

# PERMANENT MAGNET GENERATOR DESIGN AND TESTING FOR HYBRIDE PV-PICOHYDRO POWER PLANT

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## ABSTRACT

*The development of Hibride PV-Picohydro plant is needed to be able to achieve the sustainability of electrical energy in the remote area. one of the them being developed is picohydro power plant. One of the main components of picohydro is electric generator. small scale power generators such as for picohydro are still limited in the market, therefore in picohydro design research, a permanent magnet generator is required that can generate minimum power of 200 Watt. the research aims is to design and test the pichohydro generator it can produce more than 200 Watt. pichohydro Generator need to design and manufacture the main components such as the shaft, stator Support and windings coil modification. Furthermore, the place generator test will be in laboratory to get the performance of the generator. The generator test will be discussed where the number of coil windings 80 wires and 0.6 mm wire diameter. Result of research permanent magnet generator has been made according to designing specs. From the test results obtained voltage between 12 volts and 18 volts is at 500 rpm to 700 rpm, whit the result that the shaft will bethe picohydro operating speed. Power that test results at 700 rpm with a voltage of 18 volts at 14 watts.*

**Key words:** Generator Test, Permanent Magnet Generator, Picohydro

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## 1. INTRODUCTION

The PV-power hydro hybrid power plant is one of the long-developed plants. This power plant generates with two energy resources so that sustained energy can be achieved. the example for developing PV-microhydro in Toli Ethiopia has designed a PV-Power hydro hybrid to get the cost of the plant if solar panels are added [1]. Another example of using a PV-microhydro hybrid is found at Bunnasopit School, Thailand, with the capacity to generate electricity at 36 kWh / day while the PV can generate electricity at 14 kWh /day [2].

Hybrid power plant sistem also depeolved for the photovoltac system and picohydro scale. The Low head energy for Power hydro Resources is abundant specially in river irrigation in the rural area.

Classification of power hydro plants can be distinguished based on the generated power capacity. Picohydro plant is a type of small-scale water energy generator that is less than 5kW [3]. In designing a picohydro wake, an electric generator is required in accordance with the design power, in this case the picohydro is designed to wake up with 200 watts of power. However, a 200 watt power generator is hard to find, so we need to build a generator for the picohydro. so the purpose of this research is to design build and test the generator for pichohydro power 200 Watt. the generator to be developed is a generator with a permanent magnet, with a 12 pool.

The Picohidro power plant is a power plant that has a maximum power of 5 kW which is usually applied to remote areas, especially hilly countryside [4]. The rural areas have considerable potential for hydro power, especially small reative power, so the picohydro generator is still potential to be developed as the price per Kwh is still the cheapest at around 18 cent / kWh compared to other power plants such as solar sell and wind power [5] .

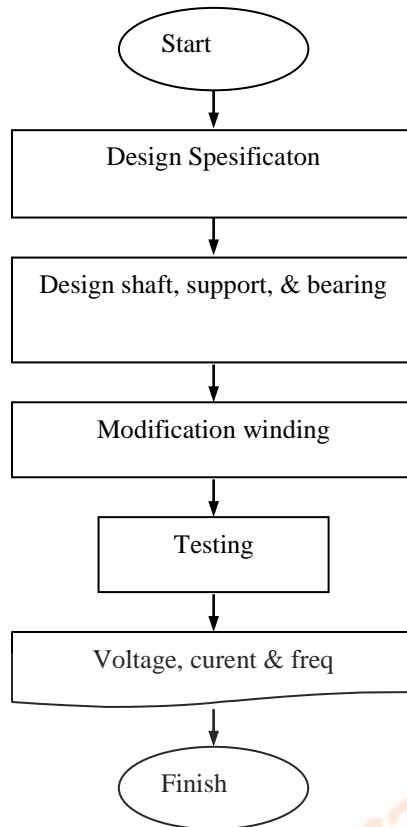
The picohydro power plant has been developed for a low head that is under 2 meters as has been done by shantika, (2015) designed a picohydro build for river flow with a 100 watt design power [3].

Portable picohydro research with 100 watts of power for rural homes was also developed which uses a lot of commercially available materials such as PVC and can be made by handmade [6].

The permanent generator has the advantage that the rotor does not need to use the brush so as to reduce friction due to friction. As mentioned by Fitzgerald, A.E.1997 that most applications of the axial flux machine are for a brushless DC motor [7].

