An investigation of dummy load energy in gunung sawur 1 microhydro power plant - Lumajang East Java

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Abstract. Dummy load are used for microhydro power plant which its work controlled by electronic load controller. Electrical energy supply to dummy load will increased or decreased automatically depends on consumer load. All this time, dummy load energy of microhydro are rejected to the environment without any use. This research was carried out by investigating on Gunung Sawur 1 micro hydroelectric power plant in Sumberwuluh Village, Candipuro Districts, Lumajang Regency, East Java, Indonesia. Purposes of this research are to find out the potency of dummy load electric energy on Gunung Sawur 1 microhydro and possibility of its utilization. The research was carried out by recording data of electrical energy of dummy load on microhydro using Fluke 1735 power logger. Research results show that voltage of dummy load was fluctuated, from 0 volt until higher than 100 volts. In the night, the average of dummy load power is 2502.5 watts. Then during the day, the average of dummy load power is 3688.5 watts. The average total electric energy of dummy load is 66.1 kWh per day. Utilization unstable voltage and energy of dummy load can only be used for heating process, such as water heating or water purification on distillation system.

1. Introduction

The dummy loads are needed for balancing of consumer loads and the generator electric power at the microhydro power plant (MHPP). Working of dummy load is controlled using electronic load controller (ELC). ELC work based on the amount of electrical energy in consumer loads. The supply of electric energy to the dummy load will increased automatically if the consumer loads decreases and will decrease if the consumer loads increases. This condition will keep the loads of MHPP generator still stable[1, 2, 3].

Dummy loads are generally in the form of water heating elements or air heating elements. The electric energy that is supplied to the dummy load will become heat energy which is generally just rejected into the environment without any use. Gunung Sawur 1 is a MHPP that uses an dummy load of air heater elements. The electric energy of the dummy in Gunung Sawur 1 MHPP also rejected into the environment and sometimes even disturbing when the operator of turbine is in the power house because the air in the power house gets hot. This study aims to determine the electrical energy potential of dummy load in Gunung Sawur 1 MHPP and its potential of utilization.

2. Electronics Controller of MHPP

Electronic Controller at MHPP needed to stabilize turbine rotation. A stable turbine rotation will produce a fixed voltage and frequency in accordance with the control settings. Stable electricity

voltage and frequency will ensure the safety of electrical and electronics equipment used by MHPP consumers. The main components of electronics controller in the MHPP are ELC modules and dummy loads [4, 5, 6, 7].

2.1. ELC

ELC on MHPP is an electronics module that is used to regulated electrical energy that is supplied to a dummy load whose value is affected by consumer load. ELC will increase electricity supply to the dummy load automatically when the consumer load decreases. Conversely, if the consumer load increases, the electricity supply to the dummy load will be reduced by the ELC. This condition makes the load received by the generator of MHPP will always be stable so that the voltage and electrical frequency produced will be stable [4, 5, 6, 7].

Gunung Sawur 1 MHPP uses ELC for 3 phase systems. The ELC on Gunung Sawur 1 MHPP has two 3 phase outputs supplied to the dummy loads (Figure 1).

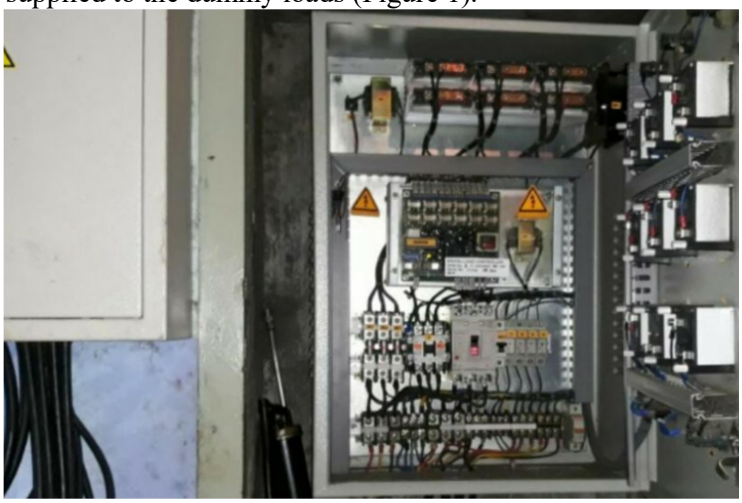

Figure 1. ELC module at Gunung Sawur 1 MHPP

2.2. Dummy load

Dummy load is the balancing load used on MHPP. Dummy load is usually a heating element. The heating element that is used as a dummy load can be a water heater element or an air heating element. Dummy load must have a power capacity that is greater than the maximum power generated by the micro hydroelectric generator, so that if the consumer loads is zero (0 watts) then all the power generated by the MHPP will be supplied to the dummy loads [6,7].

