JURNAL ECOTIPE
Electronic, Control, Telecommunication, Information, and Power Engineering

Volume 9, Issue 2, October 2022, pp. 133-139
ISSN 2355-5068 ; e-ISSN 2622-4852
DOI: 10.33019/jurnalecotipe.v9i2.2991

Feasibility Study of Raw Material for Hybrid Power Plant in Coastal Cilacap Selatan

Afrizal Abdi Musyafiq[1], Vicky Prasetia[2], Purwiyanto[3], Hera Susanti[4], Novita Asma Ilahi[5], Hendi Purnata[6], Saepul Rahmat[7]
[1,2,3,4,5,6,7]Department of Electronic Engineering, Polytechnic of Cilacap, Cilacap, 53212, Indonesia

ARTICLE INFO

Article historys:

Received : 23/05/2022
Revised : 01/09/2022
Accepted : 05/10/2022

Keywords:

Cilacap, Coastline, Potential Raw Material, Solar, Wind

ABSTRACT

Cilacap Regency is a coastal area south of the island of Java. The purpose of this study is to determine the potential of raw materials available in the South Cilacap Coastal area and to determine the potential power that can be generated for the PLTH system through the calculation of the raw material data that has been obtained. This research method begins with direct measurements of wind speed and light intensity. Both devices read data in real time and connect online. The data obtained is processed to determine the wind speed and the average intensity of sunlight. The results of these calculations are entered into the equations to calculate the potential power that can be generated. Based on the calculation, the average wind speed is 3-4 m/s and the light intensity is 54612 watt/m2. The results of the calculation of the potential power that can be generated from the PLTB system in the coastal area of South Cilacap is equivalent to 508 watts/day. The potential power that can be generated from PLTS is 10.8 kW/day. The total potential power that can be generated from the PLTH system on the coast of South Cilacap is equivalent to 273.22 kWh/day.

Copyright © 2022. Published by Universitas Bangka Belitung
All rights reserved

Corresponding Author:

Hera Susanti
Polytechnic of Cilacap, Jl. Dr. Soetomo No.1, Sidakaya, Cilacap Regency, 53212, Indonesia
Email: herasusanti@pnc.ac.id

1. INTRODUCTION

Indonesia is a large and vast country that is bestowed with potential Natural Resources (SDA)[1] as well as Human Resources (HR) with diverse and diverse backgrounds. Potential natural resources can be utilized as much as possible to prosper and improve the economy of the Indonesian people. Abundant natural resources can be used as raw material [2,3] to convert energy into electrical energy in a power generation system [4,5]. SDA can be used as raw material with the greatest potential starting from geothermal; water; Sun; wind; wave; biomass; and others [6,7,8,9,10,11]. Abundant natural resources are used to the fullest to support government programs in meeting national energy needs in the new renewable mix.

Based on Law Number 30 of 2007 concerning Energy, it is stated that in order to regulate the supply and use of energy in a sustainable manner, the central government and local governments require the use of new and renewable energy in accordance with their respective authorities. Based on Government Regulation number 79 of 2014 concerning National Energy Policy, it is confirmed that the government is committed to increasing the ratio of new and renewable energy in the national energy mix by 23% by 2025 [12]. The use of new renewable energy that can be developed is hybrid technology. Hybrid technology is a technology that uses 2 (two) or more generating systems to convert energy into electrical

Volume 9, Issue 2, October 2022, pp. 133-139
ISSN 2355-5068 ; e-ISSN 2622-4852
DOI: 10.33019/jurnalecotipe.v9i2.2991

energy stored in power storage. The hybrid technology applied in this project consists of generating electricity from wind power and solar power.

A wind power plant is a generating system that utilizes energy from wind speed, which is converted into mechanical energy to drive propellers, which are connected to turbines and generators so that they can produce electrical energy. solar power plant, is a generating system that utilizes energy from the intensity of sunlight, which is then converted into chemical energy in the solar panel module, to produce electrical energy.

