potensial study on wind energy

by Bayu Rudianto

Submission date: 04-May-2020 11:50AM (UTC+0700)
Submission ID: 1315290968
File name: 1809-6269-1-PB_1.pdf (1.47M)
Word count: 2629
Character count: 12975

POTENTIALS STUDY ON WIND ENERGY IN PAYANGAN BEACH, JEMBER BY DRONE SURVEYOR DATA OBSERVATION

Bayu Rudiyanto[1], Muhammad Fakhri Andi Hamdika[2], Azamataufiq Budiprasojo[3]*, Budi Hariono[4]

[1]Energy Engineering Laboratory, Department of Renewable Energy Engineering, Politeknik Negeri Jember, Jember 68121, Indonesia
[2]Student of Department of Renewable Energy Engineering, Politeknik Negeri Jember, Jember 68121, Indonesia
[3]Engineering Computing Laboratory, Faculty Engineering, Politeknik Negeri Jember, Jember 68121, Indonesia
[4]Department of Agriculture Engineering Technology, Politeknik Negeri Jember, Jember 68121, Indonesia

E-mail: azamataufiq@polije.ac.id

Abstract. In an effort to develop and improve the energy mix, diversification of one of the new renewable energies that needs to be studied is wind energy. Wind energy is a renewable energy whose availability is of all time. Wind energy is also a renewable energy that does not produce pollution in its development. In Jember district, wind energy has the potential to be studied and developed especially in the southern coastal areas, one of them is on Payangan beach. This study aims to find out how much the potential of wind energy that can be converted into electrical energy on the Payangan coast. Observation of wind speed data using a drone surveyor enables researchers to reach a monitoring point that is impossible to reach by conventional anemometers. The wind speed varies between 3 to 52 m/s with a dominant wind speed of 25.2 m/s which has a wind power potential of 9644 Watt/m^2 and the power absorbed by the generating system is 1402 Watt/ m^2 area of the windmill.

***Keywords**:* Drone Surveyor, Electricity, Wind Energy, Potential

1. Introduction

National energy needs today increase. This should be balanced by development and enhancement energy mix. The use of fossil energy domination to non-renewable declination and it is estimated that in the long run will be more low level of harvested timber. Therefore, the addition of portions renewable energy besides reflect the energy security higher also increase the rate of concern to the environment. On 2016 in the achievement indicators energy mix, renewable energy reach 7.7%. While energy supply from coal, petroleum, and natural gas respectively reached 34.6 %, 33.8 %, and 23.9 %. [1]

An effort in the addition of portions ebt is study potential renewable energy in Indonesia. Wind energy is a source of non polutif energy which is available of all time. Wind energy potential in Indonesia is 107,2 GW. [2]

Wind energy on the south coast of Jember district has the potential to study and developed. According to Mustaqim Indawan, the average wind speed in the southern coast of Jember (Watu Ulo beach) of the range from 4,209 ms^{-2}. [3] Therefore, wind energy on a Payangan beach is also potential to be used as a source of energy to the wind power plant in a way studies the wind characteristics. In a

ISBN : 978-602-14917-9-9

study on the wind energy potential of Payangan beach, we use drone surveyors that has already been integrated with wind speed sensors. With the technology of drone surveyors, data monitoring process a lot faster, the movement more flexible, and coverage of the data broad.

The purpose of this research is to find out how much the potential of wind energy to be converted into electrical energy through the development planning of the Wind Power Plant (PLTB). In addition, this research will be useful in further presentation of digital data on wind characteristics in the Payangan beach.

2. Literature Review

2.1 Drone Surveyor

Drones are airplanes or helicopter shaped objects that fly by radio waves as unmanned aerial vehicles or airplanes that are driven remotely. Drones were originally developed for military purposes such as combat or reconnaissance but now they are used in various parts including surveillance, transportation, observation, and agriculture.

