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FEASIBILITY STUDY OF MICRO HYDRO POWER PLANT CAPACITY IN BLUMBANG BANJARARUM KALIBAWANG KULONPROGO

Lintang Timur[1], Fifin Hindarti[2,*], Rosiana Indrawati[3]

[1,2,3]Department of Energy Engineering, Faculty of Industrial Technology, Institut Teknologi Yogyakarta
*Correspondence: viendarti@ity.ac.id

Abstract

The Blumbang micro hydro power plant is a power plant utilizing hydropower that supplies electricity to the Blumbang area. The resulting supply is very large, around 30 kWh. However, it cannot be fully used by the surrounding society. So, it is necessary to do a feasibility study to increase the power capacity to determine supply and demand. This research aims to determine the community's supply and demand, which will impact the potential that can be taken by society.

The method used is field observations, supply and demand observations, analysis of differences in supply and demand. The results that the feasibility of increasing the power capacity. It supplies generated from PLTMH Blumbang ranges from 24-26 kWh of the electricity demand of micro hydro power plant, 6 kWh demand electricity of micro hydro power plant and PLN 16 kWh. The Blumbang society's electricity bill has decreased with the Blumbang micro hydro power plant.

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1. Introduction

The consumption of electrical energy increases every year along with the increase in population and economic growth of the people in an area (Fadillah et al., 2015). In 2017 - 2018 there was an increase in electricity production by 3%. In 2018, the most dominant energy for electricity was fossil energy, such as 50% coal, 29% natural gas, and 14% newest energy (Suharyati et al., 2019).

Indonesia has the potential of a water source that is so large and can be the electrical energy source (Durrani et al., 2019). Micro hydro power plant is one of the electrical energy sources of water power that cannot spoil the environment (Zeb et al., 2019)(Budiyanto, 2015). The water-energy source that can be used for micro hydro power plant is 19,385 Mw and spreads in Indonesia entirely (Fajarsari et al., 2015). The excess of this power can adapt to the peak load or the net disturbance by a fast response (Puskom ESDM, 2018)

The village of Blumbang, Banjararum sub-district, Kalibawang district, and Kulon Progo regency has not been optimal for electrical current. Blumbang village is in the hill area and full of nature thickly. When the rain is falling, and the hurricane is coming, there often happens to extinguish electricity from PLN, the State Electricity Company. That is why electricity has not been optimal in Blumbang village. The village that is located in the mountain range and far away from the center of the city makes that village stay sturdy.

The Blumbang micro hydro power plant is one of the use of hydropower located in Dusun Blumbang Banjararum Kalibawang Yogyakarta. In 2014, Blumbang village was assisted by Gadjah Mada University (UGM), and the Ministry of Energy and Mineral Resources (ESDM) established micro hydro power plant. At the beginning of the year, it only found one machine and pipeline. When time is running fast, one device is not enough and not optimal. So, in 2015 there is an addition of one machine, so the electricity total is about 30 kW. The condition of Blumbang micro hydro power plant can be seen in Figure 1.

Figure 1. The condition of PLTMH Blumbang

Yogyakarta has an electrical energy supply that is so large, especially in the newest energy sector (Sudiro et al., 2019). The sources can be increased, such as the sun's energy, wind speed energy, and micro hydro. The sun has the potential for 4,8 kWh/m2/day. The wind speed energy is 4 to 5m/second. And hydro micro is 1.188,6 kW (Alhasibi, 2010). The condition of an area that has the society and various customs in doing life will influence a load of an area.

The electricity company has to fulfill the society's needs about service of quantity, time, and place with the need portion each other. The society has the right to get an electric current that is compatible and standard (Tampubolon et al., 2014). According to (Prasetijo et al., 2012) the output of power that is resulted from the generator can use the similarity:

$$P= \sqrt{3}.V.I.\cos \varphi \quad (1)$$

P = Power / Capacity (Watt)
V = Voltage / Strain (Volt)
I = Intensity / Current (Ampere)
Cos ϕ = 0,8 (Value)

The length of transmission and distribution from the power toward the load results in the disturbance by the natural factors such as the wind, thunder, etc. If the net is longer and longer, the loss of power is more significant and more prominent. So, it needs technical efforts to decrease the losses. For instance, it shortens the net, re-conductor, the installation of the implied guardhouse, the installation of capacitor, Automatic Voltage Regulator (AVR), the substitution of a connector (Bawan, 2012).