One of the provinces that has natural resource potential for wind and solar raw materials is Central Java, with its territory stretching from the south coast to the north coast. The southern coast of Central Java stretches from Cilacap Regency to the border with Kulonprogo, Yogyakarta Special Region. Cilacap Regency is one of the areas on the southern coast of Java which has an area of 2,124 km2 with a population of 1,906,849 people in 2019. The purpose of this study was to determine the potential of raw materials available in the South Cilacap Coastal area and to determine the potential power that can be used. generated for the PLTH system through the calculation of the raw material data that has been obtained.

2. RESEARCH METHOD

Research on the feasibility study of the potential raw material for a new renewable energy-based hybrid system in Coastal Cilacap Selatan to support the government's program in meeting the new renewable energy mix target of 23% by 2025 was carried out around the Cilacap State Polytechnic campus. The research tools used are divided into 2 (two) types, namely the main tools and supporting tools. The main tools mostly function to assist the data collection process for this research. Support tools mostly function as data acquisition and data processing software. The research materials used are raw materials to support new renewable energy such as wind speed and sunlight intensity.

Sources of data obtained in this study are primary and secondary data sources. The primary data source is direct data collection, namely the measurement of wind speed and sunlight intensity for 24 hours in 6 consecutive months (July-December). Installation of wind speed monitoring equipment is placed on a 10 meter high pole. The situation around the tool is that there are several trees as high as 5-8 meters and there are buildings around it which have a height of 8 meters. The installation of a monitoring tool for the intensity of sunlight is placed in a field area near the Electrical Engineering Study Program building with conditions around the field without obstacles from falling sunlight onto the monitoring tool. Secondary data sources are obtained from the results of literature studies in the form of scientific articles and field observations.

The initial method of this research in data collection was carried out with research preparation consisting of checking tools and calibration of tools. The tools and equipment used in the research are Arduino; 16 x 2 LCD; I2C character LCD; anemometer; sim800 modem; RTC DS1307; 18650 battery; battery holder; battery chargers; plastic box; step-down DC; CB connector; jumper cables; usb cable; sensor data cable. The need for tools and materials after the design of the tool has a discussion of the needs caused by a lack or incompatibility of tools and materials in the design of environmentally friendly lawn mowers based on new and renewable energy. Discussion of tool requirements where the use of basic equipment such as combination pliers, (+) and (-) screwdrivers, wrenches, drills, electric welding, rivet pliers, hammers, markers, rulers, scissors, grinders taken from the tool room can be used in the design process mechanical parts, but the rotary drive holder requires a lathe which requires a good shape and level of precision in order to reduce friction and vibration levels when the knife is made, where the manufacture is carried out in an electrical workshop, Department of Electronics Engineering, State Polytechnic of Cilacap. The mechanical and electrical parts used are tinol, PCB, ferrite chlorite, connecting cable size 0.75, cable terminals, adhesive glue, insulation, fire insulation, tiret, cucumber and spiral then online purchase including rotation speed controller, jumper cable, sensor voltage, current sensor, INA219 sensor, DC motor optocoupler sensor, Solar cell, arduino and battery[13,14].

2.1. Measuring the power potential of wind energy

Measurements are made using an anemometer which is used to measure wind speed in real time. Wind speed is measured for a minimum of 3 months to determine the character of the wind speed in

JURNAL ECOTIPE
Electronic, Control, Telecommunication, Information, and Power Engineering
Volume 9, Issue 2, October 2022, pp. 133-139
ISSN 2355-5068 ; e-ISSN 2622-4852
DOI: 10.33019/jurnalecotipe.v9i2.2991

certain trimesters during the year. The results of the wind speed obtained are entered in the following equation:

$$P = \frac{1}{2}\,\rho\,\pi\,C_p\,R^2\,v^2 \quad (1)$$

Information in equation (1) where P is the power potential that can be generated (watts); is the wind density (kg/m3); Cp is the maximum velocity coefficient with a value of 0.25 – 0.45; R is the turbine blade radius (meters); and v is the average wind speed (m/s).