Drones can be classified as fixed wing drones and rotary wing drones according to the method of operation. Fixed wing drones and rotary wing drones have several strengths and weaknesses. Fixed wing drones can fly longer than rotary wing drones because energy efficiency when flying in the air uses air lift but requires a certain amount of space to take off and land. Although rotary wing drones can take off and land vertically, they can fly for a shorter time than fixed wing aircraft because of low energy efficiency. [4]

Surveyor drones are not much different from general drones. The difference is that the accessories attached to the surveyor drone are used to support the surveyor's activities in taking measurement data accurately. The advantages of using surveyor drones in this study are due to their high flexibility, wide coverage area, and faster remote data when compared to conventional surveyors.

(a) (b)

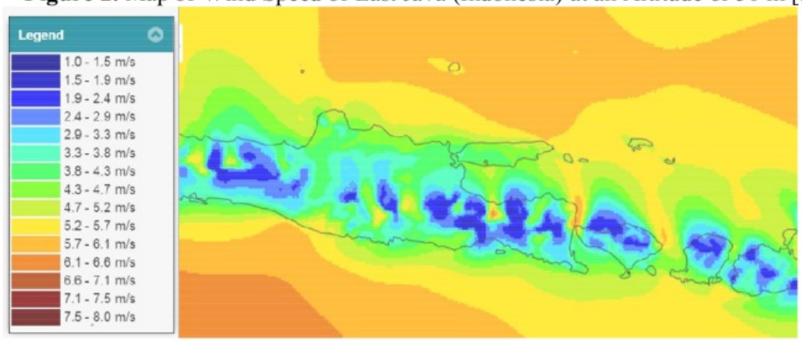
Figure 1. (a) Fixed Wings Drone, (b) Rotary Wings Drone

2.2 Wind Energy

The following figure shows a map of wind resources for the island of Java (Indonesia) at an altitude of 500 m. So that it can be analyzed the potential of wind energy on the south coast of East Java suitable to be developed into Wind Power Plant. The average wind speed for the land area is around 3.3 m/s - 4.3 m/s, and on the shoreline the average wind speed is around 4.3 m/s - 5.7 m/s.

ISBN : 978-602-14917-9-9

Figure 2. Map of Wind Speed of East Java (Indonesia) at an Altitude of 50 m [5]



In the use of wind energy to be converted into electrical energy, wind speed and direction data are needed over a long period of time. Wind energy is energy that comes from wind speed which is useful for turning blades on a windmill. Wind turbines work by capturing kinetic energy in the wind with blades and transferring it to the drive shaft. Axle with gearbox (speed-increasing gearbox) supported by medium-speed generators, high-speed generators, low-speed or direct-drive generators. The task of the generator is to convert energy from shaft rotation into electrical energy. In modern wind turbines, rotor blades can be controlled to maximize the production of wind speeds as desired, as well as maintaining the power produced to remain stable and limit the mechanical load on turbines at high wind speeds.

A general explanation regarding turbine technology and electricity in Wind Power Plant can be seen in the following Figure 3.

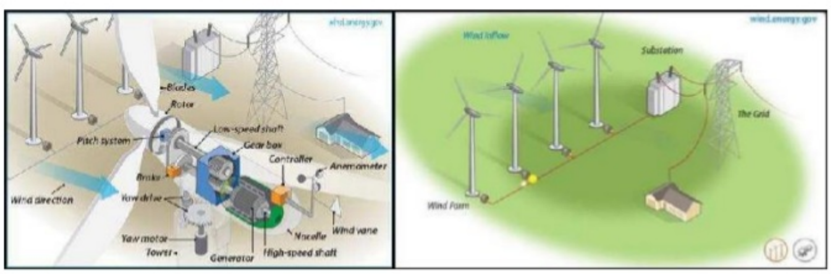


Figure 3. Turbine Technology and Electricity in Wind Power Plant in general

Wind energy can be calculated using the following formula.

$$E = \frac{1}{2} . m . V^2 \quad (1)$$

Where,
E : wind kinetic energy (joule)
m : air mass (kg)
V : wind velocity (m/s)

If in an air unit has an area and moves with a certain speed, then the amount of mass of air flowing per second is as follows.