2. Methodology

This research is done in Blumbang village, Banjararum sub-district, Kalibawang district, Kulon Progo regency, Yogyakarta province. The time of research starts in June 2020 till August 2020. The research's free variable is the supply and demand of electricity in Blumbang micro hydro power plant, while the study's tied variable is the proper PLTMH Blumbang. The location of Blumbang micro hydro power plant is shown in Figure 2.

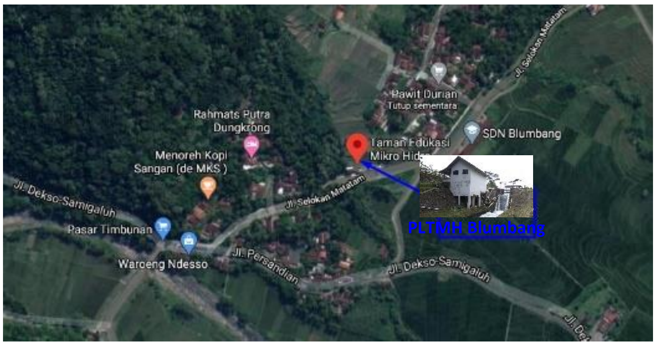

Figure 2. Location of Blumbang micro hydro power plant

The instruments and the materials that are used in this research are:
1) Ampere Clamp (Digital Clamp Multi-meters UT200)
2) Questionnaires
3) Microsoft Excel 2016(freeware)
4) survey form list
5) Arc Map 10.3(freeware)
6) IBM SPSS 25(freeware).

In this research, the authors conducted research using data collection methods and literature studies. The data was collected by reviewing or directly surveying the field. In addition, data collection was also carried out by visiting several related parties. Then the data needed are primary data and secondary data. Primary data is data that is obtained directly from the field by direct observation of the research location. The preliminary data needed is in the form of generator output data that supply the community's electricity needs and the capacity of energy used by the community.

Meanwhile, secondary data is data obtained from other sources related to the research material and is not a direct result of the research itself. Secondary data required are climatological data and maps of the research location. The instrument used for taking the data is the guidance of the structured interview used to do the direct interview to Blumbang micro hydro power plant's user society to determine the housing's electricity usage. The data are collected from the Blumbang micro hydro power plant's electricity energy capacity and load data from the Blumbang micro hydro power plant's user society.

In getting the supply data, finding out the capacity data of Blumbang micro hydro power plant's electrical energy. The taking of data in one month of the second week is the electricity output data in Power House and drop data of strain. Meanwhile, to get the demand data, finding out the electricity load of customers from 62 users of Blumbang micro hydro power plant Kulon Progo. The taking of data in one month of the second week is the observation by directly seeing the condition of customer home and interviews with the society about the load used for 24 hours. The data analysis uses the ANOVA calculation, which is one direction with the purpose. Its purpose finds out the difference in the comparison between supply and demand of electricity; it is known the difference between the supply and demand if there is a significant difference.

3. Results & Discussion

The supply of electricity of Blumbang micro hydro power plant is used directly by Blumbang village's society. The output data of electricity can be seen on the Data Load Controller (DLC) instrument, which will show the electricity output from the generator. DLC controlling basically aims to prevent the power that is increased by the generator to the same with the absorbed energy. It will increase the frequency and the strain continuously by bestowing the more power not used by society to the blast load. The supply data which is obtained along the observation is shown in Table 1, Table 2, Table 3, and Table 4.

