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Optimization of Offshore Wind Potential in Gampong Durung Politeknik Pelayaran Malahayati for Electricity in Aceh Besar

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ABSTRACT

Utilization of renewable energy especially offshore wind energy increasingly becoming a focus in efforts to diversify energy sources and reduce carbon emissions. Studies This aiming for investigate potential wind off beach in Gampong Durung Politeknik Pelayaran Malahayati Aceh Besar, and proposes an optimization strategy to utilize it in supporting electricity in the region. The research was conducted through a series of methodological steps, including wind pattern mapping, wind speed measurement, historical data analysis, and mathematical modeling. The re-sults of the study show that Village Durung own potential significant winds, with speed and di-rection steady wind throughout year with done speed data measurement wind in Gampong Du-rung on some point. From the results measurement speed wind obtained speed the average wind for 3 months measurement in a way in order are 2.6 m/s, 2.4 m/s, and 2.6 m/s with direction wind most namely northwest. From the results calculation speed wind at 09.00-12.00 which is 463.252 watts, 463.252 watts and 557.7425 watts, then at 13.00-16.00 which is 1115.69 watts, 664.28 watts and 742.355 watts. Based on this analysis, adequate infrastructure planning is also pro-posed to integrate this wind energy with the electricity system in Aceh Besar. By considering economic, environmental and social aspects, this optimization project is expected to be able to provide a positive contribution in meeting the need for sustainable electricity in the region. With Thus, research This suggest that the potential energy wind off beach in Gampong area Durung optimized more Continue. Investment in technology energy wind can give benefit significant economic and environmental for public Aceh Besar coast. The next recommended step is do studies more carry on about design turbine more wind efficient as well as analysis cost For ensure proper implementation useful and sustainable. In conclusion, the research This highlight the huge potential of offshore wind energy as a reliable and sustainable energy source for the people of Aceh Besar.

Keywords: *enewable energy, optimation, wind power, wind potential*

INTRODUCTION

With progress technology and growth a population that continues to grow increasing , demand will energy is also increasing increased . However , the use of energy fossils which are source main energy has cause serious impact . Data shows that more of 82% of the energy used originate from fossils , which are source energy that is not can updated . In Indonesia, there are potential big in energy alternative like energy solar , wave sea , hot earth , and wind that has not utilized in a way maximum . Impact from generator electricity that uses material burn fossil including im-provement emission pollutant such as SO_2, NO_4, and CO_2, which have set up in standard emis-sions determined by the Decree of the Minister of State for the Environment Life No. KEP. 13/MENLH/3/1995.

There is various the impact that arises from use material burn fossils, good in a way direct and also No direct. Impact direct includes: a) Pollution environment consequence waste and res-idue industry that can pollute air and groundwater, b) Noise continuous consequence operation industry, c) Reduction quality environment that makes the area not suitable for settlements, d) Disturbed aesthetics in the area industry. Impact No direct includes: a) Increasing urbanization Because encouragement economy from sector industry, b) Changes values and culture social community [1].

Aceh Besar Regency own need energy around 763,556,209 kilowatt-hours (Kwh), but only around 84,000 Kw which was fulfilled in 2018. According to, the energy alternative offer potential big but Not yet utilized completely. Some limiting factors utilization energy alternative including investment large, dependence on imports component from abroad, limitations in research and study related, lack of Power competition compared to with energy fossils, and uncertainty will availability energy alternatives that still exist low [2][3].

Village Duran is A gampong (village) located in the sub-district Ujong Thank you, Aceh Besar Regency, Aceh Province, Indonesia. This village is located at coordinates 5° 32' 20" North and longitude 95° 12' 10" East (Google earth) which is close to the beach. Order geology area The Indonesian sea is quite complicated as consequence from interac-tion of 3 (three) plates main that is the moving Pacific Ocean plate towards the west, the plate Indian Ocean- The moving Australian continent toward north and plate the moving Eurasian con-tinent to direction east southeast. Movement plates the result in the occurrence incident spectacu-lar geology that can to form place backup oil and gas as well as other mineral resources that can become source riches beneficial nature For prosperity people and others party can also be area vulnerable disaster geology that can destroy life man [4].