$$m = \rho . A . V \quad (2)$$

Where,

ISBN : 978-602-14917-9-9

m : air mass (kg)
ρ : air density (kg/m^3)
A : area (m^2)
V : wind velocity (m/s)

Next, power being produced by the wind is as follows.

$$P = \frac{1}{2}\,\rho \,.\, A \,.\, V^3 \quad (3)$$

Where,
P : wind power (watt)
ρ : air density (1,2 kg/m^3)
A : area (m^2)
V : wind velocity (m/s)

According to Brown, C.K. and Warne (1975) in his research, effective wind power that might be produced by wind turbines is as follows.

$$Pw = \frac{1}{2}\,Cp \,.\, \rho \,.\, D^2 \,.\, V^3 \quad (4)$$

Where,
Pw : effective wind power (watt) Cp : power coefficient (0,4)
ρ : air density (1,2 kg/m^3)
D : wind turbine area (m^2) V : wind velocity (m/s)

To generate electricity through the conversion of wind power systems can be formulated as follows.

$$Psystem/_{A} = \frac{1}{2}\,Cp \,.\, \eta tr \,.\, \eta g \,.\, \eta b \,.\, \rho \,.\, V^3 \quad (5)$$

Where,
Ps/A : system power per area (watt/m^2)
Cp : power coefficient (0,4)
Ƞtr : transmission efficiency (0,95)
Ƞg : generator efficiency (0,85)
Ƞb : battery efficiency (0,75)
ρ : air density (1,2 kg/m^3)
V : wind velocity (m/s)

By substituting the above value into equation (5), the electrical energy that can be generated / unit area of the windmill blade cross section is as follows.

$$Psystem/_{A} = 0{,}1454\ kg/m^3 \,.\, V^3 \text{ (Watt/m}^2\text{)} \quad (6)$$

And for the interval *dt* obtained is as follows.

$$Psystem/_{A} = 0{,}1454\ kg/m^3 \,.\, V^3 .\, dt \text{ (Watt/m}^2\text{)} \quad (7)$$

3. Material and Methodology

3.1 Tools and Materials

- Drone Surveyor tipe quadcopter (Rotary Wings)
- Drone Battery (Lithium polymer)
- Payload of Drone
- Drone Tool Equipments
- Remote Control Drone and Payload

ISBN : 978-602-14917-9-9

Figure 4. Wind Energy Potential Survey Equipment at Payangan Beach in Jember

ISBN : 978-602-14917-9-9

3.2 Procedure

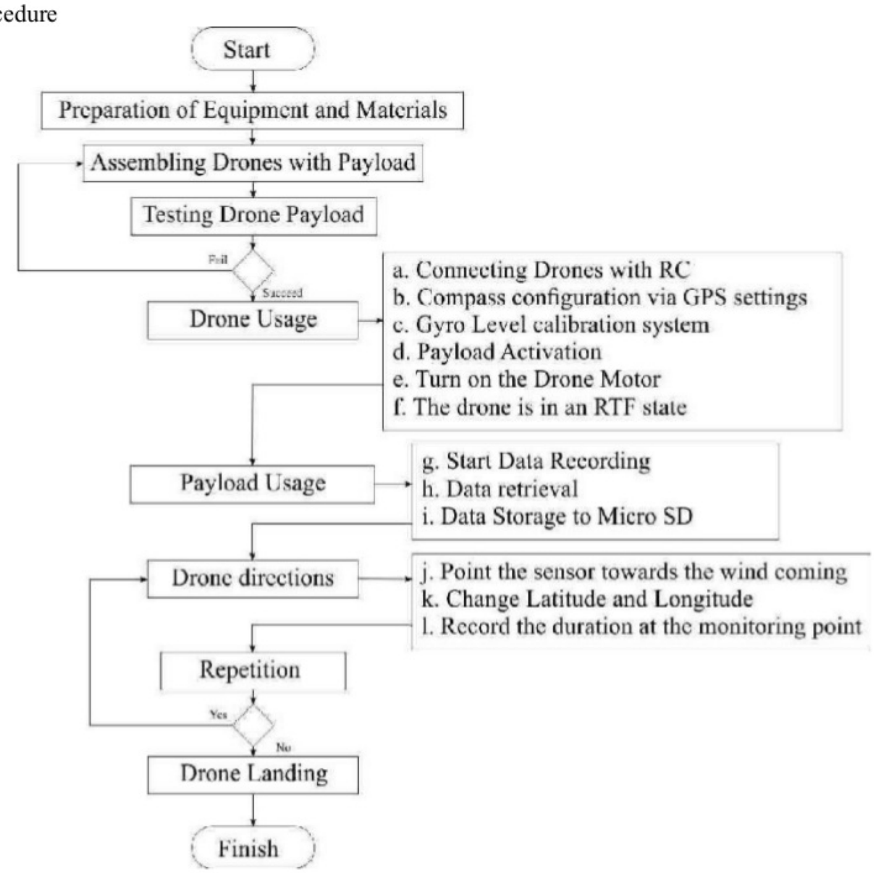
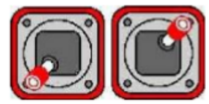
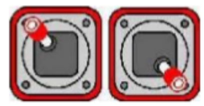


