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# ANALYSIS OF WIND POWER POTENTIAL IN SAMIANG BAY, KOTABARU, SOUTH KALIMANTAN

## *(ANALISIS POTENSI WIND POWER PADA TELUK SAMIANG, KOTABARU, KALIMANTAN SELATAN)*

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## ABSTRACT

*This research was conducted to determine the potential for wind power from the Tamiang Bay area, Kotabaru, South Kalimantan. This study uses data on the average daily wind speed in Tamiang Bay with latitude -4.058883°, longitude 116.050259° obtained from the European Center for Medium-Range Weather Forecasts (ECMWF). Based on the analysis using Master Equation that has been done, the average daily wind speed in Tamiang Bay is 4 m/s for a height of 10 m and 5.98 m/s for a height of 50 m. Through the assumption that using a Gamesa G114-2.5 MW wind turbine with a tower height of 80 m, in one year, the Tamiang Bay area has the potential to produce 2646.58 MWh of wind power. Thus, the Tamiang Bay area is said to be very potential for wind power development.*

*Keyword: Tamiang Bay; wind power; wind velocity.*

## ABSTRAK

*Penelitian ini dilakukan untuk mengetahui potensi wind power pada kawasan Teluk Tamiang, Kotabaru, Kalimantan Selatan. Penelitian ini menggunakan data kecepatan angin rata-rata harian di Teluk Tamiang dengan garis lintang -4.058883°, garis bujur 116.050259° yang diperoleh dari European Center for Medium-Range Weather Forecasts (ECMWF). Berdasarkan analisis yang telah dilakukan, kecepatan angin rata-rata harian di Teluk Tamiang adalah 4 m/s untuk ketinggian 10 m dan 5,98 m/s untuk ketinggian 50 m. Melalui asumsi penggunaan turbin angin Gamesa G114-2,5 MW dengan ketinggian menara 80 m, dalam satu tahun kawasan Teluk Tamiang berpotensi menghasilkan wind power sebesar 2.646,58 MWh. Dengan demikian, kawasan Teluk Tamiang dikatakan sangat potensial untuk pengembangan wind power.*

*Kata Kunci: Kecepatan angin; kekuatan angin; Teluk tamiang.*

## INTRODUCTION

Energy has an important role in the economic growth of a country (Dat et al., 2020). This has an impact on increasing energy consumption in Indonesia from 1990 to 2021 (“Indonesia Energy Information | Enerdata,” n.d.). The increase in energy consumption is certainly followed by an increase in CO2 gas emissions (Osobajo et al., 2020). In fact, according to data obtained from the United Nations Environment Program (UNEP), Indonesia has always experienced an increase in CO2 emissions from 1970 to 2018 (“UNEP Climate Action Note | Data you need to know,” n.d.). If this is ignored, the impact of global warming is inevitable.

As a form of the government's efforts in dealing with these problems, a policy related to the development of renewable energy was issued as stated in the Rencana Umum Energi Nasional (REUN) (Langer et al., 2021). The Indonesian government continues to encourage efforts to develop renewable energy in various fields because basically, renewable energy can be applied to the fields of transportation (Irawan et al., 2021), industry (Taibi et al., 2010), households (Pojani et al., 2018), and so on. In 2025, it is targeted that the use of renewable energy in Indonesia will reach 23% and increase to 31% in 2050 (Budiarto and Surjosatyo, 2021). However, in 2020 energy sources in Indonesia are still dominated by fossils by 50% and gas and oil by 35.64% (Budiarto and Surjosatyo, 2021). In response to these problems, the government is committed to continuing to encourage the use of renewable energy until it reaches the target in 2025 and 2050.

Unfortunately, the main focus of renewable energy development by the government is solar power (Langer et al., 2021) and there has been an increase in the construction of solar power capacity by 51 MW in 2015 to 159.43 MW in 2019 (Sijabat and Mostavan, 2021). In fact, wind power is no less potential to be developed in Indonesia. Indonesia has an average wind speed of 2 – 7 m/s and has the potential to develop small and medium wind power (Satwika et al., 2019). Especially on the island of Borneo, wind power is very potential to be developed (Fatchurrahman and Zakaria, 2020). Based on data obtained from the South Kalimantan Energy Outlook (2019), South Kalimantan Province will become the second largest wind farm project after North Sulawesi with a capacity of 70 MW in 2021. However, Kotabaru Regency in South Kalimantan Province is no less potential for wind power development areas because the location is close to the sea.

