© Universiti Tun Hussein Onn Malaysia Publisher's Office

PAAT

http://publisher.uthm.edu.my/ojs/index.php/paat

e-ISSN : 2821-2924

Progress in Aerospace and Aviation Technology

Feasibility Study of Offshore Wind Wheel Installation in South China Sea at Malaysia

NurFatin Nasyitah Mat Tarmizi[1], Nurhayati Rosly[1*]

[1]Department of Aeronautical Engineering, Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia, 84600, Batu Pahat, Johor, MALAYSIA

*Corresponding Author

DOI: https://doi.org/10.30880/paat.2023.03.02.005
Received 9 November 2023; Accepted 19 November 2023; Available online 14 December 2023

Abstract: As the global demand for renewable energy continues to rise, it becomes crucial to investigate the viability of offshore wind power generation. This paper presents a comprehensive feasibility study assessing the viability of the South China Sea wind turbine installation. This study will describe the current situation of wind energy across the world and specifically discusses offshore wind farm technology. The study begins with a comprehensive literature review emphasizing the significance of wind power in mitigating climate change and reducing reliance on fossil fuels. The objectives of this are to study on the availability of offshore wind resources in Malaysia and to analyze the effect of micro-siting towards wind farm energy production and performance. This study indicates the best sites to set up offshore wind farm in Malaysia. According to the data, Mersing has a favorable availability of wind resources, which makes it the best place to put the turbines. Critical review for better understanding about the importance of micro-siting of wind farms social and economic was conducted. The micro-siting technique is helpful since it provides a methodical and well-informed way of choosing a location. It helps decision-makers strike a balance between the project's, the community's, and the environment's demands by considering various elements and tailoring the analysis to the particulars of a certain project. As technology and methodology evolve, the micro-siting approach will become more important in attaining sustainable and efficient development.

Keywords: Renewable energy, wind, micro-siting

1. Introduction

Various causes, including increasing energy usage and the limitations of resources such as fossil fuels, have resulted in global demand for better alternative energy sources [1]. Considering that these resources damage the environment and have dangerous side effects like global warming, there is a major market for producing alternative energy sources. Renewable energy is defined as energy that can be produced from clean sources such as the sun, wind, and waves. Developing new energy, which is gaining popularity in the energy production sector, may benefit optimizing the sustainability of our energy system worldwide since environmental pollution and its related risks can be avoided. The benefits of offshore wind energy include safety, no pollution, renewability, large reserves, widespread distribution, and no exploitation of natural resources [2]. Wind power generation is the main method for using and utilizing wind energy resources. It also has been extensively employed in irrigation, wind heating, ship navigation, water pumping, and other projects [3], and it will play a significant role in the world's energy supply.

Many countries, including Germany, Greece, India, China, Turkey, Taiwan, Thailand, and others, have conducted various assessments of the potential for wind energy [4]. Thus, Malaysia is involved in utilizing the potential of wind energy as a sustainable energy source that has many advantages for our country. Fossil energy resources, including natural gas, coal, and crude oil, are abundant in Malaysia. Additionally, the country has renewable energy sources, including solar, wind, biomass, biogas, and others.

*Corresponding author: nurhayati@uthm.edu.my

For centuries, we have been using fossil fuels to generate powerful energy. The fuels such as coal, oil, and gas are burnt to produce steam that works the turbines, producing electricity. This process is being used to generate electricity all this while. However, burning carbon fuels will produce a massive amount of carbon dioxide, which causes many harmful effects such as climate change, acidic rain, and air pollution, which we inhale every time [5].

The method used in this research is to collect wind speed data from the Malaysian Meteorological Department at a certain location in the South China Sea. The information is also obtained as a case study from other publications. In this research, the data from 2013 until 2022 will be used. The data will be analyzed to determine whether the location has the potential for wind energy. The feasibility of installing wind turbines in the South China Sea will be explored more in this research.

This study will describe the current situation of wind energy across the world and specifically discusses offshore wind farm technology. Subsequently, the feasibility of wind wheel installation in the Malaysia will be investigated at three different locations. Analysis was conducted to assess the potential wind energy in the Mersing, Kerteh and Kuala Terengganu. The results of this study improve knowledge of wind energy potential as well as the Malaysia up to potential future of the renewable energy development.