Figure 5. Flow of Wind Potential Data Retrieval at Payangan Beach Using Drone Surveyor Technology

ISBN : 978-602-14917-9-9

Table 1. Explanation of Drone and Payload Usage

Subject	Information	Methode
a	Connect the Drone with the remote control in the way shown on the side, hold for 3-4 seconds until you hear a beep on the drone	
b	Adjusting the compass through the GPS system so that drone users can more easily determine the position of the drone, after pressing the remote lever like the picture on the side, swing the drone to resemble the number 8 or ∞ shaped	
c	Calibration of the gyro level system that is useful for adjusting the surface of the drone to water in accordance with the position of the initial placement of the drone	
d	Payload activation by connecting the power cable to a power source or drone battery	-
e	Turn on the drone motor, the propeller will rotate at standby / idle speed	
f	The drone is ready to fly (RTF)	-
g	Payload activation by pressing the on button on the payload remote control	-
h	The data retrieval process starts right after the payload is activated	-
i	Coordinate data, altitude, wind speed captured by the payload via the sensor will be sent and saved into the Micro SD that is already installed	-
j	Directing the sensor in the direction of the wind coming in accordance with the direction settings of the drone, for more ease faced the sensor in the direction of the drone's head	
k	Drone control in accordance with the desired wind energy monitoring point (latitude and longitude)	
l	Adjust the calculation duration per monitoring point according to the needs and capabilities of the battery and to make it easier to sort data based on time	-

3. Results and Discussions

In a study that took place at Payangan beach in Jember district, we took preliminary data on Friday, August 9, 2019 for a certain duration of time according to the ability / durability of the drone batteries we use. The period of collecting wind speed data through the drone surveyor is every 5 x 110 seconds or in one session the data collection is obtained 22 data of wind speed every 110 seconds. Then we divided the number of available drone batteries into 3 data retrieval sessions. The height of the drone used in all data retrieval sessions is 30 masl.

ISBN : 978-602-14917-9-9

Initial data collection uses primary data that researchers collect themselves in the field with the aim of obtaining valid data and in accordance with conditions in the field. The process of collecting wind speed data at Payangan beach as shown in Figure 6.
From the research, it was obtained the value of wind speed in Payangan Beach in Jember district from direct measurements as tabulated in Table 2. regarding initial observations of wind speed on Payangan Beach.