Gunung Sawur 1 MHPP uses a dummy load of 6 heating elements with each capacity around 3000 w at 220V voltage. Dummy load on the Gunung Sawur 1 MHPP is assembled in star circuit into 2 series. The first star circuit is connected to the output 1 of ELC and the second star circuit is connected to output 2 of ELC (Figure 2).

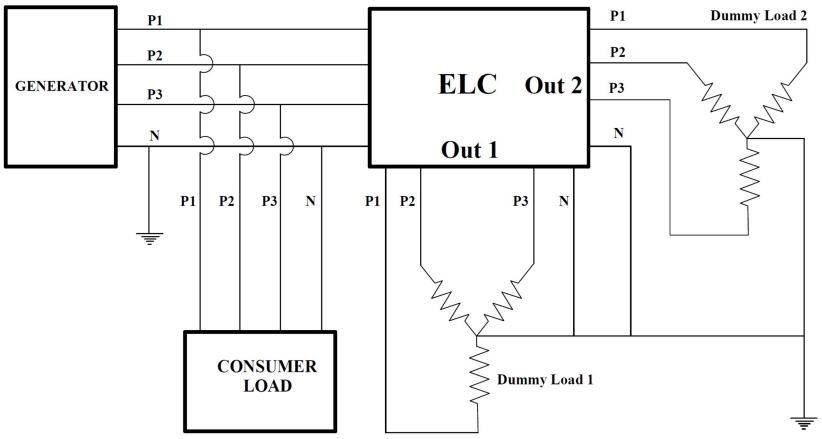

Figure 2. Dummy loads wiring diagram in Gunung Sawur 1 MHPP

3. Method

This research was carried out in Gunung Sawur 1 MHPP were located in Sumberwuluh Village, Candipuro District, Lumajang Regency, East Java, Indonesia at the elevation 650 m above sea level. The research started February until May 2018. The equipment used is the Fluke 1735 three phase power logger which is used to recording the electrical data on dummy loads in the Gunung Sawur 1 MHPP. The investigation of dummy loads energy in Gunung Sawur 1 MHPP use these following steps:

- Preparation of the power logger.
- Installation of probes and clamps sensors (Figure 3).
- The recording forevery 1 minute.
- Let the data logger record for several days.
- Recording stoped.
- Probes and clamps uninstalled.
- Downloading recorded data.
- Data processed using MS Excel [8].

Figure 3. Instalating of probes and clamps sensors on dummy loads

Observation data is displayed in graph and table. The standard deviation is calculated in order to determine the deviation value that accured [9].

4. Result and discussion

The electrical data resulted from investigation of dummy load in Gunung Sawur 1 MHPP . The electrical voltages on the dummy loads were fluctuate from 0 volt to more than 100 volts (Figure 4). The average voltage of dummy load is 78.9 volts with standard deviation of 38.3 volts. This voltage variation occurs because the consumer load is always changing from time to time. When the consumer load is high, the electrical voltage that is supplied to the dummy load will be low even when the peak voltage of the electricity supplying the dummy load is 0 volt because all electrical energy are supplied to the consumer loads. Based on the Figure 4, the peak load is in the morning and early evening. At that time the voltage supplying the dummy load is very low even 0 volt. The peak load that occurs in the morning is caused by high electricity consumption because some consumers cook rice using a rice cooker that requires a lot of electric energy. The peak load that occurs at the beginning of the night because electricity is widely used for lighting and electronic equipment such as television.

