Piko Hydro Scale 12 Volt for Lighting Requirements in Farmed

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ABSTRACT

The level of consumption of domestic electrical energy is increasing along with the economic growth of the population in Indonesia, especially in Aceh, Gayo Lues Regency is a lot of potential water energy that has not been utilized to produce electrical energy. The pico hydro power plant is a renewable energy that is environmentally friendly, it is expected to be able to utilize the potential of water flow around farmer's plantations, and to find out how much power capacity is generated in the flow of water in farmer's gardens, and aims to find out how much output power the generator will generate from the potential of water flow to be used as a substitute for the use of fossil fuels, as lighting at night and to recharge farmers' electronic equipment in the fields of Gayo Lues Regency. The methodology used for data collection in this study was to collect data directly from the field by means of measurement and testing of tools, The results of the measurements to get the value of irrigation cross section area with an average value of 4.98 m^2. The results of water flow velocity measurements with an average value of 1.72 m/s. The results of irrigation water discharge calculations with an average value of 8.58 m^3/s.The data obtained from this study was by bidding water with a height of water falling on a test of 0.8 meters, 0.9 meters and 1 meter By calculating and analyzing the water discharge that has the potential to produce electric power with an average water discharge of 8.58 m3/s, the type of turbine used in this study is the Kaplan turbine with head adjustment and more specifically for the turbine and alternator with power 40 watts.

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1. INTRODUCTION

In small-scale hydroelectric power plants or Pico-hydro scale, it can be said that it is one of the power generation technologies in that its use is very reliable and the cost of manufacture is relatively cheap and environmentally friendly. other. Hydroelectric power plants that are large or medium in scale are very much used as power plants in Indonesia, especially Aceh, which has areas where there is an abundance of potential water energy [1] [2].

Gayo Lues is a regency which is located in an area where there are so many rivers and waterfalls in the area, some of the farmers in Gayo Lues live in the mountains to open coffee plantations in the mountains, so there is no lighting at night [3]. Due to its location far from the village, it is difficult to distribute electricity, so there is no lighting at night and it is an obstacle for farmers who need electrical energy as lighting at night or to recharge farmer's electronic equipment

[4]. It is ironic to see the very potential of water. it's good that it's not used optimally, if only the development of Piko Hydro Power Plants can be implemented then the harvest results of farmers in Gayo Lues will be better, of course farmers in Gayo Lues don't have to worry anymore about lighting at night or recharging electronic equipment farmer [5].

Based on the problems in this study, the researcher outlines something that can be identified as follows: How to utilize the potential of water flow around farmer's plantations, what is the generated power capacity of water flows in farmer's gardens, How much output power can be generated by generators from potential flows water to use. The output produced in this study is to make it easier for farmers to provide electricity as lighting in the fields [6].

PLT-PH has three main components, namely water as a source of energy, turbines and generators. PLTPH construction does not use the relocation of local community residences in the construction of dams or reservoirs [7]. Pico Hydro Power Plant (PLTPH) is using the difference in the height of the water fall, the amount of water discharge in units per second found in irrigation water flows, rivers and waterfalls [8]. This water flow will rotate the shaft of a turbine so that it releases mechanical energy. The mechanical energy then rotates to drive the generator so that the generator can produce electrical energy that will be utilized [9] [10].

This research was conducted at the Lempuh Village Dam, Gayo Lues Regency (Figure 1), where the potential for water flow is right next to the farmer's plantation.

Figure 1. Dam in the village of Lempuh, Gayo Lues Regency

Rapid Pipe (penstock), Rapids are used to channel water from rivers or irrigation with a certain slope and directed to the turbine blades. The rapid pipe material used in this study uses 4 inch PVC pipe material.

Water Turbine Casing, this turbine casing uses a TY-4x3 pvc connection material which is used to distribute and channel the water flow to the turbine blades so as to produce more optimal power output from the turbine [11].

Water turbine blades, its function is to convert the potential energy of water into mechanical energy, where when the flow of water channeled from the stag pipe is directed at the turbine blades so that it hits the turbine blades and the process of converting the potential energy of the water is converted into mechanical energy in the form of rotational energy [12][13].

Bearing Mount, Serves to keep the bearings from moving so that the AS shaft from the turbine blade to the generator does not directly rub against the turbine casing and stabilizes the rotation of the turbine shaft. This component utilizes the former front drum components of motorcycles [14] [15] .

The axle shaft used in this study is to transmit rotational [16] power from the turbine blades or torque which is then forwarded to the generator shaft. The turbine shaft is adjusted so that it can receive the load when it operates in a certain cycle [14] [17].