2.2. Measuring the power potential of solar energy [15][16]

Measurements are made using a luxmeter which functions to measure the intensity of sunlight in real time. The results of the sunlight intensity obtained are entered in the following equation:

$$P = \frac{E}{I_{av}\,\eta_m}\,n\,.\,p_m \quad (2)$$

Information in equation (2) where P is the power generated by the solar panel module (watts); E is energy (watt hour); Iav is the average luminous intensity (W/m2); m is the efficiency of the module (%); n is the number of modules; and Pm is the maximum power of a module (watts).

3. RESULTS AND DISCUSSION

3.1. Making Device for Data Retrieval

The process of making a data collection device consists of an anemometer that is associated with the process of collecting wind speed data. The data obtained can then be processed in real time and can be connected online with the website. The wind speed data collection process is carried out in a tower around the electrical engineering building with position coordinates at 7°43'06.5" South Latitude - 109°01'10.4" East Longitude at an altitude of 10 meters. The situation around the building is that there are trees that are approximately 5-7 meters high and there is also a 34-meter-high joint college building. Wind speed is stochastic, meaning that the data obtained cannot be conditioned because the wind is a natural trait that moves freely and randomly anywhere and anytime. The wind speed data processing approach is carried out using the Weidbull statistical method. Making the next device is taking data from the luxmeter which is related to the process of collecting data on the intensity of sunlight. The data obtained can then be processed in real time and can be connected online with the website. The process of collecting data on the intensity of sunlight is carried out in the area of the PNC electronics engineering building which has position coordinates at 7°43'06.5" South Latitude - 109°01'10.4" East Longitude. The value of the intensity of sunlight obtained varies depending on the weather in the data collection process, but the value of the intensity of sunlight at its peak at around 09.00 to 15.00 is the same value. The device that is made processes data every 10 minutes and the data is collected so that the average highest value is taken.

3.2. Analysis of Raw Material Data Collection Process for New Renewable Energy

The process of collecting wind speed data in the southern coastal area begins with making a wind speed measuring sensor connected to an anemometer as shown in Figure 1. Then the sensor is programmed to be able to send existing data in real time and the data can be transferred online via the android program. The data collected during the day is calculated with the average speed using the Weidbull method approach, so that the average wind speed is obtained for a full day. Based on the equation for calculating the power potential that can be generated from wind energy, the average wind speed in the southern coastal area is 3-4 m/s. This is evidenced by the data listed in the table in the data collection process. If it is known that the wind density value is 1.2 kg/m3. The blade radius used is 1 meter and the maximum speed coefficient value is 0.25. So based on the calculation, the potential value of wind energy generation in the coastal area of South Cilacap is 101,736 watts. In this project, it is planned that there will be 5 installed wind turbines, so that the total potential power that can be generated is 508 watts/day or equivalent to the energy produced of 12.2 kwh/day.

JURNAL ECTIPE
Electronic, Control, Telecommunication, Information, and Power Engineering
Volume 9, Issue 2, October 2022, pp. 133-139
ISSN 2355-5068 ; e-ISSN 2622-4852
DOI: 10.33019/jurnalecotipe.v9i2.2991

Table 1. Primary data of wind speed

Date	Time	Wind velocity (m/s)
August 1, 2020	22:31:00	2,83
August 2, 2020	02:13:00	4,9
August 3, 2020	10:23:00	5,65
August 4, 2020	12:27:00	5,09
August 5, 2020	05:43:00	8,86
August 6, 2020	09:55:00	4,52
August 7, 2020	11:56:00	3,77
August 8, 2020	15:32:00	5,28
August 9, 2020	23:11:00	5,28
August 10, 2020	03:09:00	4,71
August 11, 2020	06:06:00	13,19
August 12, 2020	09:03:00	3,77
August 13, 2020	16:02:00	4,52
August 14, 2020	19:11:00	6,35
August 15, 2020	20:12:00	3,96
August 16, 2020	21:15:00	3,77
August 17, 2020	22:18:00	3,77
August 18, 2020	17:19:00	4,15
August 19, 2020	18:21:00	3,39
August 20, 2020	04:24:00	9,52
August 21, 2020	07:26:00	3,58
August 22, 2020	06:27:00	5,28
August 23, 2020	08:29:00	5,65
August 24, 2020	02:37:00	4,9
August 25, 2020	01:38:00	4,15
August 26, 2020	00:33:00	5,47
August 27, 2020	17:30:00	6,41
August 28, 2020	12:39:00	8,29
August 29, 2020	22:45:00	4,15
August 30, 2020	20:48:00	5,77
August 31, 2020	18:49:00	6,25

