Feasibility Study of Performance Low Capacity Hybrid Energy Power Plant System in Remote Area

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Abstract—. The fossil energy utilization for electricity generation is currently starting to be limited because it is predicted that the availability of fossil energy for the next few decades will run out. Renewable energy is an alternative energy that can be used to generate electricity. Solar power plant is one of the electrical energy generators with renewable energy sources that have been widely used. Solar power plant is a Distributed Generator that can be applied directly to consumers and it is very suitable for use in remote areas which currently still use diesel as a fuel for power generation. In this research, the design of a hybrid power generation system between Soalr Energy and Wind will be carried out to replace the use of diesel as a source of electricity generation. After the generator design is done, then the performance test of the hybrid system will be carried out in order to see the feasibility of the design that has been made. From the test results, the results of the Hybrid Energy Generator have efficiencies ranging from 10-12% where this shows that the power plant system is still said to be unable to work efficiently. The average amount of energy produced from this Hybrid PLT system is 1,304 kWh per day. Based on the results of the economic feasibility analysis, that the use of the hybrid system is able to produce savings of Rp. 1,700 – Rp. 2,100/kWh per day.

Keywords—hybrid, Energy Generation, testing, performance.

I. INTRODUCTION

The consumption of electrical energy is increasing day by day, various electronic devices to support all human activities have been created. Without realizing it, the need for electrical energy will also increase along with the development of various technologies [1]. The consumption of electrical energy is increasing day by day, various electronic devices to support all human activities have been created. The increase in energy demand must go hand in hand with the current energy availability. The electricity provided by PLN, 90 percent is generated using fossil fuels zing it, the need for electrical energy will also increase along with the development of various technologies [2][3]. Fossil fuels found in Indonesia will also run out in a certain period of time, because their availability is very limited. 95% of energy use in Indonesia is still dominated by fossil fuels such as coal, oil and gas which are very limited in number [4][5]. One way to meet the increasing energy needs with the current limited fossil fuels is to use renewable energy [6][7]. Currently, of the total installed capacity of national power plants, renewable energy accounts for 14.7% with a capacity of 10,426 MW [7]. The use of fossil energy for electricity generation is currently starting to be limited because its availability in the next few decades is predicted to run out. Renewable energy is an alternative energy that can be used as an energy source to generate electricity [7].

The development of renewable is currently very necessary to be able to replace fossil energy whose availability is dwindling. With its abundant availability, renewable energy can be used as an energy source for power plants that can be applied even to remote areas. A hybrid system in a power plant is an integrated system of two or more power plants. Hybrid systems can be carried out by combining fossil power plants with renewable energy, renewable energy with PLN, or a combination of 2 or more renewable energy power plants.

Indonesia is a country with a tropical climate, which has very good sunlight. With good solar radiation, it needs to be utilized, one of which is with a Solar Power Plant [2][8]. Solar power plant is a generator that converts electrical energy into solar energy. This plant is one type of environmentally friendly generator. Because PLN's fossil fuels will run out over time, so it is necessary to develop this solar power plant as an alternative energy [9][10]. Indonesia located on the equator that is estimated to have solar radiation of 4.8 kWh/m2/day. Solar panels convert photon energy into electrical energy where the sun plays an important role in this, changing environmental conditions can affect the output power of solar panels. Solar power plants are generators with renewable energy sources that are currently widely used. Solar power plant is a Distributed Generator that can be applied directly to consumers and is very suitable for use in remote areas which currently still use diesel as fuel for power generation [12][13].

Currently, there are still many remote areas that used diesel as a power plant. However, the use of diesel is still considered ineffective because the price of the fuel used is still relatively expensive, its availability is limited and it still produces high emissions. It is necessary to replace the source of electrical energy used to reduce the negative impact of its use.

A hybrid power plant is a generation system consisting of 2 (two) or more generators with different sources. The purpose of this hybrid system is to support the weaknesses of each generator in order to be able to maximize the performance of each other so that the reliability of the system can be well maintained. The hybrid system is an alternative in providing electricity that cannot be reached by PLN because of its easy distribution in remote areas. The power plants commonly used in this hybrid system are solar power plants, micro hydro power plants, and wind power plants [13][14].

