EVALUATING WIND SPEED CHARACTERISTICS IN TANJUNG SEDILI, MALAYSIA THROUGH WEIBULL DISTRIBUTION

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ABSTRACT

Due to its location in a low wind speed region, Malaysia has yet to acknowledge and utilize the wind energy as a potential renewable energy source. The viability of a chosen location can be determined with the wind speed analysis. Therefore, the aim of this study is to conduct an analysis using MATLAB for the selected location in Malaysia. Wind speed measurement were taken at Tanjung Sedili, Johor over a period of three months. The wind speed data will undergo post-process analysis and wind frequency assessment by using Weibull distribution. The average wind speed over the three months is approximately 3 m/s which is relatively low and not suitable for conventional wind turbine design. The shape parameters, k for Weibull distribution estimated for the three months are 2.135, 2.06, 2.09 indicating that the distribution curve is broader and exhibit greater variability. With careful consideration and planning to maximize energy production, Malaysia has the potential to exploit a fair amount of wind energy, contributing to the energy mix in the future.

KEY WORDS

Wind energy; MATLAB; Weibull Distribution.

1. INTRODUCTION

Wind energy has experienced significant growth over the past few decades worldwide. However, Malaysia has yet to recognize and utilize its potential as a renewable energy source, primarily due to its geographical location near the equator, which classifies it as a low wind speed region. In recent years, Malaysia has accelerated efforts to reduce its dependency on fossil fuels and expedite the transition to renewable energy in order to achieve net zero emission by 2050. According to the Malaysia National Energy Transition Roadmap 2023, wind energy is not listed as one of the potential components of the country's energy mix[1]. This omission may be attributed to the past installation of wind turbines[4] in Malaysia which were deemed as lack of success and resulted in unreturned investment. Major obstacles lie not only on the resources but also on the lack of site assessment prior to installation. Reliable wind resource analysis is a crucial factor yet often overlooked during the wind turbines installation process. The objective of this study is to conduct an analysis using MATLAB for the chosen location in Malaysia that can be categorize as low wind speed.

2. METHODOLOGY

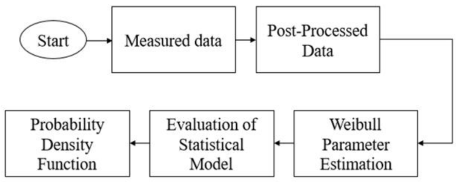

Figure l: Flowchart of the study

To gain a deeper understanding on the wind resources of the chosen location, it is required to measure wind speed data directly over a specified period[3]. Highly reliant on the data from the meteorological department can introduce uncertainty due to extrapolation error and changes in topography. Wind speed was measured using a cup anemometer fixed on top of the 10 m mast, with readings taken at with one-minute intervals as shown in Figure 2. The study was conducted at Tanjung Sedili, Johor which is placed facing an open sea over a period of three months from June until August. MATLAB is an exceptional tool for site assessment analysis due to its capability to process large datasets such as wind speed measurements. The collected data underwent post-processed analysis that include the determination of mean wind speed in monthly basis, maximum wind speed in each month and extrapolating the data to heights of 25 m and 50 m. The wind speed data will be assessed by using wind frequency distribution specifically Weibull distribution and evaluated by using Root Mean Square Error (RMSE).

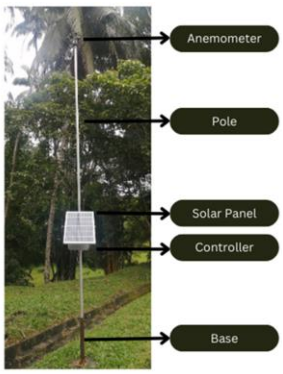

Figure 2: Wind speed logging system

2.1 Weibull Distribution
Weibull distribution is one of the distinguished methods in assessing wind resources and widely used in wind energy studies due to its flexibility that can complement with the erratic nature of wind[2]. In this study, the Maximum Likelihood Method has been used for estimation of the shape parameter, k. The probability density function can be determined as follows:

$$f(v) = \left(\frac{k}{c}\right)\left(\frac{v}{c}\right)^{k-1} exp\left[-\left(\frac{v}{c}\right)^{k}\right] \quad (1)$$

Where :
k : Shape parameter
c : Scale parameter (m/s)
v : Scale parameter (m/s)

3. RESULTS AND DISCUSSION

The wind speed data computed in the MATLAB is presented in Table 1. The average wind speed in over the three months is in the range of 3 m/s which is relatively low and not suitable for conventional wind turbine design which typically have cut-in at 5 m/s. Extrapolation to 25 m and 50 m also only results in a slight increase in the average wind speed, which the highest value calculated at 4.01 m/s. The highest velocity recorded was in June with a speed of 19.1 m/s, while the lowest is at 0 m/s which is a common occurrence especially in the low wind speed region. Wind speeds at 3 m/s accounted for up to 30% of the total wind speed duration in a month. This indicates that the wind speed in the location is inconsistent and contains a wide range of wind speeds which can also reflects the value of shape parameter, k. The shape parameters, k for Weibull distribution estimated for the three months are 2.135, 2.06, 2.09 indicating a broader distribution curve with greater variability. The evaluation through RMSE suggests that the data in July has a larger difference between the measured values and those estimated by using Weibull distribution compared to the other two months.

Table 1: Wind speed parameters for June until August

Parameter	**Value**		
	June	**July**	**August**
Mean wind speed (m/s)	3.274	3.401	3.554
Mean wind speed (m/s) at 25 m	3.523	3.669	3.825
Mean wind speed (m/s) at 50 m	3.776	3.932	4.099
Max wind speed (m/s)	19.1	17.3	14.2
Standard Deviation	1.628	1.755	1.806
Wind speed duration at 3 m/s (hr)	276.07	223.87	278.97
Shape parameter, k	2.135	2.06	2.09
Scale parameter, c (m/s)	3.70	3.85	4.01
RMSE	0.0432	0.1622	0.0447

Based on these finding, to effectively exploit wind resources, proper site assessment needs to be conducted prior to wind turbine installation. Wind turbine design should be able to cater to Malaysia's wind speed conditions emphasizing the need for a low cut-in wind speed. This should be one of the parameters that need to be considered that most of the conventional wind turbines did not have. Consequently, the matching of wind turbine systems is critical for application in low wind speed environment.

4. CONCLUSION

Due to Malaysia's classification as a low wind speed region, the utilization of wind energy has not yet been fully realized. However, these findings suggest that Malaysia possesses a fair amount of wind energy that can be exploited highlighting the significance of selecting appropriate wind turbine designs to maximize energy production.

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