The alternator functions as a supplier of electrical energy which will be used as a battery charger or to supply other electrical systems, which are usually used as a source of lighting on motorcycle electricity, the energy produced by the alternator is an AC voltage which is usually referred to as an alternator [18] [19]. The working principle of the alternator is similar to the working principle of an electric generator, which works according to Faraday's law, where if a conducting wire is rotated in a magnetic field until it cuts the magnetic force line (GGM), it will produce an electric force line (GGL) in units of volts. at the end of the conducting wire. The alternator that will be used is a lighting coil resistance of 0.24 – 0.36 Ω charging of 0.32 – 0.48 Ω. the current that will come out before being given a load on the alternator is 12.3 - 13.3 V at 1500 rpm [20] [21][22].

The rectifier in this study has the function of rectifying the voltage/current from the generator which still contains alternating current (AC) and rectifying it into direct current (DC). The load in this test the load used is a 12 volt light bulb which will later be used as lighting [23].

In determining the flow rate of irrigation water, measurements are made directly, measuring the velocity of the river flow with a float, measuring the depth of the water, measuring the height of the falling water, calculating the flow rate of the water, hydraulic potential, generating power potential.

2. RESEARCH METHOD

As for the flowchart in this study that has been made, you can see Figure 2 of the following research flowchart:.

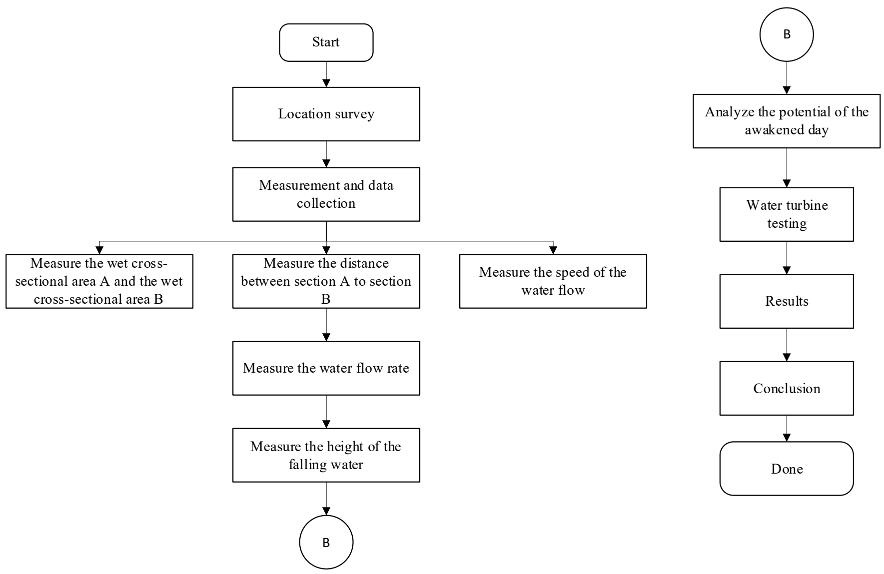

Figure 2. Research flowchart

2.1. Location and time of Research

This research was conducted at the Dam of Lempuh Village, Gayo Lues Regency, where the potential for very reliable water flow for testing a prototype-scale pico-hydro power plant (PLTPH). The time of the research began in October 2021 - February 2022.

2.2. Method of collecting data

Literature study was carried out to study the theoretical aspects of various references in order to obtain a standard formula that is used in the study of the potential of pico-hydro power plants. The measurement is carried out to find out the data in the form of irrigation water flow rate data. In this measurement, manual measurements were carried out due to the limitations of measuring instruments and Measurement of the voltage generated by the generator with a high parian head falling water when testing the kaplan turbine.

2.3. Data analysis technique

Data analysis techniques are needed to obtain the overall data and then use the literature that has obtained the data and analyzed it to draw conclusions [24].