Table 1. Shows primary wind speed data taken in the coastal area of South Cilacap using an anemometer that is connected to an android-based and real-time data collection device. Based on Table 1. The highest speed occurred on August 13, 2020 at 06.06 WIB at 13.19 m/s and the lowest speed occurred on August 1, 2020 at 22.31 WIB at 2.83 m/s. The wind speed data value reaches the highest point above the average because the device reads the wind speed data when the highest value is stored and processed by the anemometer wind speed measurement system that has been programmed. So that the value of the data obtained for 1 full month for the average value of wind speed has different variance values.

JURNAL ECOTIPE
Electronic, Control, Telecommunication, Information, and Power Engineering
Volume 9, Issue 2, October 2022, pp. 133-139
ISSN 2355-5068 ; e-ISSN 2622-4852
DOI: 10.33019/jurnalecotipe.v9i2.2991

Figure 1. Primary wind speed data collection in the coastal area of Cilacap regency

Next, proceed with the process of taking data on the value of the intensity of sunlight by direct measurement using a luxmeter and a sensor measuring the intensity of sunlight. The solar light intensity sensor is integrated with the android program so that it can be monitored in real time and the data can be accessed online. The workings of measuring the intensity of sunlight with a sensor begins with creating a program with related equations. Then it is done by calibrating the sunlight intensity sensor with a luxmeter as shown in Figure 2.

Figure 2. Primary data collection of sunlight intensity in coastal areas, Cilacap regency

Measurement of the intensity of sunlight was carried out for 24 hours, with the highest value of sunlight intensity obtained at 54,612 watts/m2. The value of the intensity of sunlight from the measurement results is always different every hour. If the manufacture of this prototype requires an area of 100 m2 and the efficiency of the solar panel module used is around 20-30%, then the potential power that can be generated from a PLTS is 1.63 MW. If the dimension specifications of a solar panel module are 1482 x 992 x 35 mm and are able to produce a peak power of 200 Wp, then the effective area of a solar panel module is 1,470 m2. Based on the needs assessment, it was found that the number of solar

JURNAL ECTIPE
Electronic, Control, Telecommunication, Information, and Power Engineering
Volume 9, Issue 2, October 2022, pp. 133-139
ISSN 2355-5068 ; e-ISSN 2622-4852
DOI: 10.33019/jurnalecotipe.v9i2.2991

panel modules used were 68 solar panel modules with a potential power that could be generated of 10.8 kW/day or equivalent to the energy produced of 261.12 kWh/day.

Table 2. Primary data intensity of sunlight

Time	Sunlight Intensity (watt/m^2)
00:00:00	1
01:00:00	1
02:00:00	1
03:00:00	1
04:00:00	1
05:00:00	1
06:00:00	1
07:00:00	22.089
08:00:00	22.109
09:00:00	33.850
10:00:00	54.612
11:00:00	54.612
12:00:00	54.612
13:00:00	54.612
14:00:00	54.612
15:00:00	33.850
16:00:00	15.400
17:00:00	12.462
18:00:00	1
19:00:00	1
20:00:00	1
21:00:00	1
22:00:00	1
23:00:00	1
24:00:00	1

Table 2. Shows primary data on the intensity of sunlight taken in the coastal area of South Cilacap using a luxmeter that is connected to an android-based and real-time data collection device. Based on Table 2. The value of the intensity of sunlight obtained from 10:00 to 14:00 WIB is 54,612 watts/m2. The lowest value of sunlight intensity is at 17.00 WIB at 12,462 watt/m2. The conditions for data collection were in a clear sky without clouds throughout the sunrise.

