Analysis of Ciheras Beach Wind Potential for Minimal Pollutant Electrical Energy Generation

1st Adi Nugraha
Department Electrical Engineering
Sultan Ageng Tirtayasa University
Banten, Indonesia
adi.n@untirta.ac.id

2nd Agus Ramelan
Department Electrical Engineering
Sebelas Maret University
Surakarta, Indonesia
agusramelan@staff.uns.ac.id

3rd Nike Sartika
Department Electrical Engineering
UIN Sunan Gunung Djati
Bandung, Indonesia
nikesartika@uinsgd.ac.id

*Corresponding author: adi.n@untirta.ac.id
Received: September 18, 2023; **Accepted**: November 27, 2023

***Abstract*—Pollutant is a serious problem today as the use of non-renewable energy sources is still a favorite, especially those sourced from coal and petroleum fuels. To anticipate dependence on coal-fired power plants, many studies have been conducted related to environmentally friendly power plants. One of the environmentally friendly power plants is wind power plants. Based on the criteria of wind turbines such as TSD-500, a wind speed of at least 3 m/s is required to start production. The purpose of this study is to find out how much potential clean energy is generated through wind energy generation on the coast of Ciheras. The research method in data collection used is qualitative descriptive. The results of the analysis found that the energy obtained from the process of converting wind energy into electrical energy can illuminate 9 houses, with each house consuming 70 Watts of power for 5 hours.**

Keywords—Air pollution, renewable energy, clean energy, electricity, power generation

I. INTRODUCTION

Pollution is a serious problem today [1]. Until the DKI Jakarta Provincial Government enforces a work-from-home policy for its employees to reduce air pollution in the capital city [2]. One of the causes of air pollution is from steam power plants, whose fuel is coal [3]. In Indonesia, currently the use of non-renewable energy sources is still a favorite, especially those sourced from coal and petroleum fuel [4]. PLTU that uses fossil energy, namely coal as fuel in producing electricity, is known as an environmentally unfriendly activity because the results of PLTU activities will release waste that is harmful to the surrounding environment [5], Because it releases a large number of particles in the form of aerosols into the atmosphere.

Coal is mostly composed of carbon and many other elements including sulfur, nitrogen, organometallic compounds, and minerals, which contribute to the formation of highly toxic secondary compounds in contact with the atmosphere [6]. Continuous inhalation of this harmful substance can trigger many diseases such as respiratory and cardiovascular diseases, systemic inflammation, and nerve degeneration [7]. On the other hand, technological developments such as today all household appliances, military, and even the world of education are dominated by electronic equipment [8]. So that electrical energy is the main key in the midst of the development of today's electronic world [9].

It is impossible to eliminate the role of coal-fired power plants in generating electrical energy. To anticipate dependence on coal-fired power plants, many studies have been conducted related to environmentally friendly power plants. One of the environmentally friendly power plants is wind power plants [10]. In addition, in general, the uneven distribution of electricity to all regions in Indonesia such as rural or remote areas causes people to need alternative energy.

Wind is energy available in nature [11]. The movement of wind from high-pressure air to low-pressure air causes a flow of energy that can provide thrust to an object [12]. It depends on how much wind speed in seconds hits an object. Wind power generation is cheap and easy to get [13]. Because the main material that operates only requires wind energy to drive the turbine. Which then the kinetic energy from the turbine is converted into electrical energy by the generator. After that, electricity is stored in the battery to be used for daily purposes.

Based on the criteria of such a wind turbine as TSD-500, a wind speed of at least 3 m/s is required to start production. And areas that have an average wind speed above 3 m / s are found on the south coast of Java, Sumatra, and islands in eastern Indonesia. Cipatujah Beach, Tasikmalaya, West Java is one part of monitoring on the south coast of Java. This is what makes researchers analyze the potential of wind that is sufficient to be used as a wind power plant as an electrical energy plant with minimal pollutants.

II. METHOHDS

The research method in data collection used is qualitative descriptive, using the following steps:

- Observation, namely by making observations on "Analysis of Ciheras Beach Wind Potential for Minimal Pollutant Electric Energy Generation" to find out how it performs in the field.
- Interview, namely by asking a number of questions related to "Analysis of Ciheras Beach Wind Potential for Minimal Pollutants of Electric Energy Plants" to the community for technical problems in the field.
- Literature study, namely by looking for references and sources of information through several books and internet sites to complement the study of wind potential analysis. The author also obtained several references that support the search for this study.