1) Calculate the wet cross-sectional area
Description:
$$A = L \times d \qquad (2.1)$$
A = Wet cross-sectional area (m^2)
L = Cross Section Width (m)
d = Water depth (m)

2) Calculate the speed of the water flow
Description:
$$V = D / t \qquad (2.2)$$
V = Water flow rate (m/s)
D = The distance between section A to section B (m)
t = The time taken from section A to section B (s)
3) Calculating the water flow rate
Description:
$$Q = V \times A \qquad (2.3)$$
Q = Water flow discharge (m^3/s)
V = Water flow rate (m/s)
A = Wet cross-sectional area (m)
4) Analyze the hydraulic potential and the generated electric power
$$Ph = \rho \times Q \times h \times g \qquad (2.4)$$
p_h = theoretical output power (Kw)
p = fluid density (Kg/m^3)
g = gravity (m/s^2)
h = effective altitude (m)
Q = water discharge (m^3/s)
5) Analyzing Power Generated
$$Pe = \mu t \times Ph \qquad (2.5)$$
Pel = Awakening capacity (Kw)
Ph = Hydraulic power potential (Kw)
ηt = Efficiency estimation (%)
6) Analyze the electric power generated by the generator
$$P = V \times I \qquad (2.6)$$
$$V = P/I \qquad (2.7)$$
$$I = P/V \qquad (2.8)$$

2.4. System Blog Diagram

In this design there are blog sections for the pico hydro power plant system in the prototype stage, while the blog sections for the system are as follows:

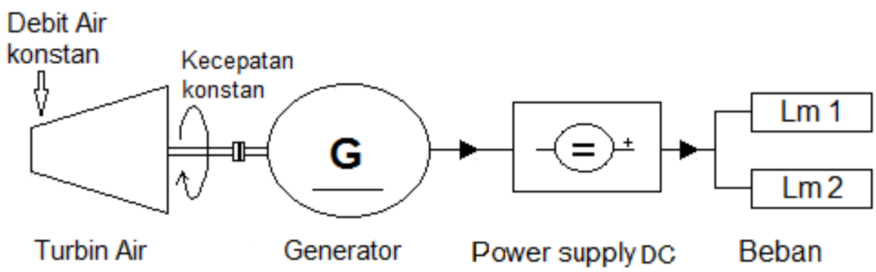

Figure 3. Tool Blog Diagram

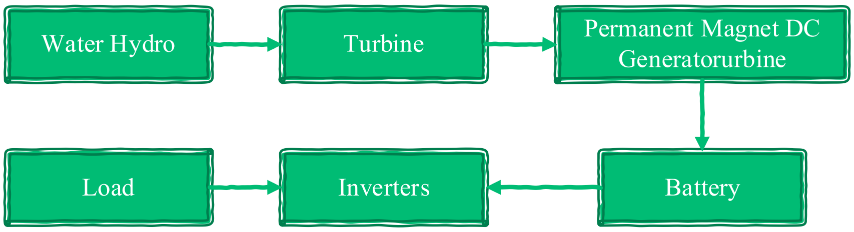

Figure 4. Convert DC to AC

3. RESULTS AND DISCUSSION

The test was carried out to determine the performance of each component in this PLTPH. The test data obtained later will be analyzed to be used as a reference in drawing conclusions. So it can be concluded whether the tools that have been made can work well and in accordance with the expected criteria, and know the advantages and disadvantages.

3.1. Test result

1) The results of the measurement of the irrigation cross section area

Irrigation cross-sectional area can be searched with this following equation: Irrigation cross section area = wet cross section width X Irrigation Average depth, the following results are obtained.

Table1. Measurement of the area of wet cross -sectional irrigation

Day		Irrigation cross -sectional area m2 Irrigation Depth (M) Into each side: Left side (cm)	Middle side (cm)	Right side (cm)	Total average (cm)	A= L× *d* cm conversion irrigation area to m (m2)
Monday	Leber Irigasi 90 m	5,2	5,8	5,8	5,6	5,04
Thursday		5,4	5,6	5,8	5,6	5,04
Wenesday		5,2	5,5	5,7	5,46	4,91
Tuesday		5,2	5,4	5,8	5,46	4,91
Friday		5,1	5,6	5,8	5,5	4,95
Saturday		5,2	5,7	5,9	5,6	5,04
Sunday		5,2	5,6	5,8	5,53	4,97
		Avarage =				4,98

The value in the measurement of this irrigation water depth is carried out during the dry season so that the average depth of water in irrigation is only 4.98 m2, in each measurement into the water on 3 sides, while for the height of the irrigation at the study site there is 70 cm. If it is estimated that during the rainy season the depth in irrigation water is estimated to increase.