Contribution sector energy and resources mineral resources for development national until with moment This Still show significant numbers. On three year final sector contribution energy and resources mineral resources to the APBN average 30%, while to GDP is around 13% every year year . Contribution the biggest from sector energy and mineral resources are produced from sub sector oil and natural gas.

Energy and mineral resources in particular source Power energy there is something not can updated or energy fossils that after utilized source energy the will exhausted and there are also resources energy that can updated or utilized in a way Keep going continuously as renewable en-ergy. Energy marine is results conversion style mechanics, style potential, and differences sea water temperature [3][5].

Potential energy sufficient maritime tall among them energy hot ocean thermal, tidal en-ergy, energy waves (wind wave energy), and energy current sea (current energy). Responding to condition mentioned, it is necessary realized a formulation policy about marine energy and mineral resources, in effort utilise energy new energy renewable, and energy alternatives that can become priority and can utilized optimally for as big as possible prosperity and well-being In-donesian people [6].

METHOD

Study This according to level explanation and data types and the analysis including study descriptive quantitative with design descriptive and experimental. Descriptive design used For identify and measure potential wind off beach in Gampong Durung, and For describe condition geographical and meteorological in the region. While design experimental used For test eligibility technical system generator electricity power the proposed wind, with simulation condition real using the collected data from field .

Study carried out in Gampong Durung, which is located in the area Coast Polytechnic Cruise Malahayati, Aceh Besar. Election location This based on potential significant wind and conditions geographic support development energy wind off beach. This location own access di-rect to waters open that allows installation turbine wind off beach with efficiency tall.

Data collection was carried out during period three month, covering season west wind and wind east, forget variation speed representative wind throughout year. Observation and measurement done in a way continuous For ensure accuracy and consistency of the data obtained. The time selected also takes into account period peak activity winds in the area, which are usu-ally happen between April to June 2024.

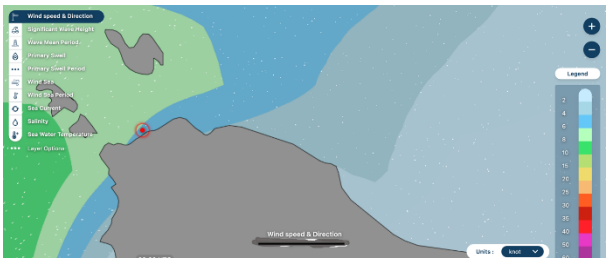

Figure 1. Speed and direction wind at the research location in Gampong Durung, Aceh Besar Re-gency,

Figure 2. Research location in Gampong Durung, Aceh Besar Regency

Data Collection Techniques

a. Measurement Speed and Direction Wind

Speed and direction data wind is the main data in study this. Measurement done use an-emometer and wind vane installed in several point strategic along beach Village Durung. Measur-ing tool mounted at a height certain For get representative data.

Figure 3. Anemometer Tool

Measurement done in a way continuous with time interval certain in some point with different time namely morning (09:00 – 12:00), afternoon (13:00 – 14:00) and evening (15:00 – 16:00), taking into account conditions in the field every day during three month. The data obtained Then recorded and analyzed for get daily, monthly, as well as averages distribution speed and direc-tion wind.

b. Measurement Condition Geographical and Meteorological

Besides speed wind, condition data geographical and meteorological data are also col-lected for support analysis potential energy wind. Data collected includes:

a. Topography and Bathymetry: Topographic data used for understand profile height and features the surrounding surface location research, while bathymetric data give information about depth sea at the proposed location for installation turbine.

b. Air Temperature and Humidity: Measurement temperature and humidity air done use thermometer and hygrometer. This data used for count density air, which affects efficiency conversion energy wind become electricity.

c. Pressure and Conditions Weather: Pressure data air and conditions weather collected from station weather local or using a digital barometer. Conditions weather, including rainfall rain and fog, were also observed Because can influence performance turbine wind [7].

c. Collection of Social and Economic Data

Social and economic data collected through survey and interview with public local as well as parties related others. Survey This aiming for identify view public to development energy wind off beach, impact expected socio-economic, as well as potential possible benefits and con-straints appear.