Wind history data is taken for one month and samples are taken for the rainy season. With an anemometer wind speed is calculated and recorded daily. Wind speed data is analyzed and calculated by the following equation.

$$P_{wind} = \frac{1}{2} x (\rho \; x \; A \; x \; V^3) \qquad (1)$$

Where:

ρ = air density (1.225)

A = cross-sectional area of the blade (A)

V = Wind speed [m/s]

To find out the amount of energy every day when the wind, then we look at the following formula:

$$\text{Power} = Power\;[KW]\;x\;Time\;[Hour] \qquad (2)$$

III. Results and Discussion

Wind is kinetic energy that can be obtained for free in nature [14]. To be converted into electrical energy by a TSD-500 generator, it takes a wind speed of at least 3 m/s to start producing. Wind moves from low temperature to higher temperature or from high pressure to low pressure [15]. Therefore, in Indonesia, there are 2 seasons caused by differences in air pressure in an area called monsoon. Monsoon winds have 2 types. It is the east monsoon and the west monsoon [16].

The western monsoon occurs between October and April while the eastern monsoon occurs from April to October, the opposite of the western monsoon. April and October are the transitional months of the monsoon. The following is a graph of the potential monsoon transition of the lunar wind.

A. *October sample*

Here are the results of measuring wind speed using an anemometer in October.

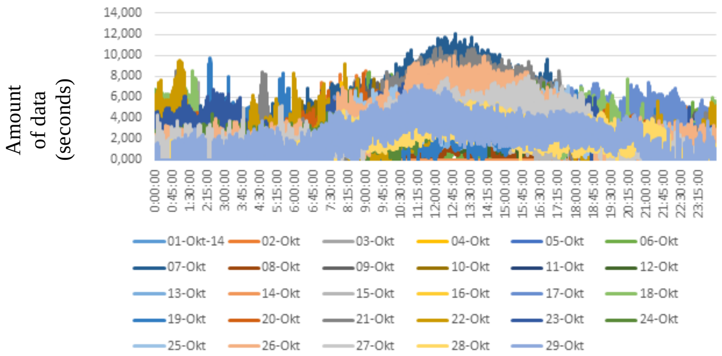

Fig. 1. October 2014 wind speed measurement results

The maximum wind speed on October 17 was in the range between wind speeds of 8-9 m / s. The highest wind speed for one month occurred on October 7, which is a wind speed range of 12-13 m/s. But the duration is only 1 second. shown in Figure 2.

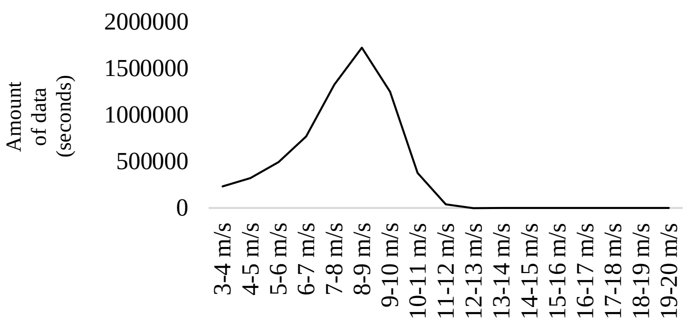

Fig. 2. Graph of the highest wind speed for one month

After being classified according to wind speed, wind power is calculated by the following formula:

By the formula, we assume that the radius of the blade is 1 m. Then we determine the wind classification of 3-4 m/s, 4 – 5m/s = 4m/s, 5 – 6 m/s = 5m/s, 6 – 7 m/s = 6 m/s, 7 – 8 m/s = 7m/s, 8-9 m/s = 8 m/s, 9-10m/s = 9 m/s, 10-11m/s = 10m/s, 11-12 m/s = 11 m/s and 12-13 m/s we determine the value of 12 m/s.

The energy value can be obtained by multiplying the power gain per day in watts, shown in Table 1 by the number of hours each day, then the total daily energy is added. So the power gain for October is about 53 MW and the total energy is 523 MWH

TABLE I. Power Gain per Day

Date	Power gain (watts)	Total hour	Energy Gain (WH)
1	1127150,0	9,9	11,1x106
2	3151277,1	10,9	34,5x106
3	1920351,2	9,9	19.0x106
4	1033299,2	7,7	7,9x106
5	664239,7	5,3	3,5x106
6	353302,6	2,9	1.0x106
7	6525398,9	12,3	80.0x106
8	188327,4	2,2	411,9x106
9	2213051,3	9,6	21,3x106
10	1530975,5	9,0	13,7x106
11	1276768,4	9,0	11,5x106
12	225575,5	2,8	628,4x106
13	603187,9	6,1	3,7x106
14	0	0,0	0
15	974787	5,8	5,7x106
16	2008099,4	8,7	17,4x106
17	2608886,2	14,2	37,1x106
18	2145917	10,8	23,2x106
19	603386,6	4,8	2,9x106
20	2609017,0	9,6	25.0x106
21	5257200,7	9,0	47,2x106
22	2292052,8	9,3	21,3x106
23	2671810,8	13,6	36,3x106
24	1841722,9	8,3	15,2x106
25	2045326,1	9,5	19,4x106
26	3994040,2	9,6	38,4x106
27	1780287,5	9,3	16,5x106
28	519845,9	5,1	2,7x106
29	873590,2	7,2	6,3x106
Entire	**53038875**	**232,2**	**523.0x106**