Table 2. Wind Speed at an altitude of 30 meters above sea level in Payangan Beach

No.	Second	WindVelocity(m/s)		
		13.00 pm	13.15 pm	13.30 pm
1	5	27	24	11
2	10	27	26	22
3	15	38	31	31
4	20	35	18	22
5	25	52	16	6
6	30	47	9	14
7	35	39	10	19
8	40	25	12	22
9	45	31	43	3
10	50	25	18	12
11	55	20	21	17
12	60	24	24	6
13	65	31	6	26
14	70	35	27	20
15	75	24	21	34
16	80	30	10	40
17	85	31	5	31
18	90	32	6	24
19	95	21	3	6
20	100	30	6	7
21	105	19	6	6
22	110	22	6	17

The data in the above table, if shown in the graph, it will look like the following Figure 6.

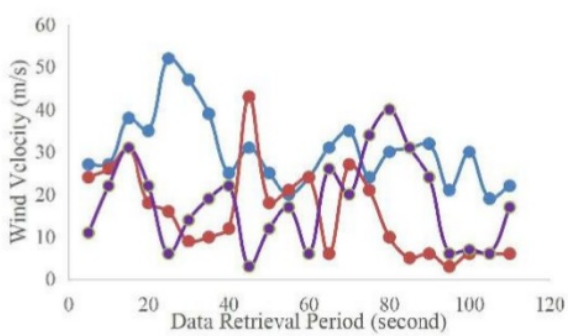


Figure 6. Wind Speed at Payangan Beach at an altitude of 30 meters above sea level

ISBN : 978-602-14917-9-9

By knowing the mode value from the wind speed data above, the wind velocity (V) value can be determined by the following formula.

From the wind speed data above, the determination of wind speed at Payangan beach by analyzing the numbers that often appear (mode) as shown in Table 3 below.

Table 3. Velocity Mode

Data	Frequency
1-10	16
11-20	13
21-30	22
31-40	12
41-50	2
51-60	1

By knowing the mode value from the wind speed data above, the wind velocity (V) value can be determined by the following formula.

$$V = Tb + P\left(\frac{d1}{d1 + d2}\right) \quad (8)$$

$$V = 20{,}5 + 10\left(\frac{9}{9 + 10}\right) (m/s)$$

$$V = 25{,}23684211\ m/s$$

Where,

V : wind velocity (m/s)

Tb : the lower edge of the median class

(20,5) P : class length (10)

d1 : difference in mode class frequency with the previous class (22-13=9)

d2 : difference in mode class frequency with the class afterwards (22-12=10)

Meanwhile, to predict wind power per unit area (m^2), it can be calculated using equation (3) as follows.

$$P/A = \frac{1}{2}\ 1{,}2\ kg/m^3\ .\ (25{,}2368411\ m/s)^3$$

$$P/A = 9643{,}98\ Watt/m^2$$

Wind turbine power can also be predicted by substituting the results of equation (8) into equation (6) as follows.

$$Psystem/A = 0{,}1454\ kg/m^3\ .\ (25{,}2368411\ m/s)^3$$

$$Psystem/A = 1402{,}235\ Watt/m^2$$

5. Conslusions

From this research it can be concluded as follows:

1. Based on the situation on the ground, the use of drone surveyors in collecting wind potential data has the advantage of diversifying location data that is difficult to reach with conventional measurement methods.
2. Based on the wind speed chart above, wind characteristics at Payangan beach tend to be random but have a wide wind speed range between 3 - 52 m / s.
3. Based on the wind speed mode table, the highest frequency of wind recorded at a speed of 21-30 m / s is 22 times from 66 single data collected or 33.33%.
4. Based on the potential wind power, a wind speed of 25.2 m / s has a wind power of 9644 Watt/m^2 and a power converted to a generator of 1402 Watt/m^2.

ISBN : 978-602-14917-9-9

Acknowledgements

Our thanks to the Directorate General of Higher Education, Ministry of Research, Technology and Higher Education, Republic of Indonesia. This grant is given of fundamental research grant in 2019.