Interview done with official government local, expert energy, as well as representative from companies that may involved in project This. Data collected covers information about poli-cy energy, support financial, as well as applicable regulations For development energy renewable in the region .

RESULTS AND DISCUSSION

1. Measurement Potential Wind in the Village Durung during April, May, and June 2024

Measurement speed wind in Gampong Durung done in a way continuous use anemometer installed at 3 points with time different that is morning (09:00 – 12:00), afternoon (13:00 – 14:00) and evening (15:00 – 16:00) and averaged every day For get speed wind daily . From the results measurement this , analysis statistics done For every month .

1.1 Speed Daily Average Wind

Speed data daily average wind measured during three month with results as following :

a. April 2024: Speed wind range between 4.5 m/s to 6.1 m/s, with monthly average speed of 4.8 m/s.

Table 1. Distribution Speed Wind and Temperature in April 2024

Date	Speed Average Wind (m/s)	Average Morning Temperature (°C)	Average Day Temperature (°C)	Average Afternoon Temperature (°C)
April 1st	4.5	27.0	30.5	28.2
April 2	4.8	26.8	30.8	28.4
April 3	4.9	27.2	31.0	28.6
April 4th	4.2	26.7	30.2	27.9
April 5th	4.6	27.0	30.7	28.1
April 6	4.0	26.5	30.0	27.6
April 7	4.4	27.1	30.9	28.3
April 8th	4.7	27.3	31.1	28.5
April 9th	3.8	26.6	30.0	27.7
April 10	5.0	27.4	31.3	28.8
April 11	5.3	27.6	31.5	29.0
April 12	5.6	27.8	31.8	29.2
April 13	4.8	27.0	30.7	28.2
April 14	5.1	27.2	31.0	28.5
April 15	5.5	27.5	31.4	28.8
April 16	5.7	27.9	31.9	29.1
April 17	4.3	27.0	30.6	28.1
April 18	4.0	26.7	30.2	27.8
April 19	4.5	27.1	30.8	28.3
April 20	4.6	27.2	30.9	28.4
April 21	5.2	27.6	31.4	28.9
April 22	5.4	27.8	31.6	29.1
April 23	5.5	27.9	31.7	29.2
April 24	5.1	27.3	31.2	28.6
April 25	4.8	27.1	30.8	28.4
April 26	5.3	27.7	31.5	29.0
April 27	5.9	28.0	32.0	29.5
April 28	6.1	28.2	32.2	29.7
April 29	5.0	27.5	31.3	28.9
April 30	5.8	28.0	31.9	29.3

Description Table :

Date : Day in April 2024.

Speed Average Wind (m/s): Speed daily average wind in meters per second.

Average Morning Temperature (09:00 – 12:00, °C): Average temperature in the morning day.

Average Afternoon Temperature (13:00 – 14:00, °C): Average temperature during the day day .

Average Afternoon Temperature (15:00 – 16:00, °C): Average temperature in the afternoon.

b. May 2024: Speed wind range between 3.9 m/s to 6.2 m/s, with monthly average speed of 5.2 m/s.