Therefore, this study discusses the potential for wind speed in Kotabaru Regency, especially Tamiang Bay. This time, we will describe the wind speed data in Tamiang Bay. Tamiang Bay was chosen as the research object because it is the most potential area among the 22 sub-districts in Kotabaru Regency based on a study of wind speed data. The wind speed data was obtained from the European Center for Medium-Range Weather Forecasts (ECMWF) in 2012 - 2021. The data will be analyzed to estimate the potential for wind power that can be generated by the Tamiang Bay area.

This research is expected to be a reference for readers for the development of wind power in the Tamiang Bay area.

## METHOD

This study uses data on the average daily wind speed in Tamiang Bay with latitude -4.058883°, longitude 116.050259° obtained from the European Center for Medium-Range Weather Forecasts (ECMWF). ECMWF is a research institute and operational service that is active every day to produce global numerical weather predictions and other data for Member and Cooperation Countries, as well as the wider community (Frnda et al., 2019). The coordinates of Teluk Tamiang were chosen as the data collection point because they represent Kotabaru Regency. The data used is data from 2012 – 2021 as show in Table 1.

Then, the wind power potential that can be generated is calculated based on the wind speed data that has been obtained. The potential for wind power is calculated through the power equation that can be generated by the wind turbine using the following equation.

$$W_p = \frac{1}{2}\rho A v^3 \qquad (1)$$

Where $W_p$ is wind power (Watt), $C_p$ is wind turbine efficiency, A is wind turbine area (m2), and v is wind speed (m/s).

## RESULTS AND DISCUSSION

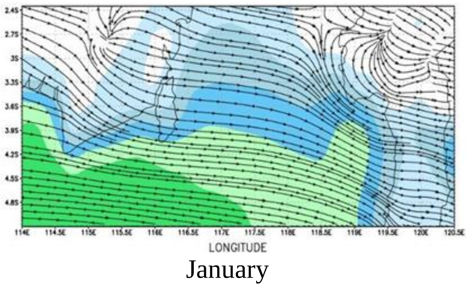
The average daily wind speed data in Tamiang Bay that has been obtained from ECMWF can be seen in Table 1.

Table 1. Average wind speed resume in Tamiang Bay

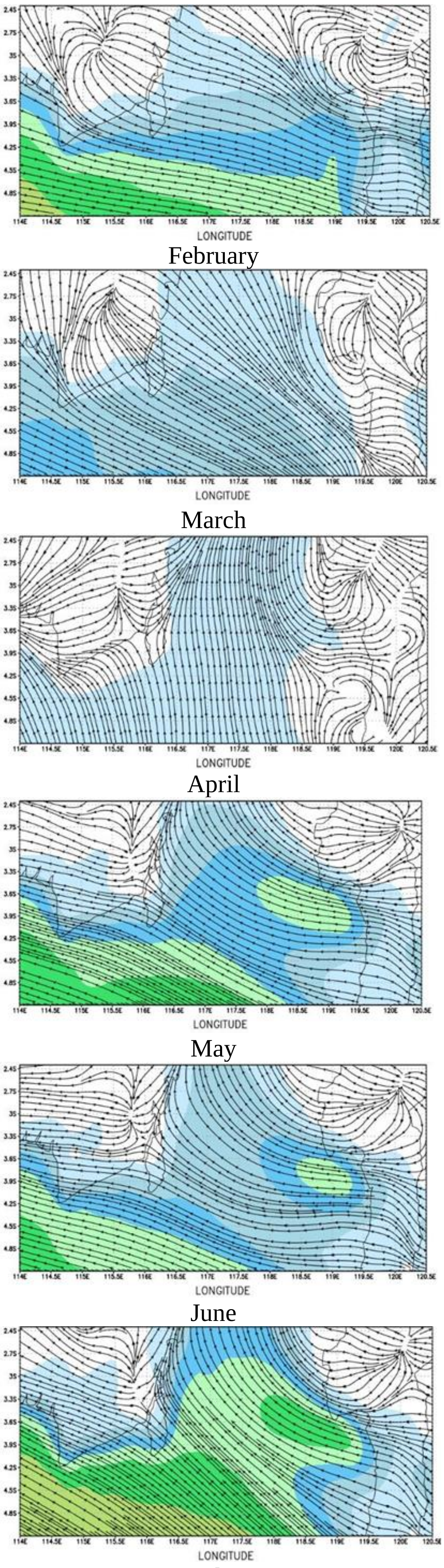
| Year | Average Wind Velocity [m/s] | |
|---|---|---|
| | h = 10 m | h = 50 m |
| 2012 | 3.96 | 5.92 |
| 2013 | 3.77 | 5.63 |
| 2014 | 4.11 | 6.14 |
| 2015 | 4.36 | 6.51 |
| 2016 | 3.22 | 4.82 |
| 2017 | 4.04 | 6.04 |
| 2018 | 4.35 | 6.50 |
| 2019 | 4.32 | 6.47 |
| 2020 | 4.10 | 6.13 |
| 2021 | 3.80 | 5.68 |
| Average | 4.00 | 5.98 |