2. Method

To know the feasibility of wind turbine installation, we must first determine the potential area for this project. As the wind turbine relies on air energy to function, the wind measurements are required to determine the most appropriate areas. Wind data is critical in this project since it is the foundation for the wind turbine to function properly.

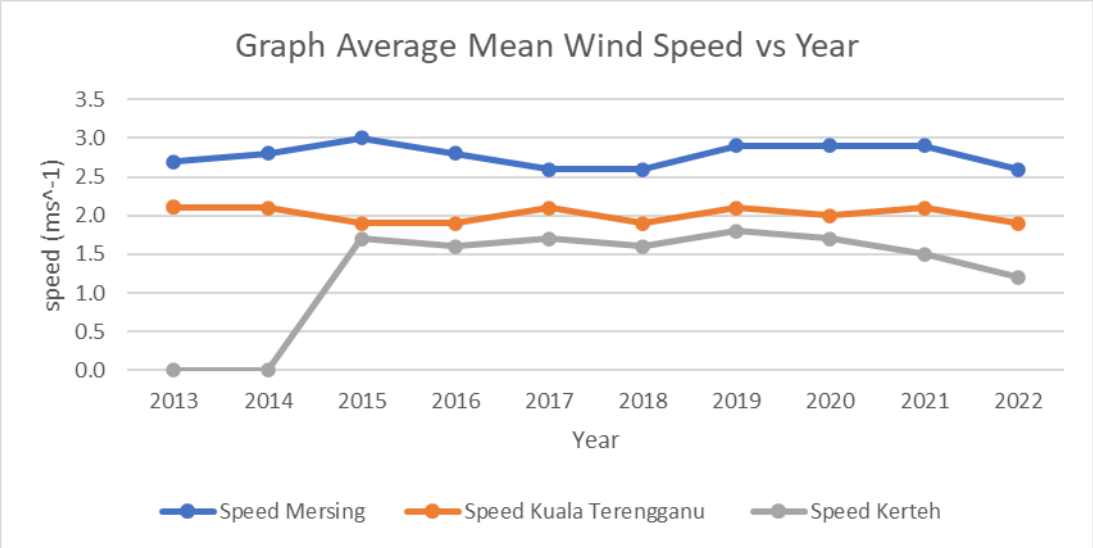
Data and information were obtained from the Malaysian Meteorology Department. Data and information were systematically gathered from this source. The application was granted with a letter of support from the Facuty of Mechanical and Manufacturing Engineering at Universiti Tun Hussein Onn Malaysia (UTHM). Data and wind speed information were obtained from Mersing, Kerteh and Kuala Terengganu stations.

The whole micro-siting procedure relies heavily on measurement data, which are often few or not easily accessible. Due to their high geographic resolution, the wind rise calculated from the numerical weather forecasting model may significantly assist this circumstance (Mekhilef et al., 2012). When the terrain is highly heterogenous, the entire wind pattern and wind shear vary considerably over a few meters of horizontal distance. In such circumstances, measurement becomes nearly impossible. A high-resolution computer model can provide the solution (Mekhilef et al., 2012). The critical review can know the strengths and weaknesses of this method and suggest the best method to optimize the wind turbine installation process.

3. Result and Discussion

3.1 Data Analysis

Wind data is crucial before determining the ideal location for a wind turbine installation. The wind data were used as the input for micro siting to determine the feasibility of wind turbine installation. In this study, wind data was obtained from three distinct locations. based on the scope of the study, a feasibility analysis of the wind energy potential in the South China Sea will be conducted. This research focuses on the regions of Mersing, Kuala Terengganu, and Kerteh. The wind data obtained from the Malaysian Meteorology Department are displayed below. All three study locations were where the Malaysian Meteorology Department stations were located.



Graph 1 - Average mean wind speed vs year

Based on the analyzed data, it can be concluded that Mersing is the most suitable location for this research. This determination is based on the graph average mean wind speed versus year. From the graph, we can see Mersing consistently experiences highest prevailing wind speed compared to other two locations studied. Mersing exhibits the highest average wind speeds annually and the highest among all other areas. These findings show that Mersing is the ideals places to install horizontal axis wind turbines due to its high prevailing wind.

