including job creation in manufacturing, installation, and maintenance, as well as the positive impacts on local communities through land lease payments and increased tax revenues from two world-leading countries in wind power development, the USA and China. Based on international experience, the second part offers deep insights and recommendations for Vietnam. Despite its significant potential for wind energy, Vietnam faces several challenges, including legal barriers, limited technical expertise, and infrastructure constraints. This article proposes a comprehensive strategy for Vietnam to overcome these challenges, including policy reform, financial support, and leveraging advancements in wind technology.

In summary, this study emphasizes the importance of adopting a comprehensive approach to wind power development, highlighting the necessity for supportive policies, technological innovation, and international cooperation. By learning from global experiences, Vietnam can tap into its wind power potential, contributing to energy security, economic development, and environmental sustainability goals.

### II. LITERATURE REVIEW

#### A. Wind Power

A renewable energy source called wind power or wind energy uses the force of the wind to create electricity. It entails utilizing wind turbines to transform kinetic energy—the spinning motion of blades caused by moving air—into electrical energy,

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or electricity. This calls for specific technologies, like a generator housed in the nacelle—the top of a wind turbine—behind the blades.

The total amount of economically extractable power available from the wind is considerably more than present human power use from all sources. Wind power, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, and produces no greenhouse gas emissions during operation, and the cost per unit of energy produced is similar to the cost for new coal and natural gas installations [1]. As a result, this renewable energy source is recognized as a good solution for the environment, which can help to reduce our reliance on fossil fuels and hydro energy.

### B. Wind Power Global Status

The wind power industry has become a crucial component in the pursuit of increasing renewable energy sources for many countries, driven by technological advancements and industrial growth. It now holds a central position in both long-term and short-term international energy strategies [1]. The interest in harnessing offshore wind power has seen a significant rise globally, driven by factors such as high energy demand, the global shift towards renewable resources, and the potential of wind speeds.

In 2015, global wind energy production reached 39 TWh, increasing to 42 TWh in 2016 [1]. Projections indicate that wind power capacity worldwide will increase by 143 mW in 2030, with European countries and China leading the market. Improved access to resources, funding, supportive policies, and faster project implementation could potentially add around 7 GW to this capacity.

**Table 1: Total Installed Wind Power Capacity (MW)**

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023 (pred.)
MW	435,284	486,964	539,296	589,531	649,744	748,738	846,035	934,500	1,045,942

Source: [1]

The European offshore wind energy sector, particularly in the North Sea, has experienced rapid growth in recent years, leading to large-scale commercial deployment of offshore wind farms. Plans for new wind farms in the Nordic and Baltic Seas by 2030 could result in a total installed capacity of 45 GW and 8 GW, respectively [1]. Offshore wind technology presents a promising solution for reducing greenhouse gas emissions, with projects like the Walney Extension offshore wind farm generating clean electricity for a significant number of homes.

While offshore wind farms have minimal visual and noise impacts at a distance from the shore, their influence on marine ecosystems requires further detailed analysis. Identifying large-scale offshore wind locations in the US and China, with favorable wind conditions in vast marine areas, could drive the development of mega offshore wind projects, presenting challenges for various stakeholders involved in wind energy projects.

### C. Impact of Wind Power to Economic Development

Using wind turbines reduces greenhouse gasses like CO<sub>2</sub> and emitting air pollution. Its environmental benefits are a source of motivation to the government and policies investing in constructing wind farms. Moreover, the impact of wind power on economic development is also attractive.

Apart from manufacturing energy, wind farms can be seen as business development. As other business developments, wind power also brings economical impacts on microeconomics and macroeconomics. According to De Silva et al. [2], The development of wind energy offers a different industrial trajectory for the electricity sector, which is seen as having the potential to benefit new groups of people. In contrast to traditional fossil fuel-fired power plants, which are typically concentrated in a few locations, wind farms can be distributed more widely across a region or country. This may lead to a corresponding change in the spatial distribution of employment and income, with new opportunities created in areas that are currently underserved by the traditional energy sector. As the demand for wind energy technologies and services grows, new industries and markets will emerge, creating opportunities for innovation and job creation [2], [3].

Wind power projects can help to create a more balanced and diversified local economy, which can make it less vulnerable to downturns in any one particular industry. This can lead to more stable employment levels, incomes, and tax revenues for local communities [2], [4]. The economic impact can be particularly crucial in rural areas, which tend to have a one-dimensional economy, such as agriculture [2].