B. *Power Distribution*

In wind power generation systems, wind fluctuating over time causes the energy produced also cannot be directly consumed. This is because the voltage that is always changing due to the process of converting wind into electrical energy itself produces different voltages. Generally speaking, the wind blows strongly during the day due to the difference in air pressure, and the wind gusts are very small at night. But vice versa with the use of electrical loads. Peak load or maximum energy consumption is in the afternoon to evening. This is due to the use of electrical energy for lighting and other needs. So if you rely on wind power alone, then the load needs will not be met. Therefore, there is a need for energy storage media, namely batteries to store energy when the wind blows and produce electrical energy through a conversion process and can be used whenever needed.

Wind energy is converted by generators into electrical energy, power in the form of AC electricity. So it cannot be directly stored in the battery. Because the battery is a DC electricity storage medium. In order to be stored using AC electricity, the *rectifier* is in charge of converting AC electricity into DC electricity which can then be stored in the battery. A battery is a storage medium for electrical energy that has its own capacity. The energy capacity that can be stored in batteries at PT LAN (Lentera Angin Nusantara) is 19200 WH or 19.2 KWH. This amount of power comes from a 2 Volt battery as many as 12 batteries installed in series so that it has a voltage of 24 Volts.

The electricity generated by the battery is DC electricity which is generally used for special electronic equipment that requires DC power. While for the purposes of other electrical appliances, such as lights, fans and other household electrical appliances use AC electricity. To generate AC electricity, the battery must be converted with a device called an inverter. The inverter is in charge of converting DC electricity into AC electricity which can then be distributed as electrical energy.

Energy from the battery cannot be consumed entirely, because it will make the battery quickly damaged. And also should not be fully charged because the battery will be over-energized thus shortening the life of the battery. The battery voltage is maintained at a maximum of 24 Volts and if it is more, the electrical load must be turned on for the energy on the battery to be consumed. And the minimum voltage is allowed only up to 20 Volts, and if there is no process of converting wind into electrical energy then the load must be extinguished.

From the previous discussion, the battery capacity is 19.2 KWH, 24 V. And the holder must be kept so that it is not more or less than is 24 – 20 Volts. This means that the power that can be consumed is only 16.6% of the total power in the battery. 16.6% of 19.2 KWH is 3200 WH. Or 3.2 KWH. Suppose the load requirement of one house alone for lighting is 70 watts with the following details:

TABLE II. POWER DISTRIBUTION

Room	Force (Watt)
1 Front porch	5
1 living room	20
2 Bedrooms	10
1 Kitchen	20
1 Bathroom	10
1 Back Terrace	5
Entire	**70**

Electrical energy for lighting is usually used from 17.00 WIB to 21.00 WIB and after that the lights are turned off for sleep rest and turned on again at 05.00 WIB to 06.00 WIB. This means that the use of electrical loads is carried out for approximately 5 hours. Then the energy used can be calculated by the following formula.

$$\text{Power} = Power\ x\ Time \quad (3)$$

Where power is in units of Watts and time in units of hours. With this calculation, the energy consumption of 1 house is as much as:

$$\text{Energy} = 70\ Watt\ x\ 5\ hour = 350[WH] \quad (4)$$

If the energy needs in each house are considered the same, then with 3.2 KWH energy can serve the energy needs of approximately 9 homes. With the following calculation:

$$= \frac{3200\ WH}{350\ WH} = 9$$

So the battery capacity owned by the LAN, with the load installed according to table 2, can serve the electrical energy needs of 9 houses. So with this calculation does not include power losses that occur during the transmission process.

C. Pollutant Generating

The main problem of power plant pollutants is exhaust gasses from combustion. As with PLTU, to produce hot steam requires combustion using fossil fuels. This is what causes the surrounding air to be polluted due to the results of combustion. It is different from wind power generation. In the generation process, there is no exhaust gas from combustion. Because the conversion process is produced from wind. The wind will drive the turbine and the turbine's motion is converted by the generator. The converted energy from the generator is stored in the battery. So that in the process of generating electrical energy, the surrounding air is not polluted. Because in practice, wind power plants have no combustion process and do not produce carbon gas.

IV. CONCLUSION

Wind energy on the coast of Ciheras-Tasikmalaya has great potential for the conversion process of wind electrical energy. The average wind speed is above 3-4 m / s in one day for more than 8 hours. This figure can be seen from the historical data of PT LAN's wind speed in 2014 in 2 months of monsoon transition, namely October and April which in general the wind direction is erratic.