The power contribution of each power plant is different/unfixed over time. This is because solar power plant and wind power plant are intermittent power sources, which change depending on natural conditions. If the conditions are sunny during the day, the solar power plant will produce maximum electrical power and at night it will not operate at all, but is replaced from the storage of power in the battery that is obtained when the solar power plant operates during the day. Meanwhile, wind power plant is able to operate all day long but is still determined by wind speed, so the power generated depends on each condition. The goals of using

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hybrid power plants is to reduce the amount of CO2 emissions and save fuel oil. Therefore, the use of a hybrid between solar and wind power plant are considered to be able to overcome the above because solar and wind energy is clean energy and environmentally friendly so that it does not produce emissions and the energy source needed does not require costs because it is readily available in nature.

In this research, the design of a hybrid power generation system between solar and wind energy will be carried out to replace the use of diesel as a source of electricity generation [13][14]. After the generator design is done, then the performance test of the hybrid system will be carried out in order to see the feasibility of the design that has been made. The design of a hybrid generation system between solar and wind energy is one of the right solutions in the utilization of renewable energy sources that have large availability and are expected to be able to replace fossil energy which will run out. [15].

II. METODE PENELITIAN

The stages to be carried out in this research can be seen in the flow chart as shown in Figure 1. In conducting research, the data comes from measurements taken directly at the research site, such as wind speed data in the area, voltage and current data generated from the turbine to storage (battery), output voltage and current data from storage (battery) to the load, and data on the magnitude of the load. These data can be obtained from primary data from direct measurements on the unit installed at the research location

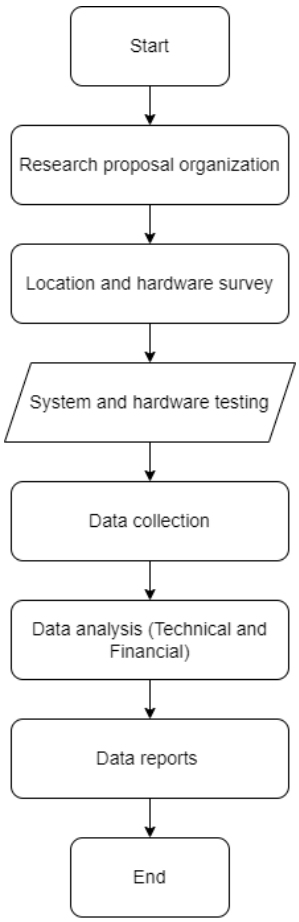

Fig. 1. Research flow chart

III. RESULTS AND DISCUSSION

In this research, an analysis test results of the 500 Wh Wind Turbine Hybrid Power Plant and 50 Wp Solar Panel will be carried out. The main focus of this research is to know the feasibility of the performance of the 500 Wh Wind Turbine Hybrid Power Plant and 50 Wp Solar Panel, both from a technical and financial point, that can be implemented in real terms to meet the needs of electrical energy, especially for people in remote areas. The following are the results of performance tests carried out on hybrid power plants which can be seen in Table 1.

TABLE 1 TESTING RESULTS OF AVERAGE PRODUCTION AND PERFORMANCE OF HYBRID POWER PLANT

Day-	Wind speed (m/s)	Irradiance (kW/m^2/day)	Voltage (Volt)	Power (Watt)	Energy (kWh)	Efficiency (%)
1	2.4	4.76	220	75165	1.242	10.37
2	2.4	4.50	219	75345	1.248	10.41
3	2.4	4.50	211	76170	1.261	10.51
4	2.8	4.76	212	77500	1.284	10.70
5	2.8	4.69	212	77500	1.284	10.70
6	4.0	6.15	212	76000	1.327	11.05
7	3.0	6.07	219	77500	1.442	12.02
8	4.0	6.14	216	75500	1.282	10.68
9	3.0	6.11	220	76500	1.395	11.63
10	3.0	6.12	220	75000	1.275	10.63

From the performance testing results of Hybrid Energy Power Plant show how much electrical energy can be generated by this hybrid system within a day. This is intended so that it can be used as a reference for the feasibility of operating hybrid power plants by utilizing solar energy with wind energy as a solution to replace fossil energy. Table 2 below shows the amount of electrical energy generated from the Hybrid PLT system.