2) The results of measurement of water flow velocity

Table 2. Water flow velocity

Day	Time	The travel time is 12 meters in each segment (d/s): Left side	Middle side	Right side	Average travel time	V = D / t (m/secon)
Monday	09:30	5,80	8,04	7,13	6,99	1,71
Thursday	09:18	5,66	8,03	7,22	6,97	1,72
Wenesday	08:45	5,47	8,05	7,17	6,89	1,74
Tuesday	14:20	5,65	8,07	7,15	6,95	1,72
Friday	15:18	5,71	7,86	7,18	6,91	1,73
Saturday	11:08	5,68	7,65	7,21	6,84	1,75
Sunday	16:05	5,70	7,87	7,19	6,92	1,73
			Avarege =			1,72

From the table above, it can be seen that the results of the measurement of water flow velocity by P use a float from a former beverage bottle that is empty from the cross -sectional point A as the initial start line to the cross-sectional point B of the finish line, with a cross -sectional length A to cross section B is 12 meters , calculated using a stopwatch how much time the buoy needed was sung from the point of the initial start line of the cross section A leading to the finish line cross -section.

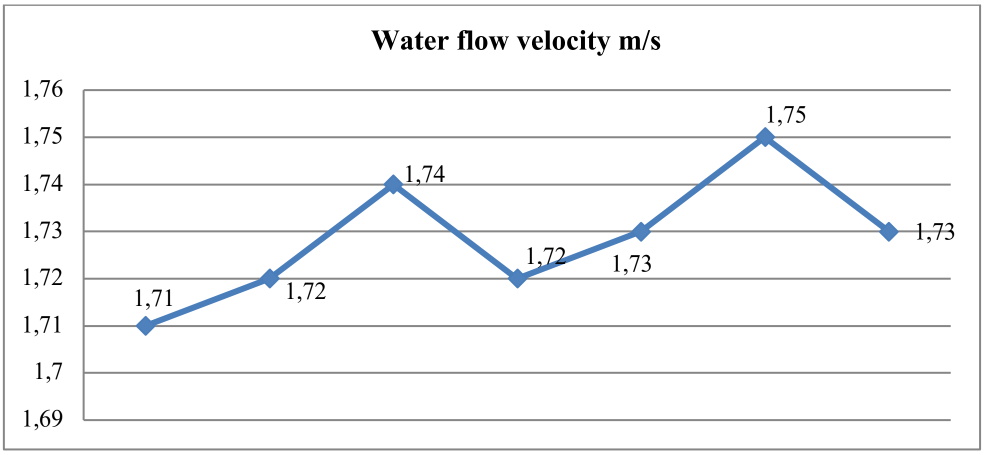

Figure 4. Water flow velocity graph

3) The results of the calculation of irrigation water discharge

Table 3. The results of the calculation of water discharge in the field

Day	Irrigation width (m)	Irrigation area (m2)	Water speed (m/s)	Water discharge Q=V ×A (m^3/s)
Monday	Lebar Irigasi 0,9 m	5,04	1,71	8,61
Thursday		5,04	1,72	8,61
Wenesday		4,91	1,74	8,46
Tuesday		4,91	1,72	8,44
Friday		4,95	1,73	8,56
Saturday		5,04	1,75	8,82
Sunday		4,97	1,73	8,59
	Average water discharge =			8,58

Based on the table it can be seen that the results of the calculation carried out, that to apply this 12 Volt Piko Hydro Piko Power Plant does not require too large water poverty, only with water discharge at 8.58 m3/s this turbine can work.

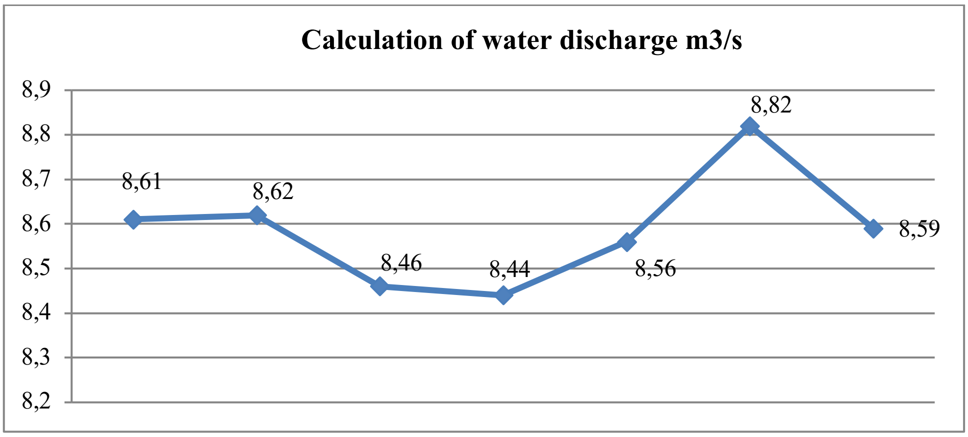

Figure 5. Water discharge graph

In Figure the water discharge graph can be noted that the water discharge depends on the speed of the water flow, where if the water flow speed increases, the water discharge will also increase where the graph above shows that the highest water discharge is on Saturdays and the water discharge The lowest is on Thursday which is 8.82 m3/s.