## **2. RESEARCH METHODS**

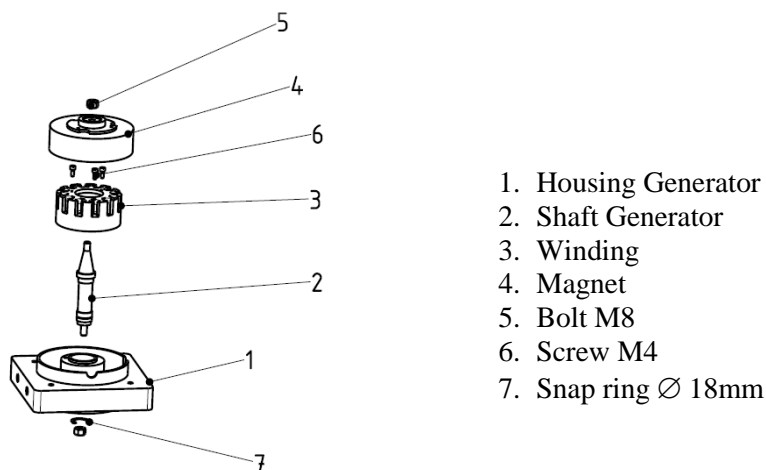
This study discusses the design of permanent magnet generator test equipment which will then be used for the picohydro generator, this research begins with design of the generator shaft and stator/coil house, decide bearings used, then modification of the coil and then assembling of all the component. The next step is testing generator on the laboratory to know the current, voltage, and generator frequency every rotation of shaft. Flowcart research as in the following figure.



**Figure 1** Flowcart research

### 3. RESULT AND DISCUSSION

Picohydro generator design is the first step before manufacturing the components, there is design of the shaft, housing, modification winding coil and the determine spesifikasi of the standard components. The generator is planned to produce a minimum of 200 watts of power by using a rotor permanent magnet. The required voltage is between 12 to 18 volts at a minimum speed of 400 rpm and the coils used have 12 pools. From the data design specifications then the authors will test the generator with 80 turns on the coil.



**Figure 2** The generator components are designed

Before performing the test it must be made several components as a permanent magnet picohydro generator that is the shaft and housing. Furthermore, assembly picohydro generator is ready to be tested in the laboratory. Generator components can be seen in Figures 2 and 3.



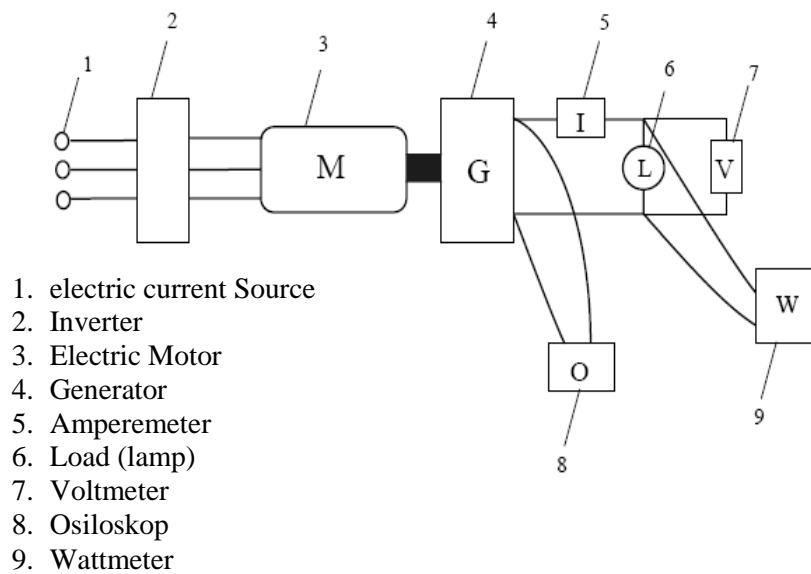
**Figure 3** Generator component manufacture

After assembly process further tested by using the load with capacity of 300 watts at 12 Volts. The generator is rotated by an electric motor with adjustable speed. The measuring instrument used is voltmeter, amperemeter and oscilloscope as in figure 4.



**Figure 4** Testing in the laboratory

The test scheme as in figure 5, where the driving force drives the electric generator, then the generator will generate electricity connected to the lamp load, then the generator output is measured by voltmeter, ampere meter and oscilloscope. The test is performed at 100 rpm shaft rotation up to 2000 rpm which is set by inverter rotation.