The data in Table 1, Table 2, Table 3, and Table 4 were obtained by making direct observations on the control panel located in the Blumbang micro hydro power plant's powerhouse. The data obtained regarding the generator output voltage, ballast load, main load, and current.

Table 1. Supply on Monday, June 15, 2020

Time	Ballast Load (A)	Main Load (A)	Generator voltage (V)	Total Current (A)	Power (Watt)	Power (KWH)
00:00-01:00	60	29	220	89	27098.72	27.10
01:00-02:00	60	29	220	89	27098.72	27.10
02:00-03:00	60	29	220	89	27098.72	27.10
03:00-04:00	60	29	220	89	27098.72	27.10
04:00-05:00	60	29	220	89	27098.72	27.10

Table 1. Continued

Time	Ballast Load (A)	Main Load (A)	Generator voltage (V)	Total Current (A)	Power (Watt)	Power (KWH)
05:00-06:00	60	29	220	89	27098.72	27.10
06:00-07:00	60	29	220	89	27098.72	27.10
07:00-08:00	60	29	220	89	27098.72	27.10
08:00-09:00	60	29	220	89	27098.72	27.10
09:00-10:00	60	29	220	89	27098.72	27.10
10:00-11:00	60	29	220	89	27098.72	27.10
11:00-12:00	60	29	220	89	27098.72	27.10
12:00-13:00	60	29	220	89	27098.72	27.10
13:00-14:00	60	29	220	89	27098.72	27.10
14:00-15:00	60	29	220	89	27098.72	27.10
15:00-16:00	60	29	220	89	27098.72	27.10
16:00-17:00	60	29	220	89	27098.72	27.10
17:00-18:00	60	29	220	89	27098.72	27.10
18:00-19:00	60	29	220	89	27098.72	27.10
19:00-20:00	60	29	220	89	27098.72	27.10
20:00-21:00	60	29	220	89	27098.72	27.10
21:00-22:00	60	29	220	89	27098.72	27.10
22:00-23:00	60	29	220	89	27098.72	27.10
23:00-24:00	60	29	220	89	27098.72	27.10

Table 2. Supply on Monday, June 22, 2020

Time	Ballast Load (A)	Main Load (A)	Generator voltage (V)	Total Current (A)	Power (Watt)	Power (KWH)
00:00-01:00	34	24	220	58	17659.84	17.66
01:00-02:00	34	24	220	58	17659.84	17.66
02:00-03:00	34	24	220	58	17659.84	17.66
03:00-04:00	34	24	220	58	17659.84	17.66
04:00-05:00	34	24	220	58	17659.84	17.66
05:00-06:00	34	24	220	58	17659.84	17.66
06:00-07:00	34	24	220	58	17659.84	17.66
07:00-08:00	34	24	220	58	17659.84	17.66
08:00-09:00	54	26	220	80	24358.40	24.36
09:00-10:00	54	26	220	80	24358.40	24.36
10:00-11:00	54	26	220	80	24358.40	24.36
11:00-12:00	54	26	220	80	24358.40	24.36
12:00-13:00	34	24	220	58	17659.84	17.66
13:00-14:00	34	24	220	58	17659.84	17.66
14:00-15:00	34	24	220	58	17659.84	17.66
15:00-16:00	34	24	220	58	17659.84	17.66
16:00-17:00	34	24	220	58	17659.84	17.66
17:00-18:00	34	24	220	58	17659.84	17.66
18:00-19:00	34	24	220	58	17659.84	17.66

Table 2. Continued

Time	Ballast Load (A)	Main Load (A)	Generator voltage (V)	Total Current (A)	Power (Watt)	Power (KWH)
19:00-20:00	34	24	220	58	17659.84	17.66
20:00-21:00	34	24	220	58	17659.84	17.66
21:00-22:00	34	24	220	58	17659.84	17.66
22:00-23:00	34	24	220	58	17659.84	17.66
23:00-24:00	34	24	220	58	17659.84	17.66