4) Water height measurement

This measurement is carried out to find out how much effect he is high in water to the power produced by the generator, the need to measure the height of water fall to find out the maximum height value of water for the Piko Hydro Power Plant.

Table 4. The measurement results height of water falls

Measurement	Measurement r Head (m)
H 1	0,8m
H 2	0,9m
H 3	1m

5) Calculation of hydraulic potential

Head height 0,8 m

Monday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,8 m × 8,61 m^3/s
= 67,5 Watt

Thursday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,8 m × 8,61 m^3/s
= 67,5 Watt

Wenesday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,8 m × 8,46 m^3/s
= 66,3 Watt

Tuesday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,8 m × 8,44 m^3/s
= 66,1 Watt

Friday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,8 m × 8,56 m^3/s
= 67,1 Watt

Sturday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,8 m × 8,82 m^3/s
= 69,1 Watt

Sunday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,8 m × 8,59 m^3/s
= 67,3 Watt

Head height 0,9 m

Monday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,9 m × 8,61 m^3/s
= 75,9 Watt

Thursday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,9 m × 8,61 m^3/s
= 75,9 Watt

Wenesday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,9 m × 8,46 m^3/s
= 74,6 Watt

Tuesday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,9 m × 8,44 m^3/s
= 74,4 Watt

Friday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,9 m × 8,56 m^3/s
= 75,4 Watt

Sturday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,9 m × 8,82 m^3/s
= 77,7 Watt

Sunday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 0,9 m × 8,59 m^3/s
= 75,7 Watt

Head height 1 m

Monday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 1 m × 8,61 m^3/s
= 84,3 Watt

Thursday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 1 m × 8,61 m^3/s
= 84,3 Watt

Wenesday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 1 m × 8,46 m^3/s
= 82,9 Watt

Tuesday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 1 m × 8,44 m^3/s
= 82,7 Watt

Friday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 1 m × 8,56 m^3/s
= 83,9 Watt

Sturday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 1 m × 8,82 m^3/s
= 86,4 Watt

Sunday
P_h = 1.000 kg/m³ × 9.8 m/s^2 × 1 m × 8,59 m^3/s
= 84,1 Watt

Table 5. Hydraulic potential

Day	Hydraulic potential (Watt)		
	Head height 0,8 m	Head height 0,9 m	Head height 1 m
Monday	67,5	75,9	84,3
Thursday	67,5	75,9	84,3
Wenesday	66,3	74,6	82,9
Tuesday	66,1	74,4	82,7
Friday	67,1	75,4	83,9
Saturday	69,1	77,7	86,4
Sunday	67,3	75,7	84,1