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In the research of De Silva et al. [2], wind resource-rich regions are often rural areas with low population densities. Wind energy operations led to a sharp increase in fixed assets in some windy rural areas, as well as increased investment in transmission lines to carry the wind energy from rural areas to urban consumers. As a result, rural development interests and environmental groups have allied themselves to promote policies that support wind generation.

Additionally, wind projects can benefit the local economy without putting a significant strain on local and state infrastructure, such as existing water and sewer systems, transportation networks, or emergency, education, and other government services [5], [6]. Thanks to wind project's high labor-to-capital ratio, meaning that they require more workers than expensive machinery and equipment. Significant economic impacts of the wind industry include payments to local landowners, short- and long-term job creation, and spending on goods and services in supporting industries [5]. All phases of wind development bring increased economic activity to the local area. During the planning stage, wind developers may need to hire local businesses to provide services such as legal services, environmental impact assessments, and engineering work [2], [6]. During the construction phase, wind farms typically create a large number of short-term jobs, such as construction workers, truck drivers, and equipment operators [6]. Additionally, nonlocal workers who come to town to work on wind farms often stay in hotels and eat at restaurants, which can benefit the local hospitality industry [6].

Once a wind farm is operational, it creates a few long-term jobs, such as turbine technicians and maintenance workers. Wind farms also generate ongoing revenue for local governments through property taxes [4]. Overall, the wind industry can have a significant positive impact on the local economy by providing income to landowners, creating jobs, and supporting local businesses.

### **III. INTERNATIONAL EXPERIENCE**

#### **A. United States**

In 2022, China was the country with the largest wind energy output, around 824 terawatt hours. The United States ranks second which was half the output of China [1]. Wind power has been developed rapidly and played an important role in supporting growth in the United States since 2011 [7]. Brown et al. [3] indicated that: Wind power development has necessarily influenced employment, income, expenditures and property taxes. Moreover, it has also affected agricultural production due to wind turbines which displaced other uses of land. They presented that the annual personal income increased about \$11,000 per megawatt of wind capacity installed during the model period, and the average aggregate increase at the county level employed 0.5 jobs per megawatt. Therefore, the average increase in the county's total personal income and employment was 0.22% and 0.4%, respectively, for counties with wind installations between 2000 and 2008.

In America, Texas produces more than 92 Terawatt-hours of electricity, surpassing the combined output of the next three leading states (Iowa, Oklahoma, and Kansas) [8]. Despite being the leading state in wind-generated electricity, wind energy contributes only 20% to Texas' overall electricity production. Texas is recognized as one of the most promising states for wind power in the United States. In 2011, two large wind energy projects completed in Texas between 2005 and 2008 with a capacity of nearly 1398 MW were estimated to have generated 680 on-site construction jobs and 4100 total construction jobs in Texas [4]. Additionally, 63 on-site jobs and a total of 350 jobs were created annually throughout the project implementation across the state. The total economic output for the entire state from this level of wind energy development is estimated at around \$1.8 billion (or \$1.32 million per MW of installed capacity) assuming a 20-year operational period for these facilities [4]. Furthermore, the counties within the scope of this project also experienced an increase in employment and overall economic output. However, according to De Silva et al. [2], they showed that wind energy development has an impact at the industry level, however, it does not have a statistically significant impact on net employment in general at the county level. Additionally, using land to install wind turbines and build wind power plants helps increase the personal income of landowners. And when the property tax base increases, there is a reduction in county general tax rates while counties have more tax revenue and school finance, which can help the state-level gain.

The US prioritizes short-term financial incentives, which creates uncertainty about the direction of its renewable energy development [9]. America is divided into many states which also affects policy issuance because each state has its own policy to develop wind power. The Inflationary Reduction Act (IRA) [10], extending the Production Tax Credit (PTC) and Investment Tax Credit (ITC) for wind projects through 2024 were enacted in August 2022. Moreover, the IRA invests in climate and energy for America by increasing credit amounts and having bonus tax incentives for PTC and ITC for projects that meet specific requirements.

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## **B. China**

China is currently the world leader in wind energy, boasting the largest installed capacity globally with 334.98 GW of onshore wind power and 30.46 GW of offshore wind power installed by the end of 2022, according to IRENA [11]. This immense capacity significantly contributes to the global total and demonstrates China's commitment to leading in renewable energy sources. The country focuses on developing wind power in regions with abundant wind resources, such as Inner Mongolia, Xinjiang, and Gansu, as well as offshore areas along the eastern coastline [12], [13]. The rapid growth achieved can be attributed to substantial government investment, supportive policies, and technological advancements.