The total distributable power depends on the amount of energy capacity in the battery. With the total battery in PT LAN, a rough calculation of energy obtained from the process of converting wind energy into electrical energy can illuminate 9 houses with each house consuming 70 Watts of power for 5 hours before finally the battery is recharged with the energy conversion process.

V. ACKNOWLEDGEMENT

Thanks to the Lentera Wind Nusantara who has authorized the collection of data. And thank you also to all those who helped.

REFERENCE

[1] S. Sudaryanto, N. D. Prasetyawati, E. Sinaga, and Muslikah, “Socialization of the Impact of Air Pollution on Health Disorders Comfort and the Environment,” in *Prosiding Midwifery Science Session*, 2020.

[2] BBC, "Air pollution: ASN Jakarta starts WFH, experts and activists claim just 'breaking down traffic,'" bbc.com, 2023. https://www.bbc.com/indonesia/articles/cjm8ng24028o (accessed Sep. 16, 2023).

[3] K. Trianisa, E. P. Purnomo, and A. N. Kasiwi, “Pengaruh Industri Batubara Terhadap Polusi Udara dalam Keseimbangan World Air Quality Index in India The Effect of Coal Industry on Air Pollution in Balance of the World Air Quality Index in India,” J. Science Technology. Context., vol. 6, no. 2, pp. 156–168, 2020.

[4] F. D. Romadhon and R. Subekti, "Analysis of renewable energy regulation in electric-based vehicles to support environmental protection (comparative analysis between Indonesia, Brazil, and Pakistan)," J. Pacta Sunt Servanda, vol. 4, no. 1, pp. 177–190, 2023.

[5] N. F. Dzahabiyyah, M. Priyanta, and Y. Adharani, "Direction of Regulation of Steam Power Plant Development in Indonesia as a Commitment to the Paris Agreement," J. Huk. Context. Spatial and Agrar., vol. 1, 2022.

[6] J. Gasparotto and K. D. B. Martinello, “Coal As An Energy Source And Its Impacts On Human Health,” Energy Geosci., vol. 2, no. 2, pp. 113–120, 2021, doi: 10.1016/j.engeos.2020.07.003.

[7] H. Kim, W. H. Kim, Y. Y. Kim, and H. Y. Park, “Air Pollution and Central Nervous System Disease: A Review of the Impact of Fine

Particulate Matter on Neurological Disorders," Front. Public Heal., vol. 8, pp. 1–12, 2020, doi: 10.3389/fpubh.2020.575330.
[8] W. Setiawan, "The Digital Age and Its Challenges," in National Seminar on Education, 2017, pp. 1–9.
[9] I. Maryanto and M. I. Sikki, "Automatic Transfer Switch (ATS) Automatic Main Failure (AMF) System Using SMS," J. Electr. Electrons., vol. 6, no. 1, pp. 19–32, 2018.
[10] N. A. Rahmi and Sudarti, "Student Perceptions of the Potential of Wind Utilization as an Energy Source Along the South Coast of Java," Edufisika, vol. 6, no. 1, pp. 57–63, 2021.
[11] A. Mulkan, Nazaruddin, and M. Abd, "Analysis of Wind Energy Utilization as a Source of Electrical Energy Generation," J. Science. It's one. Unida, vol. 3, no. 1, pp. 74–83, 2022.
[12] C. Dwi, L. Simbolon, Y. Ruhiat, and A. Saefullah, "Analysis of Wind Direction and Speed on Rainfall Distribution in Tangerang Regency," J. Teor. and Apps. Fis., vol. 10, no. 1, pp. 113–120, 2022.
[13] S. A. Solarin and M. O. Bello, "Wind energy and sustainable electricity generation: evidence from Germany," Approximately. Dev. Sustain., vol. 24, no. 7, pp. 9185–9198, 2022, doi: 10.1007/s10668-021-01818-x.
[14] D. Sumardiyanto and M. F. Hidayat, "Simple Windmill Design for Urug Village Power Plant, Sukajaya District, Bogor Regency, West Java," J. Berdikari, vol. 1, no. 2, pp. 28–36, 2018.
[15] D. K. Sari and S. Fahrezy, "The influence of wind on sea wave characteristics on Saugi Island, Pangkajene Regency and Islands," Indones. J. Geogr., vol. 1, no. 1, pp. 11–19, 2023.
[16] A. Rifai, B. Rochaddi, U. Fadika, J. Marwoto, and H. Setiyono, "Study of the Influence of Season Wind on the Spread of Sea Surface Temperatures," Indones. J. Oceanogr., vol. 2, no. 1, pp. 1–7, 2020.