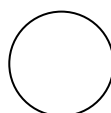


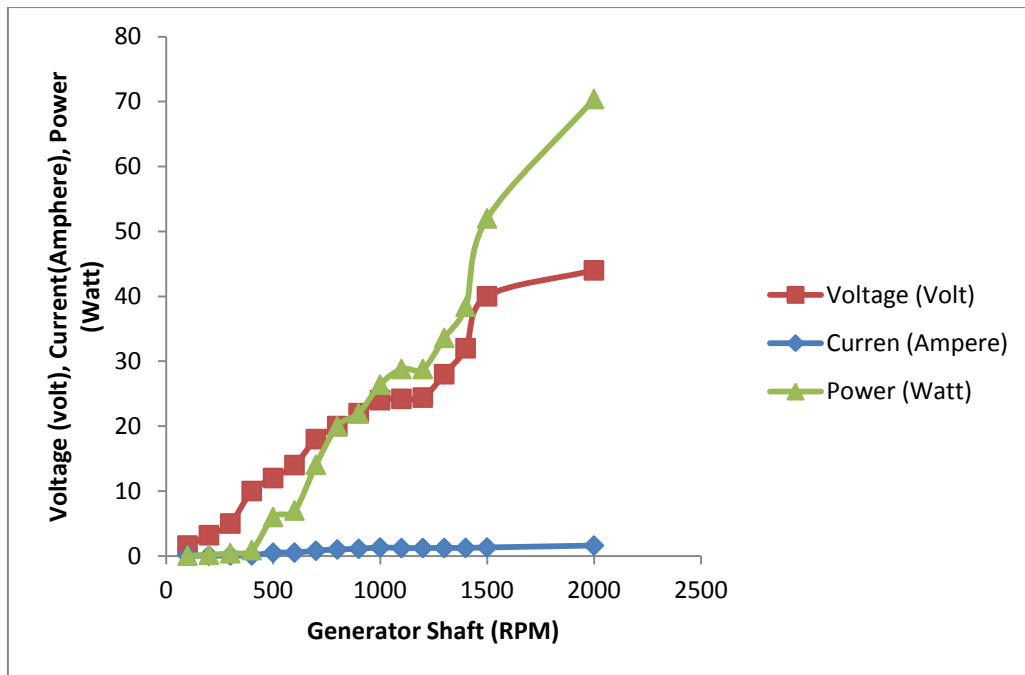
**Figure 5** Testing Scheme

From the test results obtained generator characteristics as in table 1, where the greater the rotation of the rotor / magnet then the voltage will be greater. the maximum voltage generated is 44 Volts at 2000 rpm, but the desired voltage for picohydro generator is 12 volts up to 18 volts. At that voltage can be met by spin axis of 500 rpm up to 700 rpm. But the power generated by 14 watts so it is still quite small compared with the target of 200 watts.

**Table 1** testing Result

rpm	Vac (Volt)	I (Ampere)	VI (watt)
100	1.6	0.03	0.05
200	3.2	0.03	0.18
300	5.0	0.08	0.42
400	10.0	0.09	0.90
500	12.0	0.50	6.00
600	14.0	0.52	7.00
700	18.0	0.80	14.04
800	20.0	1.00	20.00
900	22.0	1.10	22.00
1000	24.0	1.30	26.40
1100	24.2	1.21	28.80
1200	24.4	1.22	28.80
1300	28.0	1.23	33.60
1400	32.0	1.24	38.40
1500	40.0	1.30	52.00
2000	44.0	1.60	70.40





**Figure 6** Graph generator shaft rotation (rpm) versus voltage, current dan power

From the figure 6. graph voltage curve have a fluctuation state on the 1100 rpm until 2000 rpm, it causes power instability in the generator. In other state from 200 rpm until 1000 rpm have a steady state voltage, therefore in this range the generator should be have the operation of picohydro turbine. the results of the test required re-modifications include the replacement of the permanent magnet material used and changes in the winding to obtain power in accordance with the design of picohydro.

#### 4. CONCLUSION

Permanent magnet generator has been made in accordance with designing specs. From the test results obtained voltage between 12 volts and 18 volts is at 500 rpm to 700 rpm, which the result that the shaft will be the picohydro operating speed. Power that test results at 700 rpm with a voltage of 18 volts at 14 watts.