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# Design Micro Hydro Power Plant for Generate Electrical Energy About 3000 to 5000 Watt

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**Abstract**

The aim of the reseach is making the prototype design of waterwheel-based Microhydro Power Plant (MHPP). The findings of this study are the Prototype Model of Micro Hydro Power Plant (MHPP) for generate electrical energy with power 3000 to 5000 watt. This model has been constructed of fout components, sucs are (1) the disain of waterwheel prototype, (2) the disain of converter speed water wheel to dynamo, (3) the water chanel for input Potential Energy, and (4) Conductor Network of MHPP to homes.

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## INTRODUCTION

Electricity is the most important aspect of supporting the activities of human life. With the existence of electricity, the existence of electrical energy is able to light lights along the road, at home, offices, malls, and other important places.

Electricity generator is a device that can generate and produce an electrical voltage by converting certain energy into electrical energy. In addition, a power plant can also be called all machines that convert motors, light, and petroleum or other chemical objects into propulsion.

Micro-hydro is a term that consists of the word micro which means small and hydro which means water. Micro Hydro Power Plant (MHPP), is a small-scale power plant that uses hydropower as its driving force, such as irrigation channels, rivers or natural waterfalls by utilizing potential energy from high heights (heads) and the amount of time from water discharge.

Potential utilization of water flow from water sources in the mountains especially in the Village of Kwadungan, Kalikajar Wonosobo has been utilized by researchers to build a micro hydropower plant (MHPP). MHPP that was built using waterwheel is the reason, because the water discharge is relatively small, and based on observations of the use of turbine in MHPP produces MHPP that is not durable and easily damaged by flooding.

A small power plant that can use hydropower by utilizing the height of the head (in meters) and the amount of water discharge (m3/sec). The greater the flow capacity and height of the installation, the greater the energy that can be used to produce electricity. MHPP is generally a run of river type power plant where the head is obtained not by building a large dam, but by diverting the flow of river water to one side of the river then flowing it again into the river at a place where the required high difference has been obtained. Hydroelectric power plants below 200 kW are classified as MHPP.

The problems faced by the Micro Hydro Power Plant (PLTMH) Business Group are: Until now the PLTMH prototype has not been registered with patents or industrial designs in Kementrian Hukum Dan HAM RI.

The purpose of this research is: to design a prototype PLTMH based on a waterwheel for small water discharges (less than 10 liters/second), which generates electrical energy from 3000 to 5000 Watt/unit. The design of the PLTMH prototype will subsequently be registered with an Industrial Patent or Design at Kementrian Hukum Dan HAM RI.

## METHODS

Making the prototype design of waterwheel-based MHPP for small water discharges (less than 10 liters/sec), which produces electrical energy 3000-5000 Watt/unit. PLTMH prototype design procedures consist of making prototype engineering drawings of MHPP, making a description of the components of MHPP and its functions. The making of MHPP prototype technical drawings is based on measurements of three MHPP units that have been built since 2010 and have been utilized by the community in Kwadungan Village.

## RESULTS AND DISCUSSION

### MHPP Prototype Design

The working principles and the standard components of the three PLTMH are the same. The principle works as follows:

(1) The potential energy from water originating from the mass (water discharge) and the difference in height (head) is converted into kinetic energy in the form of a spinning wheel.
(2) Rotating the wheel turns the Wheel Converting Machine from the Wheel to the dynamo.
(3) The dynamo rotates at a fixed speed of an average of 1800 RPM (revolutions per minute).
(4) This dynamo rotation of 1800 RPM produces electricity.

(5) Electrical energy from PLTMH is channeled through conductors to homes that use electricity.

PLTMH prototype raw components consist of:

(1) PLTMH Ferris wheel
(2) Rotating machine from the mill to Dinamo
(3) Dinamo
(4) Supporting buildings or houses for PLTMH prototypes
(5) The network of conductors of PLTMH to PLTMH user houses.
(6) Safety Channels to prevent damage to PLTMH due to flooding.

The design of PLTMH components will be explained in the description below. The design of PLTMH is based on the third prototype of PLTMH that has been built and proved to be functioning well for more than nine years. PLTMH I, II, III.

**Waterwheel design**

MHPP waterwheel wheel has a diameter of about 400-500 centimeters. The larger the diameter, the smaller the energy needed to drive the wheel, but the cost of making the wheel is more expensive. The energy or force needed to move the wheel follows the "Lever" law in Physics. Based on experience and observation of the optimal waterwheel diameter for MHPP in quadrants with such conditions as the above conditions are 450 centimeters.

In this research, technical drawings are made from the waterwheel. This technical drawing is planned to be used as a basis for submitting Intellectual Property Rights in the form of Patents. Waterwheel engineering drawings are presented below.

waterwheel used in all three PLTMH is made of steel. Researchers got inspiration for the design of the PLTMH waterwheel from models of our ancestors' wheels used to flow or move water, not from reading journals or science about turbines.

Using of waterwheel for MHPP is a solution to the problem: "turbine-based MHP prototypes are often damaged due to flooding". Based on observations of many turbine-based MHPP dormant dormant dormant functions as expected. By using a waterwheel, MHPP is expected not to be easily damaged by flooding. Of the three wind turbine-based MHPP units used at BUMDES, Kwadungan Village provided evidence that the MHPP waterwheel system was truly resistant to the effects of flooding, this was evidenced by the fact that PLTMH I, II, III remained well and functioned normally for more than nine years. In this study, improvements were made to the dynamo, waterways, and conductor networks of the MHPP function to become more tangible, namely to produce electrical energy used by the people in Kwadungan Village.