TABLE 2 ELECTRIC ENERGY PRDUCED BY THE HYBRID ENERGY POWER PLANT

Day-	Energy Produced (kWh)
1	1.242
2	1.248
3	1.261
4	1.284
5	1.284
6	1.327
7	1.442
8	1.282
9	1.395
10	1.275

It can be seen from Table 2 above that the electrical energy produced in this Hybrid Energy Power Plant system ranges from 1,200 – 1,400 kWh per day. The magnitude of the value of the electrical energy produced will then be used as the basis for the feasibility analysis of the potential for solar energy and wind energy in Indonesia. In the utilization of solar and wind energy as a Hybrid Energy Power Plant, in addition to the technical aspect, it is necessary to study the economic feasibility of this generating system. In this discussion, we will analyze the economic feasibility of the Hybrid Energy Power Plant system based on electricity tariffs based on the electrical energy generated from this generation system and compared with diesel fuel.

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The energy produced is shown in a graph in Fig. 2 where the results of the tests carried out 10 times, the highest energy produced is 1,442 kWh per day.

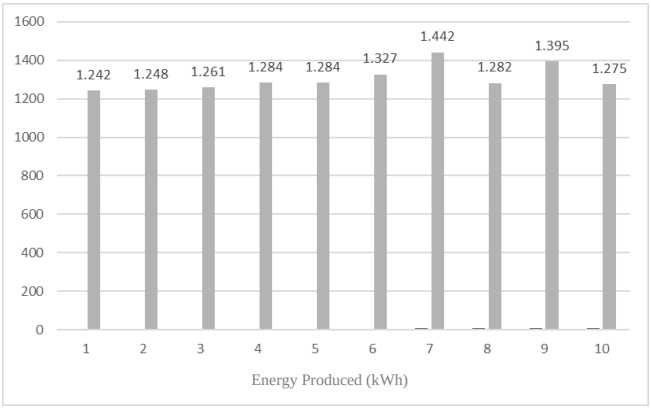

Fig. 2. Hybrid system energy graph

In the utilization of solar and wind energy as a Hybrid Energy Power Plant, in addition to the technical aspect, it is necessary to study the economic feasibility of this generating system. In this discussion, we will analyze the economic feasibility of the Hybrid Energy Power Plant system based on electricity tariffs based on the electrical energy generated from this generation system and compared with the use of diesel fuel.

With the utilization of this hybrid power generation system, residents, who previously had access to electricity from PLN, no longer had to pay electricity to PLN. These advantages can be seen in Table 3 below.

$$Profit = Energy\ Produced\ x\ Electricity\ rate \quad (1)$$

Where, Profit is the cost savings when using Hybrid PLT (Rupiah), Energy Production is the amount of energy that can be produced by Hybrid PLT (kWh), and Electricity Tariff is the cost paid for the purchase of electricity (Rp/kWh).

In this case, the electricity tariff used is the price of household electricity in Indonesia, which is Rp. 1,444.70/kWh. Table 3 below shows the price of electricity that can be saved per day from installing this system.

TABLE 3 ELECTRICITY SAVING COSTS DUE TO THE USE OF HYBRID ENERGY POWER PLANT

Day-	Energy Produced (kWh)	Profit/Saved Electricity Prices (Rp)
1	1.242	1794.32
2	1.248	1802.98
3	1.261	1821.77
4	1.284	1854.99
5	1.284	1854.99
6	1.327	1917.12
7	1.442	2083.26
8	1.282	1852.11
9	1.395	2015.36
10	1.275	1841.99

In this case, the electricity rate that used in this research is the price of household electricity in Indonesia, which is Rp. 1,444.70/kWh. From table 3 it can be seen that from the use of Hybrid Energy Power Plant, savings will be obtained in the range of Rp. 1,700 – Rp. 2,100/kWh per day. Based on secondary data, that the use of diesel fuel in 1 day is 2 L, while the price of diesel fuel is Rp. 12,500/1 Liter, the daily use of diesel fuel is Rp. 25,000.

IV. CONCLUSION

Conclusions from the research that has been done include:

1. Hybrid Energy Power Plant has an efficiency that ranges from 10-12% which shows that this power plant system is still said to be unable to work efficiently.
2. The average amount of energy produced from this Hybrid Energy Power Plant system is 1,304 kWh per day.
3. Based on the results of the financial feasibility analysis, that the use of the hybrid system is able to generate savings of Rp. 1,700 – Rp. 2,100/kWh per day.

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