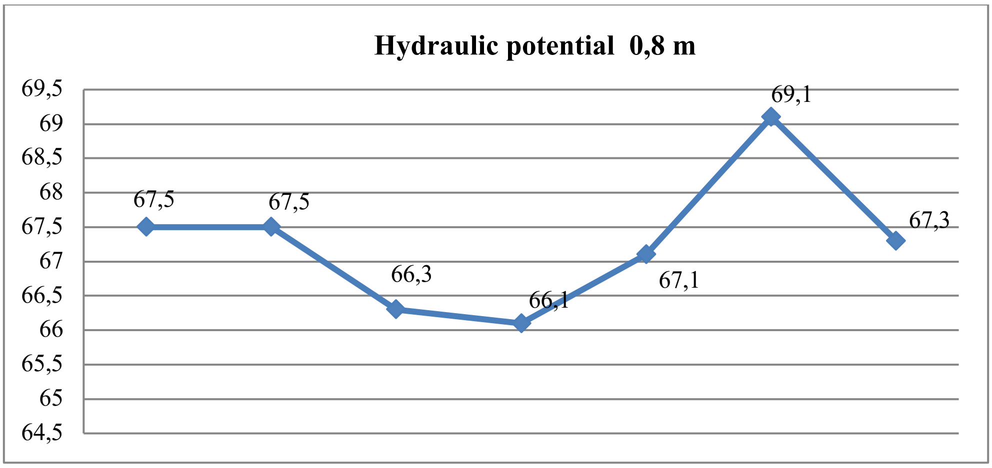

Figure 6. Hydraulic head graph head 0.8 m

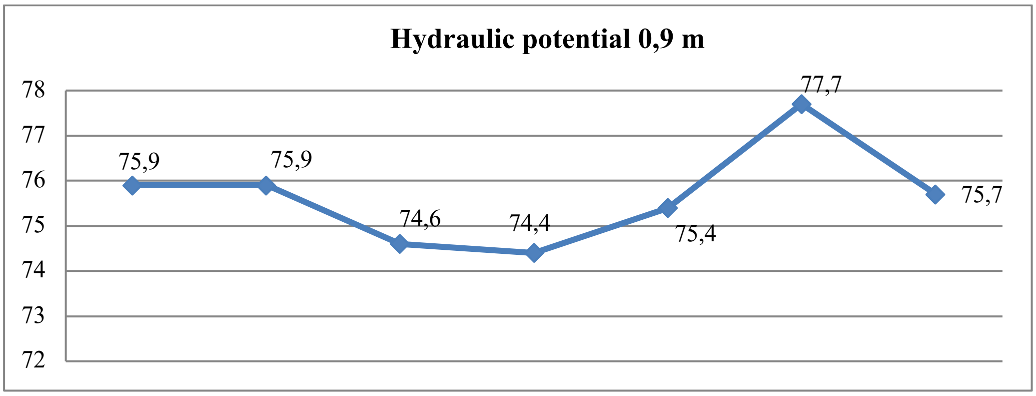

Figure 7. Hydraulic head graph head 0,9 m

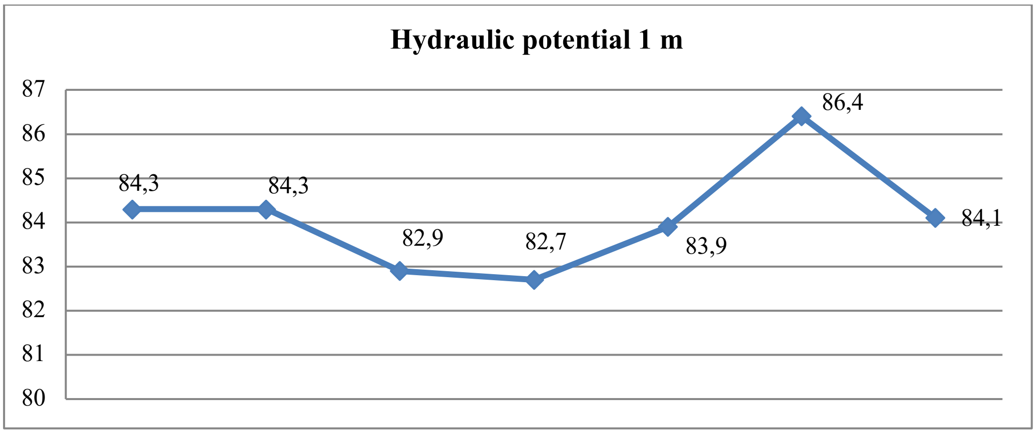

Figure 8. Hydraulic head graph head 1 m

6) Potential power generated

Table 6. Estimated power estimates

The power that is aroused by the head 0,8 m (Watt)	The power that is aroused by the head 0,9 m (Watt)	The power that is aroused by the head 1m (Watt)
33,75 Watt	37,95 Watt	42,15 Watt
33,75 Watt	37,95 Watt	42,15 Watt
33,15 Watt	37,3 Watt	41,45 Watt
33,5 Watt	37,2 Watt	41,35 Watt
33,55 Watt	37,7 Watt	41,95 Watt
34,55 Watt	38,85 Watt	43,2 Watt
33,56 Watt	37,85 Watt	42,5 Watt

From the table above, the results of the calculation of several references are known that for the small sekalaa power plant system, it can use a rough reference for prices ηt = 50%.