Research by Xia, F. and Song, F. [14] and Zhao et al. [15] emphasizes the critical role of government policies in promoting wind energy development. Policies such as feed-in tariffs, direct subsidies, and tax incentives have proven effective in encouraging investment from both private and state-owned enterprises [15]. Studies by Xia, F. and Song, F. [16] indicate that wind energy development has positively impacted local economic growth in China's construction and service sectors. However, wind power projects have been shown to reduce local revenue, a consequence of China's tax reductions encouraging businesses to invest in wind power installation.

Despite significant achievements, China's wind power sector faces numerous challenges. Issues related to grid integration, including the curtailment of wind power due to insufficient grid capacity, remain significant obstacles. Research by Q. Yang et al. [17] on the environmental impact assessments (EIA) of wind projects suggests that better planning and consideration of ecological impacts are necessary to ensure sustainable development.

China's experience underscores the importance of comprehensive policy frameworks that support the entire lifecycle of wind power development, from manufacturing and installation to operation and maintenance [18]. Moreover, the shift towards offshore wind power is seen as a strategic move to exploit untapped wind resources without the land use conflicts associated with onshore wind farms.

## **IV. SUGGESTIONS FOR VIETNAM**

### **A. Financial Support**

To develop wind power, the United States and China have implemented flexible and appropriate investment, tax, and fee support policies. In China, a Feed-In Tariff (FIT) mechanism and tax reductions have been applied to encourage private enterprises to collaborate with the government [15]. In the EU and the US, cost competitiveness has been achieved, which is a crucial factor for the growth of wind power, as it is often cheaper than any other power generation source [19]. Therefore, to develop wind power in Vietnam, the government should establish a flexible market for the production and consumption of wind power, where renewable energy sources will be more cost-effective and resource-efficient than currently.

### **B. Research and Application of Suitable Wind Power Technology**

The US, China, and EU countries are leaders in researching, developing, and providing renewable energy technologies, including wind power. China is also the world's largest wind turbine manufacturer, according to the Global Wind Energy Council (GWEC) [1]. To achieve this, the US and China have implemented strategic support policies for the development of wind power technology production and installation [15], [20]. Besides research, improving wind power technology is also a focus for these countries. This is because technical issues often arise after some time of use, and without a replacement process, the operation of wind power plants would not be guaranteed. As Vietnam is still a developing country with limited capital and technology for the wind power production sector, it is necessary to apply the wind power achievements of developed countries in a way that suits Vietnam's resources.

### **C. Development of Policies, Laws, and Simplification of Procedures**

To develop wind power, the governments of China and the US have established policy and legal frameworks that include specific support policies for renewable energy development, pricing mechanisms, and taxes [15], [20]. Currently, in Vietnam, the legal procedures for licensing wind power projects are very complicated, and the pricing and policy mechanisms for buying and selling wind power to producers and consumers still face many difficulties [21]. Therefore, the Government of Vietnam should develop a policy and legal framework to support wind power development. Additionally, it should simplify the process and eliminate unnecessary procedures to support businesses investing in the wind power sector [22].

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## V. CONCLUSIONS

In conclusion, this research has methodically investigated the field of wind power development and its complex effects on regional economies, with a particular emphasis on drawing practical conclusions and approaches that are relevant to the Vietnamese situation. We have identified the critical role wind energy plays in guiding economies toward sustainable growth, energy security, and environmental preservation by investigating the global wind energy landscape. The results of this study provide Vietnam, a nation with significant wind energy potential, with a guide for utilizing this renewable resource. The obstacles noted—such as lack of technical expertise, infrastructure constraints, and regulatory barriers—can be overcome. Quite the contrary, they offer chances for public-private partnerships, capacity building, and policy reform. The recommendations outlined advocate for a comprehensive approach that encompasses policy reform, financial incentives, and technological adoption, underpinned by a collaborative effort between the government, industry stakeholders, and the international community.

The strategic implications for Vietnam are clear: by embracing the lessons learned from global wind power development, Vietnam can not only meet its energy needs but also catalyze economic development, job creation, and environmental sustainability. The transition to wind power represents more than just an energy shift; it is a commitment to a sustainable future, where economic growth and environmental stewardship go hand in hand.

As we look towards the future, it is evident that the journey of integrating wind power into Vietnam's energy mix is both promising and essential. The path forward requires concerted efforts, innovative policies, and a steadfast commitment to sustainability. This research not only contributes to the academic discourse on renewable energy but also provides a practical framework for policymakers, industry leaders, and communities to navigate the complexities of wind power development. Ultimately, the successful implementation of the suggestions put forth can position Vietnam as a leader in renewable energy in Southeast Asia, setting a precedent for sustainable development and economic resilience.

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