Table 3. Supply on Monday, June 29, 2020

Time	Ballast Load (A)	Main Load (A)	Generator voltage (V)	Total Current (A)	Power (Watt)	Power (KWH)
00:00-01:00	68	29	220	97	29534.56	29.53
01:00-02:00	68	29	220	97	29534.56	29.53
02:00-03:00	68	29	220	97	29534.56	29.53
03:00-04:00	68	29	220	97	29534.56	29.53
04:00-05:00	68	29	220	97	29534.56	29.53
05:00-06:00	68	29	220	97	29534.56	29.53
06:00-07:00	68	29	220	97	29534.56	29.53
07:00-08:00	68	29	220	97	29534.56	29.53
08:00-09:00	45	29	220	74	22531.52	22.53
09:00-10:00	45	29	220	74	22531.52	22.53
10:00-11:00	45	29	220	74	22531.52	22.53

Table 3. Continued

Time	Ballast Load (A)	Main Load (A)	Generator voltage (V)	Total Current (A)	Power (Watt)	Power (KWH)
11:00-12:00	45	29	220	74	22531.52	22.53
12:00-13:00	45	29	220	74	22531.52	22.53
13:00-14:00	45	29	220	74	22531.52	22.53
14:00-15:00	45	29	220	74	22531.52	22.53
15:00-16:00	45	29	220	74	22531.52	22.53
16:00-17:00	45	29	220	74	22531.52	22.53
17:00-18:00	45	29	220	74	22531.52	22.53
18:00-19:00	68	29	220	97	29534.56	29.53
19:00-20:00	68	29	220	97	29534.56	29.53
20:00-21:00	68	29	220	97	29534.56	29.53
21:00-22:00	68	29	220	97	29534.56	29.53
22:00-23:00	68	29	220	97	29534.56	29.53
23:00-24:00	68	29	220	97	29534.56	29.53

Table 4. Supply on Monday, July 6, 2020

Time	Ballast Load (A)	Main Load (A)	Generator voltage (V)	Total Current (A)	Power (Watt)	Power (KWH)
00:00-01:00	72	24	220	96	29230.08	29.23
01:00-02:00	72	24	220	96	29230.08	29.23
02:00-03:00	72	24	220	96	29230.08	29.23

Table 4. Continued

Time	Ballast Load (A)	Main Load (A)	Generator voltage (V)	Total Current (A)	Power (Watt)	Power (KWH)
03:00-04:00	72	24	220	96	29230.08	29.23
04:00-05:00	72	24	220	96	29230.08	29.23
05:00-06:00	72	24	220	96	29230.08	29.23
06:00-07:00	72	24	220	96	29230.08	29.23
07:00-08:00	72	24	220	96	29230.08	29.23
08:00-09:00	62	24	220	86	26185.28	26.19
09:00-10:00	62	24	220	86	26185.28	26.19
10:00-11:00	62	24	220	86	26185.28	26.19
11:00-12:00	62	24	220	86	26185.28	26.19
12:00-13:00	72	24	220	96	29230.08	29.23
13:00-14:00	72	24	220	96	29230.08	29.23
14:00-15:00	72	24	220	96	29230.08	29.23
15:00-16:00	72	24	220	96	29230.08	29.23
16:00-17:00	72	24	220	96	29230.08	29.23
17:00-18:00	72	24	220	96	29230.08	29.23
18:00-19:00	72	24	220	96	29230.08	29.23
19:00-20:00	72	24	220	96	29230.08	29.23
20:00-21:00	72	24	220	96	29230.08	29.23
21:00-22:00	72	24	220	96	29230.08	29.23

Table 4. Continued

Time	Ballast Load (A)	Main Load (A)	Generator voltage (V)	Total Current (A)	Power (Watt)	Power (KWH)
22:00-23:00	72	24	220	96	29230.08	29.23
23:00-24:00	72	24	220	96	29230.08	29.23

Demand data is divided into 2 data, micro hydro power plant demand and micro hydro power plant & PLN demand and can be seen in Table 5 and Table 6.