Table 2. Distribution Speed Wind and Temperature in May 2024

Date	Speed Average Wind (m/s)	Average Morning Temperature (°C)	Average Day Temperature (°C)	Average Afternoon Temperature (°C)
May 1st	4.6	27.5	31.0	28.5
May 2	4.9	27.3	30.8	28.2
May 3	5.1	27.6	31.2	28.7
May 4th	4.3	27.0	30.5	28.0
May 5th	4.7	27.4	31.1	28.6
May 6	4.2	26.9	30.3	27.8
May 7th	4.5	27.2	30.9	28.3
May 8th	4.8	27.7	31.4	28.9

May 9th	3.9	26.8	30.0	27.7
May 10	5.2	27.9	31.6	29.0
May 11	5.5	28.1	31.8	29.3
May 12	5.7	28.3	32.0	29.5
May 13	4.9	27.5	31.0	28.4
May 14	5.3	27.8	31.4	28.9
May 15	5.6	28.2	31.7	29.2
May 16	5.9	28.5	32.2	29.6
May 17	4.4	27.1	30.7	28.2
May 18	4.1	26.8	30.2	27.9
May 19	4.6	27.4	31.0	28.5
May 20	4.7	27.5	31.2	28.6
May 21	5.4	28.0	31.8	29.1
May 22	5.6	28.3	32.0	29.3
May 23	5.8	28.4	32.1	29.4
May 24	5.3	27.7	31.5	28.8
May 25	4.9	27.3	31.1	28.5
May 26	5.4	28.1	31.7	29.0
May 27	6.0	28.6	32.4	29.7
May 28	6.2	28.8	32.6	29.9
May 29	5.2	28.0	31.8	29.0

Description Table :

Date : Day in May 2024.

Speed Average Wind (m/s): Speed daily average wind in meters per second .

Average Morning Temperature (09:00 – 12:00, °C): Average temperature in the morning day .

Average Afternoon Temperature (13:00 – 14:00, °C): Average temperature during the day day .

Average Afternoon Temperature (15:00 – 16:00, °C): Average temperature in the afternoon .

c. June 2024: Speed wind range between 4.0 m/s to 6.3 m/s, with monthly average speed of 5.2 m/s.

Table 3. Distribution Speed Wind and Temperature in June 2024

Date	**Speed Average Wind (m/s)**	**Average Morning Temperature (°C)**	**Average Day Temperature (°C)**	**Average Afternoon Temperature (°C)**
June 1st	4.7	27.6	31.1	28.6
June 2	4.9	27.4	30.9	28.4
June 3	5.2	27.8	31.4	28.9
June 4th	4.4	27.2	30.7	28.2
June 5th	4.8	27.6	31.3	28.7
June 6	4.3	27.1	30.6	28.1
June 7th	4.6	27.5	31.0	28.5
June 8th	4.9	28.0	31.6	29.0
June 9th	4.0	27.0	30.4	28.0
June 10	5.3	28.1	31.8	29.2
June 11th	5.6	28.3	32.0	29.4
June 12	5.8	28.5	32.3	29.6
June 13	5.0	27.7	31.2	28.8
June 14	5.4	28.0	31.6	29.1
June 15	5.7	28.4	32.0	29.3
June 16	6.0	28.7	32.5	29.7
June 17	4.5	27.3	30.9	28.4
June 18	4.2	27.0	30.5	28.1
June 19	4.7	27.6	31.1	28.6
June 20	4.8	27.7	31.3	28.7
June 21	5.5	28.2	32.0	29.2

June 22	5.7	28.4	32.2	29.4
June 23	5.9	28.5	32.4	29.6
June 24	5.4	27.8	31.6	28.9
June 25	5.0	27.4	31.2	28.5
June 26	5.5	28.2	31.9	29.1
June 27	6.1	28.8	32.6	29.8
June 28	6.3	29.0	32.8	30.0
June 29	5.3	28.1	31.9	29.0
June 30th	6.0	28.7	32.4	29.7

Description Table :

Date : Day in May 2024.

Speed Average Wind (m/s): Speed daily average wind in meters per second .

Average Morning Temperature (09:00 – 12:00, °C): Average temperature in the morning day .

Average Afternoon Temperature (13:00 – 14:00, °C): Average temperature during the day day .

Average Afternoon Temperature (15:00 – 16:00, °C): Average temperature in the afternoon .

This data illustrated in Graph 4.1 which shows fluctuation speed wind daily during three month the .