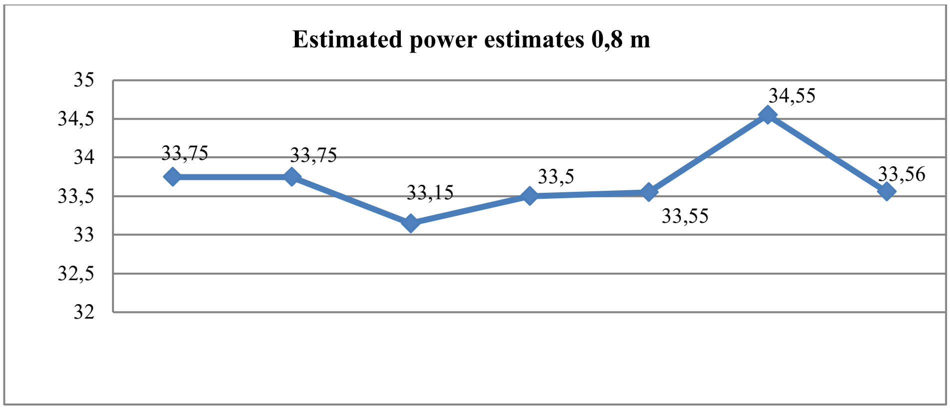

Figure 9. Power estimation graph 0,8 m

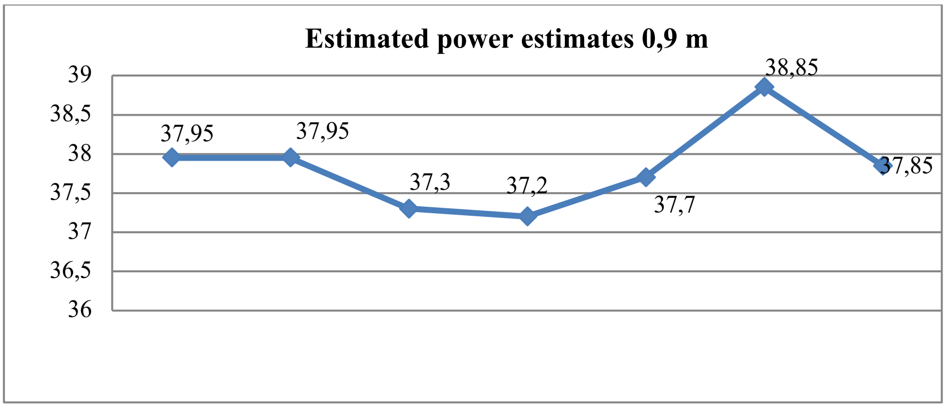

Figure 10. Power estimation graph 0,9 m

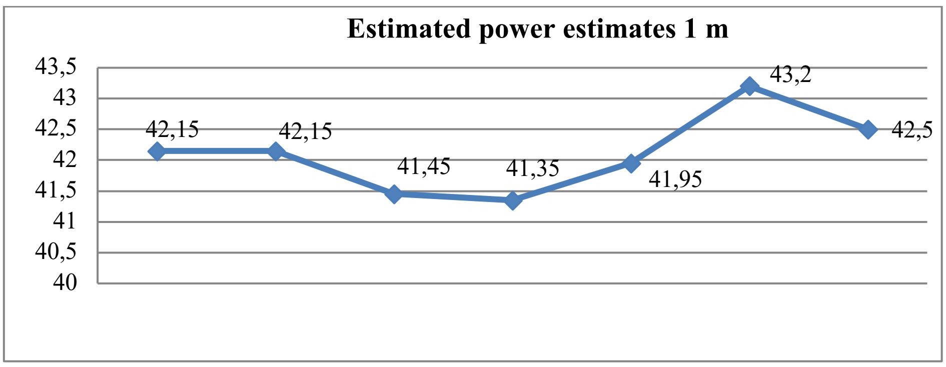

Figure 11. Power estimation graph 1 m

3.2. Generator Electricity Measurement Results

1) Voltage measurement results

This measurement is carried out to get the results of how much the electric voltage from the generator and also changes in the voltage generated when the PLTPH simulation, from the measurement results are in the Table 7.

Table 7. Output voltage

High falling water (head)	Output voltage (V)
Head 80 cm	12 V
Head 90 cm	17 V
Head 100 cm	20 V

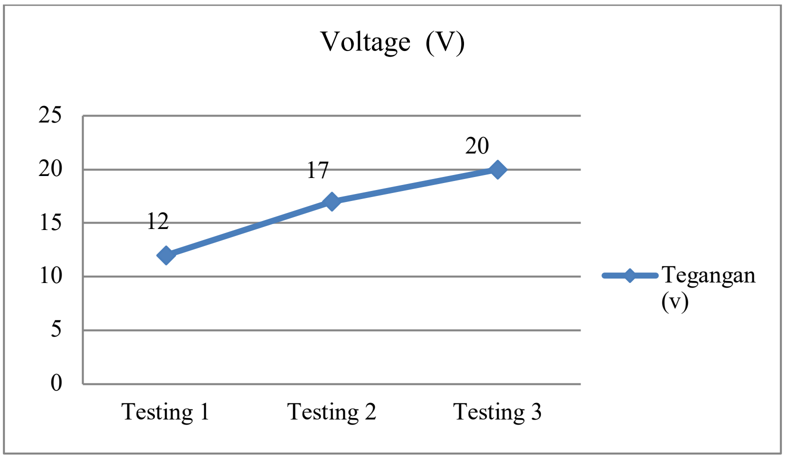

Figure 12. Voltage graph

2) Output current measurement results

The results of the measurement of the electric current in the testing of the Piko Hydro Power Plant can be seen in this following table:

Table 8. Current

High falling wate (head)	Output current (A)
Head 80 cm	1,2 A
Head 90 cm	1,7 A
Head 100 cm	2 A

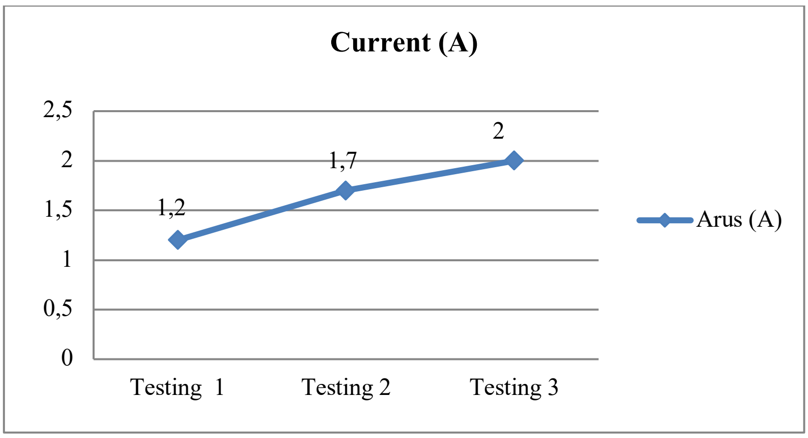

Figure 13. Current graph

3) Output power results

Output power results produced from the design of the Piko Hydro Power Plant, can be known by the equation of the following formula:

Table 9. Output power result

Testing based on altitude	Alternator output power calculation (P = V x I)	Power (Watt)
Head 80 cm	12 x 1,2	14,4 Watt
Head 90 cm	17 x 1,7	28,9 Watt
Head 100 cm	20 x 2	40 Watt

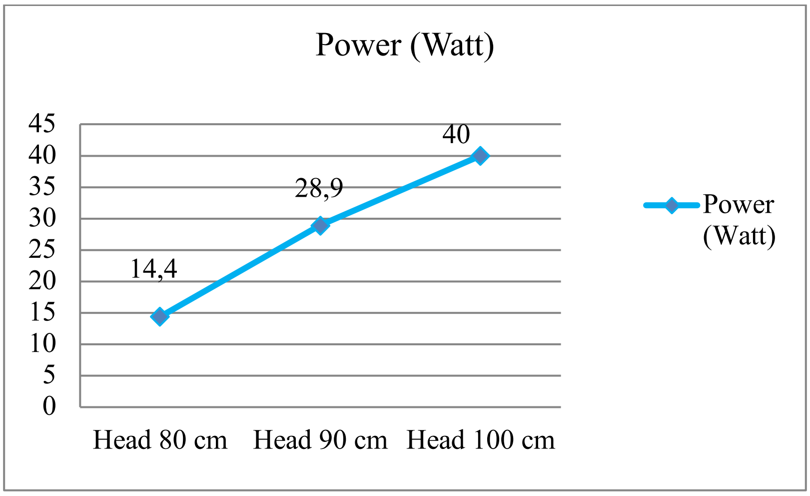

Figure 14. Power graph

4. CONCLUSION

Provide Based on the results and analysis of the system that has been made, several conclusions are obtained, namely:

1) In utilizing the flow of water in farmers' plantations first know the potential flow of water, so that the measurement can be done for the height of existing water falls, if the height of the water falls up to 80cm-1meter and the water discharge reaches 8.58 then the water flow can be used for in Build a power plant for lighting at night.
2) In the hydraulic potential and power generated from this hydro piko power plant is for the hydraulic potential 1,07 Kw >1,11 Kw and the power that is aroused : 1,07 Kw >1,11 Kw
3) The output power generated from the generator with a high fall in water in testing 1 with a height of 80 cm water voltage of 12 volt with a power of 14.4 watt test 2 with a height of water falls 90 cm voltage of 17 volt with 28.9 watt power 4 with height with height Falling water 100 cm voltage 20 volts with 40 watts of power

From the results of this final project there are still some shortcomings and need to be done for further development. Therefore the authors feel the need to give the following advice For further research, in especially those related to the manufacture of Piko Hydro Power Plants, it is as good as developing by calculating the design of the design in the water turbine and increasing the power generated by the generator, so that the generator is more efficient to produce a greater output voltage for the use of enegyi which is even bigger.

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