Nearshore and Offshore Wind Energy - Potential and Challenges in Vietnam

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***Abstract*—Energy demand for development is increasing worldwide, while fossil energy resources are gradually becoming exhausted, and their use has many negative environmental impacts. The exploitation of potential renewable sources to reduce dependence on fossil fuels is one of the key strategies for national development. Vietnam has a coastline of more than 3000 km, and has a marine area of more than 1 million km^2, with many locations having average wind speeds exceeding 6m/s. The Vietnamese Government's National Power Development Plan for the period from 2011 to 2020 with the outlook to 2030 provides for an increase in installed wind power capacity to around 1 GW by 2020 and to 6.2 GW by 2030. However, insufficient human resources trained in the field of wind power and high investment costs for equipment imported from abroad are among the biggest barriers to wind power development in Vietnam. This paper will discuss the potential and challenges of near and offshore wind energy in Vietnam.**

Keywords-Nearshore and offshore wind energy; wind power; Vietnam.

I. INTRODUCTION

Vietnam has a coastline of more than 3,000 km and a marine area of more than 1 million km^2. The population of Vietnam has increased significantly over the past decades, and now stands at over 96.5 million people [1]. In 2019, Vietnam's economy continued to show fundamental strength and resilience, supported by robust domestic demand and export-oriented manufacturing. Real Gross Domestic Product (GDP) grew by an estimated 7 percent in 2019, similar to 2018, one of the fastest growth rates in the region [2]. Rapid urbanization has also occurred from 2005 in the country [3]. Population growth coupled with increased demand for goods and services, rapid urbanization, and rapidly growing economic activities in the industrial and service sectors are putting pressure on energy sources in Vietnam. According to [2], electricity consumption in Vietnam has tripled over the past decade. Vietnam's power demand is forecasted to increase 8.7%/year on average in the National Power Development Plan (Revised PDP VII), which has replaced the PDP VII in the period of 2016 - 2030. In the coming years, the socio-economic development in Vietnam would require a substantial amount of energy. The projection of future energy demand in Vietnam by [4] is shown in Figure 1.

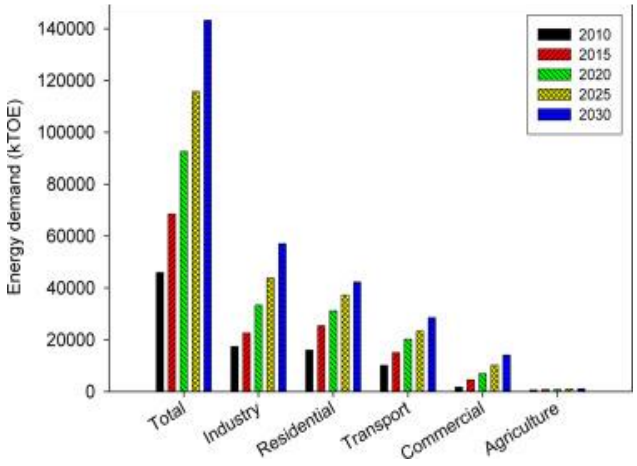

Figure 1. Projection of energy demand in Vietnam [4]

Because of increasing reliance on fossil fuels, the power sector itself accounts for nearly two-thirds of the country's greenhouse gas emissions [2]. Vietnam has a young and fast-growing economy and has put effort into tackling climate change issues at both a national and international level [5]. The Government is promoting the development and use of renewable energy sources, especially wind power, in its strategy to increase domestic energy supply and reduce dependence on fossil fuels. This will contribute to ensuring energy security, climate change mitigation, environmental protection and sustainable socio-economic development. Furthermore, an adequate and reliable energy supply is a necessary prerequisite for sustaining the economic development of the country. Despite the advantage of geographic location and governmental policies in promoting the development of near and offshore wind power, wind power has a long way to go to achieve its potential in Vietnam. The rest of the paper is structured as follows. In Section II, I discuss the potential and challenges of near and offshore wind energy in Vietnam, and offer some conclusions in Section III.

II. POTENTIAL AND CHALLENGES OF NEAR AND OFFSHORE WIND ENERGY

A. Opportunities and potential

Vietnam has an advantage of geological location for wind power development. It has a coastline of more than

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3,000 km and a marine area of more than 1 million km^2 [1]. The country's sea region has a huge potential for wind energy resources in offshore waters of up to 30m in depth (with an area of 111,000 km^2), and in water of between 30m and 60m in depth (142,000 km^2 in area), which have a potential capacity of producing 64,000 GW and 106,000 GW, respectively. One of results reported in [6] shows that the installed capacity potential is up to 38 GW in only the waters around each Phu Quy or Bach Long Vi island. The coastal area of Binh Thuan - Ca Mau provinces is the most promising region with a potential wind-powered generating capacity of almost 1000 W/m^2 [7]. It was also said that this area has 6 locations with the highest wind speeds (average wind speed of 10 m/s), each with a potential of 1,000 MW and has the advantage of not taking up land, which is a main concern in Vietnam [8]. It is considered one of the regions with high potential globally. Wind farms have been deployed in this region with a total capacity of 1 GW and are expected to be 9 GW in 2030 [7]. In addition, other researchers [9] used a numerical Weather Research and Forecast (WRF) model for studying offshore wind power potential along the southern coast of Vietnam and concluded that the southern coastal area of Vietnam is characterized by strong seasonal and spatial variability in both wind speed and direction. The authors of [9] also indicated that the offshore areas of Ninh Thuan and Binh Thuan provinces are likely to have the largest wind power potential, though still with strong seasonal variation. A recent study [6] reported that wind within 0–185 km from shore throughout Vietnam has the technical potential to generate at least 500 - 600 GW. A wind mapping for Vietnam in 2019 was published by [10]. The technical potential for offshore wind in Vietnam is shown in Figure 2.