In Table 1, it can be observed that the average wind speed in Tamiang Bay for the last 10 years is 4 m/s at an altitude of 10 m and 5.98 m/s at an altitude of 50 m. Thus, the Tamiang Bay area has the potential for wind power development. With this wind speed value, the Horizontal Axis Wind Turbine (HAWT) type can be implemented in the Tamiang Bay area (Hyams, 2012). Horizontal Axis Wind Turbine (HAWT) is recommended over Vertical Axis Wind Turbine (VAWT) because HAWT has higher efficiency.

Then, the direction of wind speed in Tamiang Bay in 2021 can be seen through the wind speed contour in Figure 1.




January



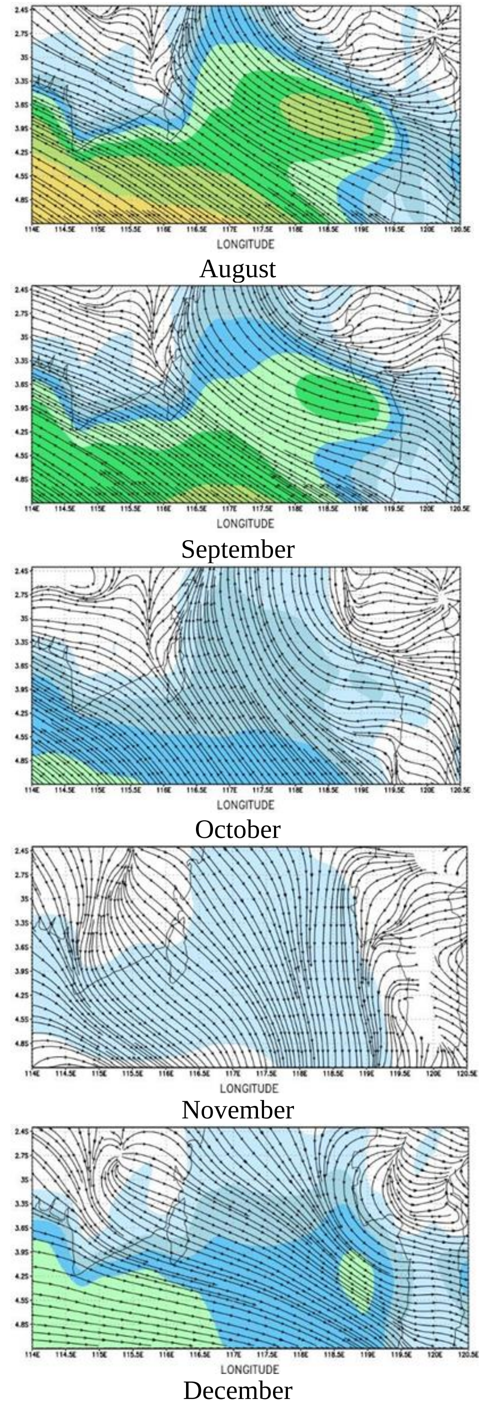




Figure 1. Wind direction contour in Tamiyang Bay in 2021.

Based on the wind speed contour above, it can be observed that the direction of wind speed in one year in Tamiang Bay tends to be the same. HAWT has a dependence on wind speed direction (Simley et al., 2016). The direction of wind speed in the Tamiang Bay area tends to be constant throughout the year. This is because the geographical position of Tamiang Bay is between the Makassar Strait and the Java Sea. Throughout the year, the air pressure in the Java Sea tends to be greater than the Makassar Strait. Therefore, the wind that crosses Tamiang Bay tends to blow from the Java Sea towards the Makassar Strait. And this strengthens the argument that HAWT has the potential to be installed in Tamiang Bay.

To calculate the estimated wind power, the wind turbine used is assumed to be as shown in Table 2.