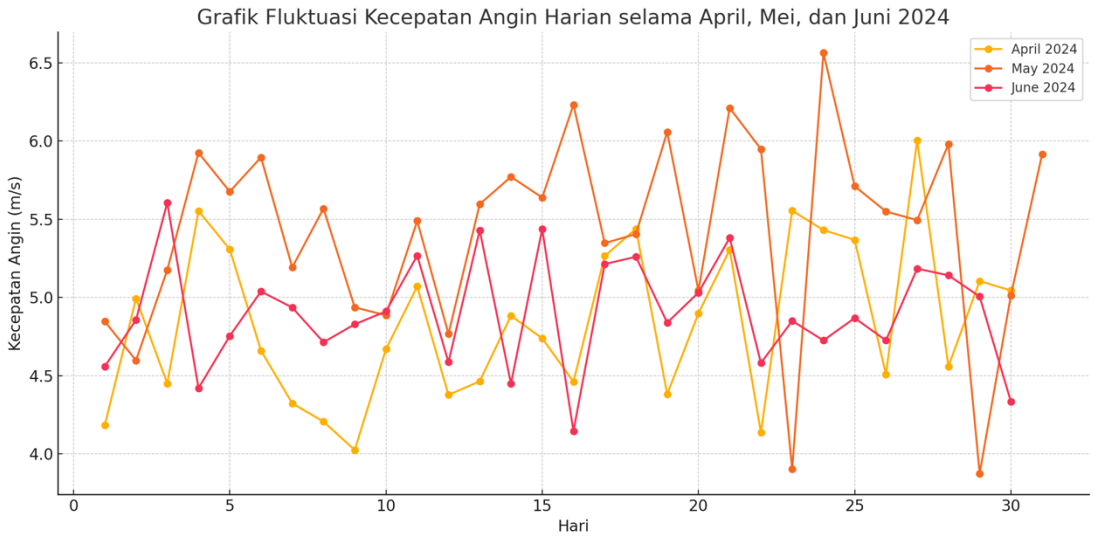

Figure 4. Graph Fluctuation Speed Wind Daily during April, May, and June 2024.

Chart on is chart fluctuation speed wind daily during April, May, and June 2024. Graph This describe change speed average wind every day For third month said . Simulation This show variation wind daily in Gampong The Durung that can used For analyze potential energy wind off beach [8][9].

1.2 Distribution Speed Wind

In addition to the daily average , the distribution frequency speed wind is also analyzed . Distribution speed wind This important For evaluate How speed wind varies throughout day and in various month . Distribution This counted based on the data taken every a number of time different that is morning (09:00 – 12:00), afternoon (13:00 – 14:00) and evening (15:00 – 16:00).

a. Distribution Speed Wind in April 2024: Majority speed wind is in the range of 4.0 to 5.5 m/s.

b. Distribution Speed Wind in May 2024: More Lots with speed wind above 5.0 m/s compared to month other .

c. Distribution Speed Wind in June 2024: Mostly speed wind range between 4.0 to 5.0 m/s.

Distribution This displayed in Histogram form for each month, which can be seen in Figure 5.