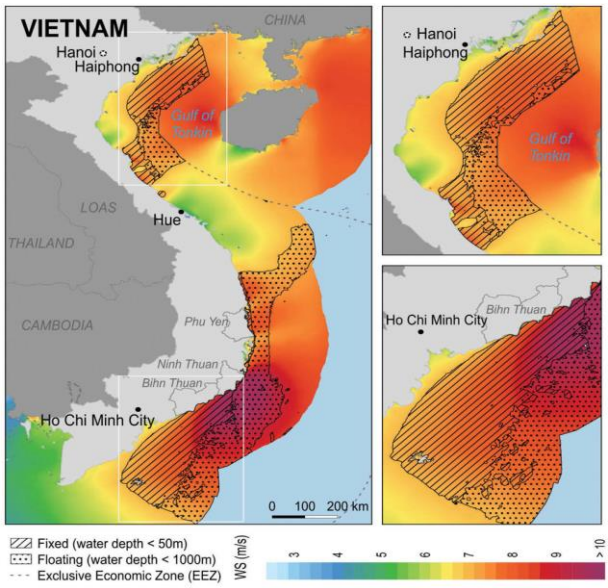

Figure 2: Technical potential for offshore wind in Vietnam [10]

Recognizing this potential, the Government of Vietnam has also issued decisions and policies to promote development in this field, including Decision 1208/2011/QĐ-TTg issued by the Prime Minister on July 21, 2011 approving the National Electricity Development Plan (PDP VII) for the period 2011-2020 with consideration to 2030. In this Decision, the installed wind power capacity needs to increase to around 1 GW by 2020 and to 6.2 GW by 2030 [11]. After the Decision singed in 2011, Decision No.2068/QĐ-TTg was issued by the Prime Minister on November 25, 2015 approving the Renewable Energy Development Strategy (REDS) to diversify the energy supply of Vietnam to the year of 2030, with a vision for 2050 [12]. The REDS emphasizes that the output of electricity produced from wind power will increase from about 180 million kWh in 2015 to about 2.5 billion kWh by 2020; about 16 billion kWh in 2030 and about 53 billion kWh in 2050. It would raise the proportion of total electricity production from wind power from the current negligible level to about 1.0% by year 2020, about 2.7% in 2030 and about 5.0% in 2050. This decision is one of strategies to encourage investment and development of wind power in Vietnam. An example for this is that Vietnam is among leading countries in developing offshore wind power in Asia: China (2.4 GW), Vietnam (0.2 GW), Japan (0.04 GW), South Korea (0.04 GW) and Taiwan (0.008 GW) [13]. In addition, because of Vietnam's wind potential and electricity demand, the Prime Minister issued Decision 39/2018/QĐ-TTg on September 10, 2018 to create a preferential FIT (Feed-in-Tariff) price mechanism to encourage the development of energy types. Currently, the purchase price for onshore wind power according to this Decision is 1,927 VND per kWh, equivalent to 8.5 cent per kWh (excluding VAT), while offshore is 2,223 VND per kWh, equivalent to 9.8 cent per kWh (not including VAT) with projects operating before November 1, 2021 [14]. This Decision has created a new momentum for the wind power market in Vietnam and attracted a series of wind power development projects. As reported by [15], until March 2020, Vietnam had 78 wind power projects with a total capacity of about 4.8GW, which were added to the planning; 11 projects (with total capacity of 377MW) have been operating and generating electricity; 31 projects (total capacity of 1.62GW) have signed power purchase agreements and are expected to be put into operation in 2020-2021. In addition, a further 250 projects with a total capacity of about 45GW have been requested as part of the electricity development plan for Vietnam.