References

[1]. National Energy Council of Indonesian. 2019. Indonesia's Energy Sustainability 2017. Jakarta
[2]. KESDM. 2016. Modeling of Energy Supply and Utilization Forecast with Regional Renewable Energy Optimization Scenarios. Jakarta: Center for Data and Information Technology of ESDM
[3]. Indrawa, Mustaqim. 2009. Analisis Dan Simulasi Pembangkit Litrik Tenaga Angin Di Daerah Tepi Pantai Watu Ulo. Jember (in Indonesia).
[4]. Han, Yong-Gu. 2017. How to Utilize Vegetation Survey Using Drone Image and Image Analysis Software. Kyungpook National University.
[5]. EMD, Wind Energy Resources of Indonesia, http://indonesia.windprospecting.com/
[6]. Brown, U.K. and Warne, D.F. 1981. An Analysis Potential for Wind Energy Production in North Western Ontanio in Wind Power Report. Ontanio Research Foundation, Canada

potensial study on wind energy

ORIGINALITY REPORT

17%	5%	10%	14%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	G Prayitno, N Safitri, A Subagiyo, B Riska. "Food security index and livelihood assets of Pandaan District, Pasuruan Regency, Indonesia", IOP Conference Series: Earth and Environmental Science, 2019 Publication	2%
2	www.scribd.com Internet Source	2%
3	Submitted to University of Aberdeen Student Paper	2%
4	Triwahju Hardianto, Bambang Supeno, Azmi Saleh, Dedy Kurnia Setiawan, Gunawan, Setya Indra. "Potential of Wind Energy and Design Configuration of Wind Farm on Puger Beach at Jember Indonesia", Energy Procedia, 2017 Publication	1%
5	Bayu Rudiyanto, IbnuAtho Illah, Nugroho Agung Pambudi, Chin-Chi Cheng et al. "Preliminary analysis of dry-steam geothermal power plant by employing exergy assessment: Case study in	1%

Kamojang geothermal power plant, Indonesia", Case Studies in Thermal Engineering, 2017
Publication

6 Submitted to Institute of Technology Carlow
Student Paper
1%

7 Rusdi Febriyanto, Bayu Rudiyanto, Nugroho Agung Pambudi, Indah widiastuti, Kukuh Mukti Wibowo, Riyanto, Nova Dany Setyawan. "Study experimental of blade NACA 4412 with pitch angle on horizontal wind turbine", Journal of Physics: Conference Series, 2019
Publication
1%

8 Submitted to University of Queensland
Student Paper
1%

9 Submitted to University of Glamorgan
Student Paper
1%

10 Pranali Yenkar, S. D. Sawarkar. "A Survey on Social Media Analytics for Smart City", 2018 2nd International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), 2018 2nd International Conference on, 2018
Publication
1%

11 Long Zhang, Hui Zhao, Shuai Hou, Zhen Zhao, Haitao Xu, Xiaobo Wu, Qiwu Wu, Ronghui
1%

Zhang. "A Survey on 5G Millimeter Wave Communications for UAV-Assisted Wireless Networks", IEEE Access, 2019
Publication

12	Charles R. Warren, Carolyn Lumsden, Simone O'Dowd, Richard V. Birnie. "'Green On Green': Public perceptions of wind power in Scotland and Ireland", Journal of Environmental Planning and Management, 2005 Publication	<1 %
13	Submitted to Nottingham Trent University Student Paper	<1 %
14	Submitted to Universiti Tenaga Nasional Student Paper	<1 %
15	Submitted to Politeknik Negeri Jember Student Paper	<1 %
16	Submitted to Universitas Jember Student Paper	<1 %
17	Submitted to CSU Office of the Chancellor Student Paper	<1 %
18	en.wikibooks.org Internet Source	<1 %
19	repository.unimal.ac.id Internet Source	<1 %
20	Submitted to University of Adelaide	

Student Paper

<1%

21	Tumiran, Sarjiya, Lesnanto M. Putranto, Wahri Sunanda, Roni Irnawan, Adi Priyanto, Ira Savitri. "The Masterplan for Developing Electricity Systems for Archipelagic Area by Considering Local Energy Resources: A Case Study of Maluku Islands", 2019 IEEE 7th International Conference on Smart Energy Grid Engineering (SEGE), 2019 Publication	<1%
22	Submitted to Curtin University of Technology Student Paper	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		