Due to the prevailing wind flowing from that direction, facing southwest is the optimal position for the wind turbine to align with the direction of the prevailing wind. By doing this, the wind turbine can perform its best. The more electricity a wind turbine can generate, the more effectively it operates. In conclusion, the wind turbine must accurately point towards the winds source to produce the most energy.

3.2 Critical Review on Micro-Siting

The micro-siting approach is crucial for locating the exact position for the maximum performance of each wind turbine in the wind farm. Recently, it has been recorded complaints of external and internal WTG damage and fracture and WTGs with noticeably low power production have appeared, indicating that the utilization rates of WTGs on wind farms located on challenging terrain fall short of expectations (Rosly et al., 2012).

Table 1 - Study case summary of micro-siting

STUDY CASE 1	STUDY CASE 2	STUDY CASE 3	STUDY CASE 4	STUDY CASE 5
• Use RIAM-COMPACT Software	• Using teaching-learning based optimization method WEPAS software	• Follow standard 3D-5D theory	• Use PSO algorithm	• Use Multi Criteria Decision Method (MCDM)
• To determine whether wind turbines in a wind farm subjected to wind hazard.	• Aims to maximise electricity output and minimize cost	• To propose innovative micro-siting design for wind farm on flat ground	• To maximize energy extraction while considering variables.	• Propose for optimizing the configuration of offshore.
• Have space constraint	• Optimized layouts	• Penalty function approach	• Penalty function approach	• Technical and regulatory aspects need to be considered
• The software is costly	• Optimize wind farm size and reduce land costs.	• Applicable to onshore and offshore	• Number of constraints affect the energy generation of	• Limited for few new parameters study.

		the wind farm	
• No need numerical equation for method.	• Comparison made with previous study	• Compare current study with Grady`s study	• RM and WPM techniques to identify the optimal position

Micro-siting is essential for the site selection and planning for a wide range of projects, particularly those related to renewable energy. It requires considering wind patterns, terrain, environmental effect, and public opinion. Micro-siting raises several difficulties that must be handled appropriately. Micro-scale wind resources evaluation and forecast may be challenging and need sophisticated modelling methods. Furthermore, the effectiveness of micro-siting initiatives may be significantly affected by the availability and quality of data on wind patterns.

4. Conclusion

Consistent wind patterns, particularly during monsoon seasons, make Malaysia a good candidate for developing its wind energy potential. Studies also show that Malaysia can create significant power from wind energy, making it a viable renewable energy option. Wind resources in Malaysia are comparatively restricted compared to those found in other countries. The wind speeds in coastal areas of the country are lower due to our geographical location and topography. The accessibility and reliability of wind resources plays a pivotal role in determining the economic feasibility of wind energy initiatives.

Acknowledgement

The authors wish to thank to the Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia that has supported on the accomplishment of research activity.

References

[1] Sun, Y. Z., Zhang, H. J., Du, Z. C., Li, Q. X., & Li, Z. X. (2003). Organic pollution of street dust in the Handan City, China. Bulletin of Environmental Contamination and Toxicology, 70(3), 422–429. https://doi.org/10.1007/s00128-003-0003-7

[2] Junginger, M., Faaij, A., & Turkenburg, W. C. (2004). Cost Reduction Prospects for Offshore Wind Farms (Vol. 28, Issue 1).

[3] Kalogirou, S. A. (2005). Seawater desalination using renewable energy sources. Progress in Energy and Combustion Science, 31(3), 242–281. https://doi.org/10.1016/j.pecs.2005.03.001

[4] Paul, S. S., Oyedepo, S. O., & Adaramola, M. S. (2012). Economic assessment of water pumping systems using wind energy conversion systems in the southern part of Nigeria. In Energy Exploration & Exploitation · (Vol. 30).

[5] Lu, X., & McElroy, M. B. (2017). Global Potential for Wind-Generated Electricity. In Wind Energy Engineering: A Handbook for Onshore and Offshore Wind Turbines (pp. 51–73). Elsevier Inc. https://doi.org/10.1016/B978-0-12-809451-8.00004-7

[6] Rosly, N., Ohya, Y., & Uchida, T. (2012). Micro Siting and Wind Energy Potential in Mersing, Malaysia Using RIAM-Compact. https://doi.org/10.13140/2.1.2148.0967