Table 2. Wind turbine specifications

| | |
|---|---|
| Merk | Gamesa |
| Type | G114-2.5 MW |
| Rating (MW) | 2.5 |
| Diameter (m) | 114 |
| Number of Blades | 3 |
| Tower Height (m) | 80 |
| Tower Type | Modular |
| Location | Onshore |
| Cut in (m/s) | 2 |
| Cut out (m/s) | 25 |

The wind turbine with this brand is proposed because it has a low cut-in value and is included in the wind speed value in the Tamiang Bay area. Because the height of the proposed wind turbine tower is 80 m, it is necessary to adjust the wind speed value for that height using the following Master Equation.

$$\left(\frac{v}{v_o}\right) = \left(\frac{H}{H_o}\right)^{\alpha} \qquad (2)$$

Where, v is the wind speed at the height of H (m/s), $v_0$ is the wind speed at the height of $H_0$, α is the coefficient of friction. The value of α is obtained through the environmental conditions approach, as shown in Table 3.

Table 3. List of air friction coefficient values with the environment.

| **Terrain Characteristics** | **Friction Coefficient ($\alpha$)** |
|---|---|
| Smooth and airy hard ground, calm water | 0.10 |
| High grass on flat ground | 0.15 |
| Tall plants, hedges, and shrubs | 0.20 |
| Countryside in the forest, lots of trees | 0.25 |
| Small town with trees and shrubs | 0.30 |
| Big city with tall buildings | 0.40 |

Based on the existing conditions at the data collection location, the appropriate friction coefficient value is 0.25. This is based on the study environment in the form of a rural area that is overgrown with trees.

Thus, the results of the calculation using Equation 1 of the estimated wind power in the Tamiang Bay area in 2021 can be seen in Table 4.

Table 4. Estimated wind power in the Tamiang Bay area

| v (m/s) at 80 m | v per year | Fraction of Hours @v | k | $P_{out}$ (kW) | Energy (MWh) per-year |
|---|---|---|---|---|---|
| 0 | 130 | 0.01 | 0.80 | 0 | 0.00 |
| 1 | 363 | 0.04 | 0.80 | 0 | 0.00 |
| 2 | 637 | 0.07 | 0.80 | 6.43 | 4.09 |
| 3 | 803 | 0.09 | 0.80 | 21.69 | 17.42 |
| 4 | 966 | 0.11 | 0.80 | 51.41 | 49.66 |
| 5 | 1163 | 0.13 | 0.80 | 100.41 | 116.78 |
| 6 | 1097 | 0.12 | 0.80 | 173.51 | 190.35 |
| 7 | 1083 | 0.12 | 0.80 | 275.53 | 298.40 |

| | | | | | |
|---|---|---|---|---|---|
| 8 | 875 | 0.10 | 0.80 | 411.29 | 359.88 |
| 9 | 643 | 0.07 | 0.80 | 1000 | 643.00 |
| 10 | 476 | 0.05 | 0.80 | 1000 | 476.00 |
| 11 | 278 | 0.03 | 0.80 | 1000 | 278.00 |
| 12 | 154 | 0.02 | 0.80 | 1000 | 154.00 |
| 13 | 59 | 0.01 | 0.80 | 1000 | 59.00 |
| 14 | 22 | 0.00 | 0.80 | 0.00 | 0.00 |
| 15 | 10 | 0.00 | 0.80 | 0.00 | 0.00 |
| 16 | 1 | 0.00 | 0.80 | 0.00 | 0.00 |
| 17 | 0 | 0.00 | 0.80 | 0.00 | 0.00 |
| 18 | 0 | 0.00 | 0.80 | 0.00 | 0.00 |
| 19 | 0 | 0.00 | 0.80 | 0.00 | 0.00 |
| 20 | 0 | 0.00 | 0.80 | 0.00 | 0.00 |
| 21 | 0 | 0.00 | 0.80 | 0.00 | 0.00 |
| 22 | 0 | 0.00 | 0.80 | 0.00 | 0.00 |
| 23 | 0 | 0.00 | 0.80 | 0.00 | 0.00 |
| 24 | 0 | 0.00 | 0.80 | 0.00 | 0.00 |
| 25 | 0 | 0.00 | 0.80 | 0.00 | 0.00 |
| | TOTAL (MWH) | | | | 2646.58 |

Based on the results of the calculations in Table 4, in one year, the Tamiang Bay area has the potential to produce wind power of 2646.58 MWh. This figure is quite large. If a wind farm is developed in the Tamiang Bay area, the potential for wind power generated will be many times over. However, there are several things that must be considered for wind power development, such as noise generated, maintenance costs, waste, and so on.

## CONCLUSION

Through this research, it can be concluded that the Tamiang Bay area has the potential to develop wind power. The average daily wind speed in Tamiang Bay is 4 m/s for a height of 10 m and 5.98 m/s for an altitude of 50 m. Based on the assumption that it uses a Gamesa G114-2.5 MW type of wind turbine, in one year, the Tamiang Bay area has the potential to generate 2646.58 MWh of wind power.

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