Table 5. The demand of micro hydropower plant

Time	Week 1	Week 2	Week 3	Week 4
00:00-01:00	5.116	3.9815	3.9815	3.9815
01:00-02:00	4.0535	3.9815	3.9815	3.9815
02:00-03:00	3.9815	3.9815	3.9815	3.9815
03:00-04:00	4.3315	4.3315	4.3315	4.3315
04:00-05:00	4.0315	4.0315	4.0315	4.0315
05:00-06:00	2.5	2.5	2.5	2.5
06:00-07:00	1.168	1.168	1.168	1.168
07:00-08:00	0.843	0.843	0.843	0.843
08:00-09:00	0.843	0.843	0.843	0.843
09:00-10:00	2.109	2.109	2.109	2.109
10:00-11:00	1.181	1.181	1.181	1.181
11:00-12:00	0.845	0.845	0.845	0.845
12:00-13:00	0.92	0.92	0.92	0.92
13:00-14:00	1.095	1.095	1.095	1.095
14:00-15:00	1.27	1.27	1.27	1.27
15:00-16:00	0.919	0.919	0.919	0.919
16:00-17:00	0.444	0.444	0.444	0.444
17:00-18:00	5.5435	5.5435	5.5435	5.5435
18:00-19:00	5.2455	5.2455	5.2455	5.2455
19:00-20:00	4.8375	4.8375	4.8375	4.8375
20:00-21:00	4.8375	4.8375	4.8375	4.8375
21:00-22:00	4.3125	4.3125	4.3125	4.3125
22:00-23:00	4.1845	4.1845	4.1845	4.1845
23:00-24:00	3.9815	3.9815	3.9815	3.9815

Table 6. Demand of micro hydro power plant & PLN

Time	Week 1	Week 2	Week 3	Week 4
00:00-01:00	6.1805	6.1805	6.1805	6.1805
01:00-02:00	6.1805	6.1805	6.1805	6.1805
02:00-03:00	6.1805	6.1805	6.1805	6.1805
03:00-04:00	6.5305	6.5305	6.5305	6.5305
04:00-05:00	6.2305	6.2305	6.2305	6.2305
05:00-06:00	16.216	16.036	16.216	16.216
06:00-07:00	6.961	6.875	6.811	6.811
07:00-08:00	8.8	8.161	7.875	7.875
08:00-09:00	7.114	6.14	6.164	6.164
09:00-10:00	7.158	6.303	6.233	6.233
10:00-11:00	6.091	5.311	5.166	5.166
11:00-12:00	4.68	4.55	4.68	4.68
12:00-13:00	5.405	4.625	4.755	4.755
13:00-14:00	9.597	5.298	6.012	6.012
14:00-15:00	8.572	5.573	6.223	6.223
15:00-16:00	6.424	4.674	5.024	5.024
16:00-17:00	3.899	3.899	3.899	3.899
17:00-18:00	8.4115	8.2425	8.3475	8.3475
18:00-19:00	10.7205	10.7205	10.7205	10.7205
19:00-20:00	10.0625	10.0625	10.0625	10.0625
20:00-21:00	10.4125	10.0625	10.4125	10.4125
21:00-22:00	9.7635	9.7015	9.7015	9.7015
22:00-23:00	9.4665	9.4455	9.3405	9.3405

The supply data and demand data that have been obtained are translated into the shape of the graph. Then from the graph, it can be seen how the comparison of both of them. That graph has resulted from the supply data and demand data that are averaged one month. It is shown in Figure 3.