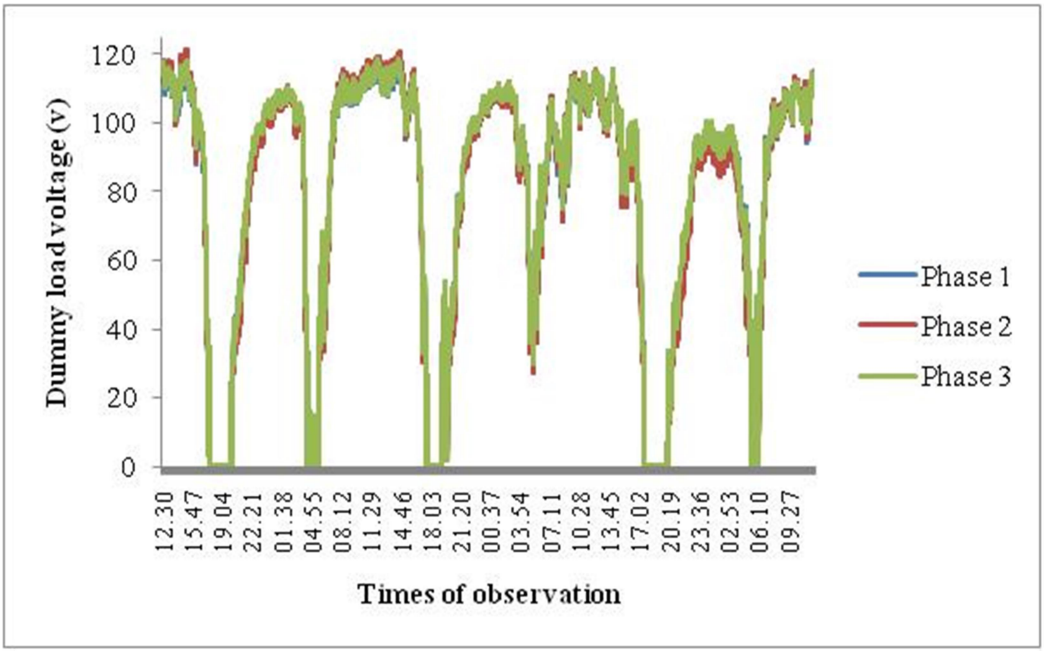

Figure 4. Voltages of dummy loads observed in Gunung Sawur 1 MHPP

Power and electrical energy dummy load during the day is greater than at night. Consumer loads during the day is smaller than at night. During the day there is almost no need for lighting. The Rural consumers generally go to the fields during the day so that the use of electricity is also low. The occurrence of fluctuations in electricity consumption during the day is more due to electricity consumption from the shop machine in the Hydro Cipta Mandiri workshop to produce some micro hydro turbines.

Unstable dummy load electrical condition only allows the opportunity to use for heating processes such as water heaters or water purification in distillation process, and also for drying process. Heating elements can accept the fluctuates voltage. The utilization of dummy load electric energy could be applied by changing the dummy load heating elements using the others for that utilization.

The average of electric power dummy load at night is 2502.5 with standard deviation of 1865.1 watts. Then the average of electric power dummy load during the day is 3688.5 with standard deviation of 1477.8 watts. A smaller standard deviation value during the day shows a smaller power variation. Power and dummy loads energy are tabulated in Table 1.

Table 1. Power and energy of dummy loads

Observation	Daily dummy power(w)	Dummy potency energy (wh)
1st day	2872.9	68949.6
2nd day	3238.7	66438.5
3th day	3184.1	64488.7
4th day	3052.8	59098.9
5th day	3219.2	70697.4
6th day	3185.9	69664.9
7th day	2914.6	63325.9
Average	3095.5	66094.9

The average of electric energy dummy load is 66094.6 wh or 66.1 kwh per day. This energy is equivalent to 237940.6 kJ[10]. This energy can be used to raise the temperature of the water from 20°C to boiled at 97°C and it will be able to evaporate about 92 kg of water. If only to increase the temperature of the water without evaporation, it would be able to heat 738.1 kg of water from a temperature of 20°C to 97°C. The energy to increased 1 gram of water temperature every °C is 4,19 J. The boiling point of water at 97°C occur at the about elevation 650 m above sea level [11]. Heat energy to evaporated of water at 97°C about 2264.4 kJ/kg [12].

5. Conclusion

The average electric energy of dummy load in Gunung Sawur 1 MHPP is 66.1 kWh per day. Utilization unstable energy of dummy load can only be used for heating process, such as water heating or water purification on distillation system.

6. Acknowledgement

This research was funded by the Ministry of Research, Technology and Higher Education of the Republic of Indonesia through PDP program 2018. Thanks to Mr. Sucipto as Owner of Hydro Cipta Mandiri and Gunung Sawur 1 MHPP manager for supporting to this research.

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