4. CONCLUSION

The conclusion in this study is that a suitable source of raw material to support new renewable energy systems in the Cilacap State Polytechnic area is wind energy reaching 10 kwh and solar energy 20 kwh. Raw material from the wind reaches an average speed of 3-4 m/s and the sun reaches 56,214 watts/m2. The highest percentage of raw materials for new and renewable energy systems is solar energy reaching 67% and wind energy at 33%.

Acknowledgments

The Center for Research and Community Service (P3M) of the Cilacap State Polytechnic for funding this research. Thank you to the Directorate General of Vocational Higher Education of the Ministry of Education, Culture, Research, and Technology and the Center for Research and Community Service (P3M) of the Cilacap State Polytechnic for funding and assisting this research.

Volume 9, Issue 2, October 2022, pp. 133-139
ISSN 2355-5068 ; e-ISSN 2622-4852
DOI: 10.33019/jurnalecotipe.v9i2.2991

REFERENCES

[1] Rahma, A.A., *Potensi Sumber Daya Alam dalam Mengembangkan Sektor Pariwisata di Indonesia*, Jurnal Nasional Pariwisata, 12, 1-8, 2020.

[2] Hadjadj, Rachid, et al, *Renewable energy and raw materials–The thermodynamic support*, Journal of Cleaner Production, 241, 2019.

[3] Praene, Jean Philippe, et al., *Comoros's energy review for promoting renewable energy sources*, Renewable Energy, 2021.

[4] Wan, Yong, et al., *Wave energy assessment related to wave energy convertors in the coastal waters of China*, Energy, 202, 2020.

[5] Yin, Zuozong, et al., *A shoe-mounted frequency up-converted piezoelectric energy harvester*, Sensors and Actuators A: Physical, 2021.

[6] Li, Yi, et al., *Numerical investigation of a novel approach to coupling compressed air energy storage in aquifers with geothermal energy*, Applied Energy, 279, 2020.

[7] Liang, Caihao, et al., *A production-cost-simulation-based method for optimal planning of the grid interconnection between countries with rich hydro energy*, Global Energy Interconnection, 3.1, 2020.

[8] Gao, Yang, et al., *Assessing the wind energy potential of China in considering its variability/intermittency*, Energy Conversion and Management, 226, 2020.

[9] Kumar, Notan, and Sanjeev Kumar Gupta., *Progress and application of phase change material in solar thermal energy: An overview Materials Today*, Proceedings, 2020.

[10] Patel, Ravi P., et al., *Wave resource assessment and wave energy exploitation along the Indian coast*, Ocean Engineering, 217, 2020.

[11] Wang, Zhaohua, et al., *Biomass energy production and its impacts on the ecological footprint: An investigation of the G7 countries*, Science of the Total Environment, 743, 2020.

[12] Ari, K.P., et al., *Kajian Peningkatan Efisiensi Energi di Industri Pulp dan Kertas*, Jurnal Energi dan Manufaktur, 13, 1-7, 2020.

[13] Azad, Kalam, et al., *Assessment of wind energy prospect by Weibull distribution for prospective wind sites in Australia*, Energy Procedia, 160, 348-355, 2019.

[14] Mangestiyono, Wiji, Bambang Setyoko, and Dista Yoel Tadeus, *Mechanical Strength of 10 kW Wind Turbine Blade Utilize Glass Fiber Reinforced Plastic*, Materials Today: Proceedings 13, 71-75, 2019.

[15] Kaya, Ozgur, Anna M. Klepacka, and Wojciech J. Florkowski., *Achieving renewable energy, climate, and air quality policy goals: Rural residential investment in solar panel*, Journal of environmental management, 248, 2019.

[16] Echarri-Iribarren, Víctor, *Conditioning using ceramic floor panels with capillary tube mats and solar thermal panels on the Mediterranean coast: Energy savings and investment amortisation*, Energy and Buildings, 202, 2019.