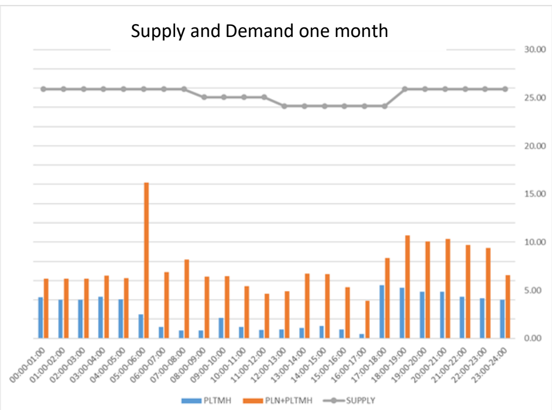

Figure 3. Graph supply and demand in one month

The supply graph and demand graph for one month show that the supply that is resulted from Blumbang micro hydro power plant is about 24-26 KWH. Meanwhile, the electricity load from the micro hydro power plant iconsumers Blumbang micro hydro power plant's electricity load originally is 6 KWH of the tallest burden on the 17:00-18:00. The electricity that is resulted by Blumbang micro hydro power plant is stable. But it cannot fully supply the electricity because it happens of not being regular of the strain that causes only to provide the house's light tools, such as the lighting equipment of housing.

Firstly, in the Blumbang micro hydro power plant interview, Blumbang micro hydro power plant's founding only supplies about 60 housings. In the beginning, the consumers use the electricity from Blumbang micro hydro power plant to light and do not use the whole load needs of housing. Currently, some people use the electricity of Blumbang micro hydro power plant, and it can result that the distribution of energy supply is not fair. The addition of consumers of Blumbang micro hydro power plant that increases can influence the distribution flow. It is only designed for about 60 users at the beginning of planning then rises to 74 housings.

The Blumbang micro hydro power plant has a 30 KW and is used to supply 4 RT in that village. The ability of 30 KW is a significant capacity to supply 74 houses. But the condition of the field shows the different states. The field condition indicates two RT, namely RT 37 and RT 40, that are different in a location with varying electricity conditions. RT 37 for the electricity condition can be stated that it has been stable and there is no problem, while the electricity condition of RT 40, the electric current is not stable. Based on field observation, the voltage which is resulted from the generator is 220 volts, but the voltage will decrease when the electricity is connected. The decreasing voltage will result in electricity, which is accepted is not stable.

According to (Shiddiq et al., 2015), the further the home's distance is from the power plant center, the smaller the electricity voltage comes to that house. Based on that theory, it can be concluded that the spread of cable transmission also influences the voltage quality, so that it causes that the society which is far away from the electricity source will be disturbed on the distribution. The condition of the distance of RT 37 from Blumbang micro hydro power plant is 224 meters, and the state of the distance of RT 40 from Blumbang M micro hydro power plant is 764 meters. The approach is made by using the ArcGIS application and the determinant of the electricity pillar points from the transmission of Blumbang micro hydro power plant.

The length of transmission and distribution from the power plant towards the burden results in disturbances by natural factors such as wind/hurricane, thunder, etc. If the net is longer and longer, the loss of power is more prominent and bigger. So, it needs technical efforts to decrease the loss. For instance, it shortens the net, re-conductor, the installation of the implied guardhouse, the installation of capacitor, automatic voltage regulator (AVR), and the connector's substitution (Bawan, 2012). Based on the above theory, Blumbang micro hydro power plant's net distribution to RT 40 is so long and needs to add the implied guardhouse.

Based on data and the result of a direct interview with the society, there are many real conditions in The Blumbang micro hydro power plant. The supply resulting from Blumbang micro hydro power plant has a big output, but it has not been stable because there is no electricity stabilizer panel. So, it results that the electricity is not divided fairly. The usage of electricity that is resulted by Blumbang micro hydro power plant has not been used optimally by the society because there is a disturbance of the unstable electricity. The unstable electricity that is resulted from Blumbang Micro Hydro Power Plant often still happens from the voltage drop, so it disturbs users pleasure and comfort. The Blumbang micro hydro power plant is the newest energy source that can be developed to be used by society optimally.

4. Conclusions

The supply resulting from PLTMH Blumbang has a significant output but has not been stable because there is no electricity stabilizer panel. The production of electricity is not divided fairly. Blumbang micro hydro power plant's existence can help society because some of the electricity needs are supplied from Blumbang micro hydropower plant, thereby reducing the costs that must be spent on electricity payments.

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