B. Difficulties and challenges

There are many difficulties and challenges for near and offshore wind power development. First, lack of human resources trained in the field of wind power is one of the biggest difficulties and challenges in wind power development. On one hand, Vietnam has a wind power project that has been in operation for nearly a decade, and it also has projects that cooperate with international organizations in assessing wind power potential. Consequently, human resources in Vietnam have had the opportunity to access wind energy technology since then (from the wind measurement campaign, detailed design, etc), and currently many wind power projects have been in

operation and are under construction. Nevertheless, Vietnam still lacks contractors with experience in installing, repairing and maintaining equipment. Several short-term training courses providing basic knowledge of wind turbine technology and key steps involved in developing wind power projects in Vietnam have been organized mainly at Hanoi University of Science and Technology and Ho Chi Minh City University of Science and Technology. However, there are no specialized majors in the field of renewable energy in general, or wind power in particular, at universities and colleges in Vietnam. Lecturers in this field are lacking and curricula are also limited, creating a shortage of human resources for wind power technology. In addition, shortages of skilled human resources for implementing complete wind power projects including, for example, carrying out assessments of wind resources, preparing investment reports, etc., basic technical and maintenance services, operation and management after installation of wind turbines, are also barriers for development of wind energy in Vietnam [4]. Training and raising professional qualifications for managers, technicians, and skilled workers for wind energy projects should be a priority. An initial step might be to encourage the establishment of specialized energy associations and organizations such as, for example, the Vietnam Wind Power Association and the Renewable Energy Organization, with the participation of experts from prestigious foreign organizations, universities, and research institutes. This mix of expertise could provide advice to the Government and further promote the development of the wind power industry in Vietnam. Second, high investment costs for wind power projects are also among the biggest barriers to wind power development in Vietnam. A successful wind power project often requires a sizable investment in infrastructure and current costs are about 2,500 USD/kW on average, which is equivalent to more than 50 million VND/kW. An example for this is that the Bac Lieu wind power project has had a total investment of about 5,300 billion VND for a total capacity of about 99.2 MW, implemented by Cong Ly Construction - Trade & Tourism Co., Ltd from 2010 to present. This project is supported by an USA bank through a loan guaranteed from the Vietnamese Government. Another difficulty is that wind power technologies are imported from abroad. Wind turbines and other related equipments used for most wind energy projects in Vietnam must be imported from countries such as the USA, Germany, Denmark and so on. In Vietnam, we mainly construct the foundation base and the parts connected to the turbine such as culverts, electrical systems, etc. Therefore, wind power projects depend almost entirely on foreign technology. The Vietnamese government should provide investors with a good opportunity to manufacture wind power equipment so that they can set up factories in Vietnam, or assemble them in Vietnam. This could be done through incentives such as a reduction in tax on assembly of wind power equipment in Vietnam. This would reduce dependence on foreign technology and help reduce the cost of purchasing equipment for wind power generation. Other difficulties and challenges include slow land clearance and a long distance to connect to the power grid [16]. There are also other challenges to wind power development. Environmental problems related to wind power plants such as noise from the turbine blades affecting the daily activities and behavior of animals such as birds, etc. have also been reported [17][18]. Another potential issue is how to dispose of outworn parts of wind turbines safely and without causing environmental pollution. Apart from environmental problems, the connection of wind power plants to any electrical system has impacts on the electricity quality such as variations in voltage, overload in the network, flickers, harmonics, voltage dips, etc. [19]. So, they are also challenges to wind power development in Vietnam in the future. In addition, Vietnam is a developing country and its laws and policies for renewable energy are not stable. This could discourage private and public investment in wind-powered energy projects. For example, [20] reported that from 2007 to 2017, the many Decisions and Circulars for wind energy development promulgated by the Government have hindered the development of wind power projects in Vietnam. More recently, the Decision 39/2018/QĐ-TTg issued on September 10, 2018, as mentioned above, creates a preferential FIT pricing mechanism to encourage wind power development as well as attract more investors, but it also creates difficulties for investors with wind power projects operating after November 1, 2021. According to the proposal of the Ministry of Industry and Trade of Vietnam [15] to the Prime Minister, the wind power purchase and sale price for the projects in operation from November 2021 to December 2022 will be 7.02 cents per kWh for onshore wind power and 8.42 cents per kWh for offshore or nearshore wind power. For projects operating in 2023, the prices are 6.81 and 8.21 cents per kWh, respectively. At present, the impact of the COVID-19 virus is affecting the turbine supply progress, prolonging construction and installation time and slowing down the progress of wind power projects. The production and supply of key equipment, components and accessories of wind power projects are also in shortage and stagnation. The interruptions of the import and export of goods, immigration of technical workers and foreign experts, etc have had negative impacts on enterprises. Investors will face financial difficulties and many influences from Covid-19 if wind power prices fall. They will also encounter the early stage market and the risks of Government's wind power planning adjustment. These could significantly reduce new wind power installations in 2023 and next years.

III. CONCLUSION

The potential for wind power in Vietnam is huge, but it is a relatively new field. Although the Government has issued a range of policies and strategies to develop this energy source, there are still many barriers to the development of this field such as, for example, insufficient human resources, dependence on overseas technology, high investment capital, etc. Developing training programs in this field in universities and research institutes is necessary. Turbines and other related equipment (electrical engine, tower, etc) typically account for a large portion of the total cost of wind power projects (farms). Assembling or manufacturing partly or fully the equipment at domestic factories will help reduce

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dependence on foreign technology and will reduce costs. Moreover, to implement a successful wind power project, it is necessary to have timely financial support from reputable domestic or international credit institutions and the Government.

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