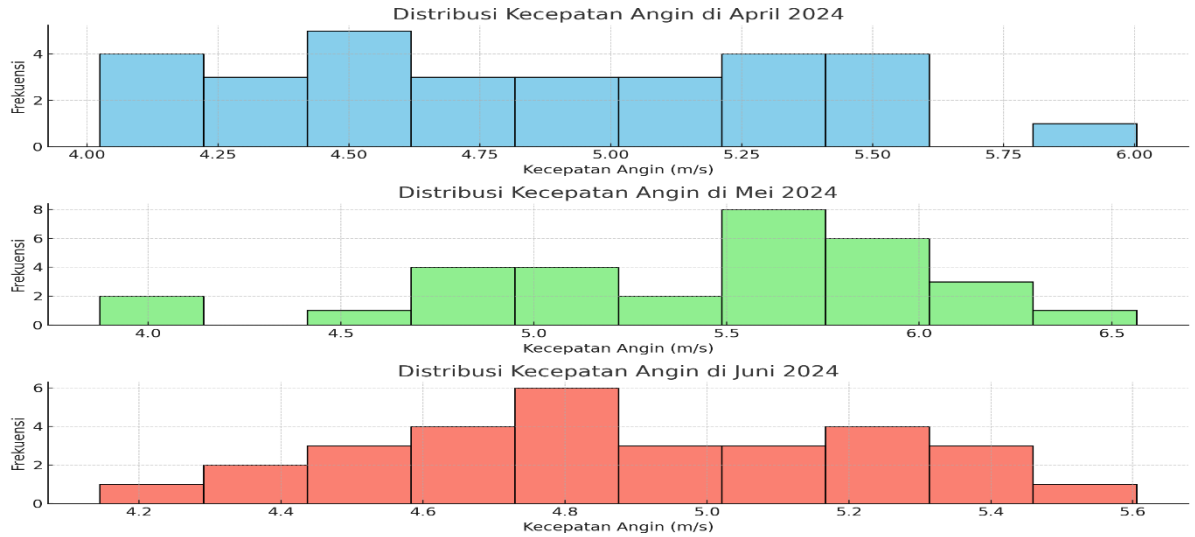

Figure 5. Distribution Histogram Speed Wind in the Village Durung for April, May, and June 2024

The image above is a distribution histogram speed wind in Gampong Durung For April, May, and June 2024. Every chart show frequency speed measured wind in range time those. You can see pattern distribution speed different winds in every month, the important thing for analysis potential energy wind off beach.

1.3. Discussion and Evaluation Potential Energy Wind

Based on results measurement during three month this , looks that potential energy wind in Gampong Durung Enough promising, with speed steady average wind above 4.8 m/s. The power produced by the turbine wind during period This range between 400 to 513 Watts, with a total energy monthly reach more from 900 kWh to third month the [6][7]. This result show that potential wind in this area worthy for utilized as source energy alternative For needs electricity local in Aceh Besar, especially For support need electricity in the area coast and reduce dependence on sources energy conventional. With improvement technology turbine and optimization placement turbine wind off beach , capacity production energy can improved, and become solution term long for need friendly energy environment in the coastal area of Aceh Besar.

CONCLUSION

Utilization energy renewable specifically energy wind off beach the more become focus in effort diversification source energy and reduction emission carbon. Study This aiming For investigate potential wind off beach in Gampong Durung Polytechnic Cruise Malahayati Aceh Besar, and proposed an optimization strategy For take advantage of it in support electricity in the area . Research done through a series step methodological, including mapping pattern wind, measurement speed wind, historical data analysis, and modeling mathematical. Research results show that Village Durung own potential significant winds, with speed and direction steady wind throughout year with done speed data measurement wind in Gampong Durung on some point. From the results measurement speed wind obtained speed the average wind for 3 months measurement in a way in order are 2.6 m/s, 2.4 m/s, and 2.6 m/s with direction wind most namely northwest. From the results calculation speed wind at 09.00-12.00 namely 463.252 watts, 463.252 watts and 557.7425 watts, then at 13.00-16.00 it was 1115.69 watts, 664.28 watts and 742.355 watts.

Based on analysis said, planning adequate infrastructure is also proposed For integrate energy wind This with system electricity in Aceh Besar. With consider aspect economic, environmental and social, projects optimization This expected capable give contribution positive in fulfil need energy electricity in a way sustainable in the region. With Thus, research This suggest that the potential energy wind off beach in Gampong area Durung optimized more Continue. Investment in technology energy wind can give benefit significant economic and environmental for public Aceh Besar coast . The next recommended step is do studies more carry on about design turbine more wind efficient as well as analysis cost For ensure proper implementation useful and sustainable. In conclusion, the research This highlight potential big from energy wind off beach as source energy that can reliable and sustainable for the people of Great Aceh.

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