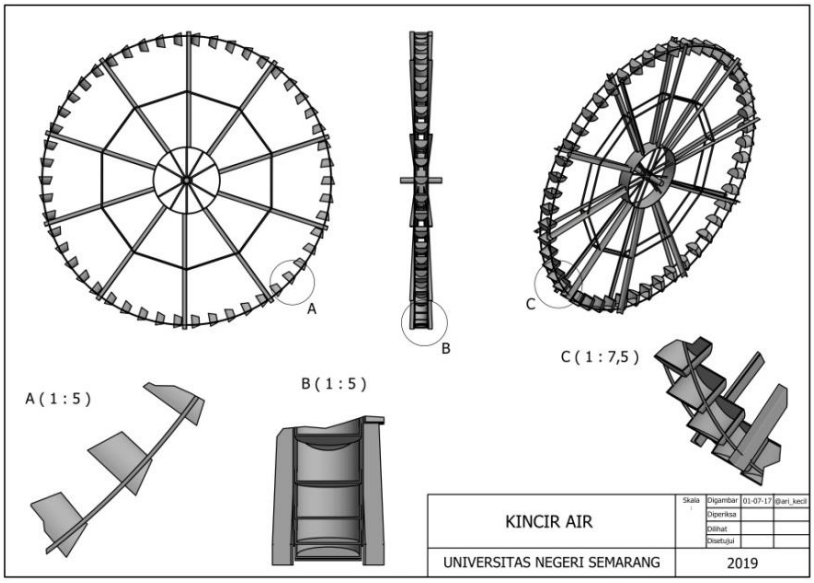


**Figure 1.** Technical drawing of waterwheel for MHPP

Figure A is a technical drawing of a waterwheel seen from the side. Figure B is a technical drawing of a waterwheel seen from the front side. Figure C is a three-dimensional engineering drawing of a waterwheel.

The shape of the fins of the waterwheel is in the form of a bowl. This fin receives water exposure from the outlet pipe of the water channel. With the application of these fins spinning wheel. The rotation of the wheel rotates the engine converting rotation and is continued by turning the dynamo to produce electrical energy.

In theory, the water hits the waterwheel can be divided into two, namely:

(1) Water outlets are placed on the side of the wheel. This modeling is called "Over Shock". This water treatment model in MHPP turns out to produce unfavorable conditions, which is water splashed everywhere. Splashes of water can hit the pinwheel. Inside the wheel axis, there is a laker component (Bearing) that is easily damaged when splashed with water so that the durability of the axis and laker is reduced.

(2) Water outlets are applied to the bottom of the wheel. This modeling is called "Under Shock". The reason for this water application model used in MHPP is that water splashes do not wet the pinwheel components so that the axis and laker become more durable and undamaged. Besides that, in the Under Shock air acceleration model, potential energy is obtained because of the higher head height difference.

**The disain of converter speed water wheel to dynamo**

Rotating machine from the waterwheel to Dinamo is a series of Pulley with various diameters connected to each other so that it can convert the rotation speed of the wheel to Dinamo speed. The magnitude of the dynamo rotation is 1800 RPM. The number of Pulleys (wheels) and Pulley diameters and the arrangement of their circuits are determined by the principles of physics formulas regarding Angular velocity. The formula is:

$\omega_1 \, r_1 = \omega_2 \, r_2$

Keterangan :

$\omega_1$ = Angular speed of the wheel 1

$r_1$ = radius of wheel 1

$\omega_2$ = Angular speed of the wheel 2

$r_2$ = radius of wheel 2

The design of the Round Conversion Machine from waterwheel to Dinamo in this study is based on the model of the Round Conversion Machine from Windmill to Dynamo that has been applied to MHPP in BUMDES MHPP Kwadungan. The basis for the use of the design of the Wheel Conversion to Windshield Dynamo Engine is the fact that the Wheel to Windshield Conversion to Dinamo Machine has been successfully applied for more than 9 years until now on the above mentioned micro hydro power plants.

The round converter machine from the waterwheel to dynamo is made from several types of materials as follows:

(1) In MHPP one, the material for the Round Conversion Machine from the waterwheel to Dinamo is a pulley or wheels made of steel. Between the pulleys connected by a belt Pulley besides functioning as a spin transmission, also functions as a flywheel.

(2) In MHPP two, the material for the Speed Converting Machine from Ferris wheel to Dinamo is pulley or wheels made of wood. Between the pulleys connected by a belt

(3) In MHPP three, the material for the Round Conversion Machine from the waterwheel to Dinamo is pulleys or wheels, some are made of wood and some are made of steel. Between the pulleys connected by a belt

Based on the observation of pulley made from wood, it works better than steel because it produces a larger pulley mass/weight so that its function as a flywheel becomes better which ultimately results in a more stable spin. Making pulley from wood is relatively difficult so special skills are given. The use of pulleys in the machine to convert the Wheel from Windmill to Dinamo from iron is relatively easier because the market has available various sizes of steel wheels so there is no need to make it.

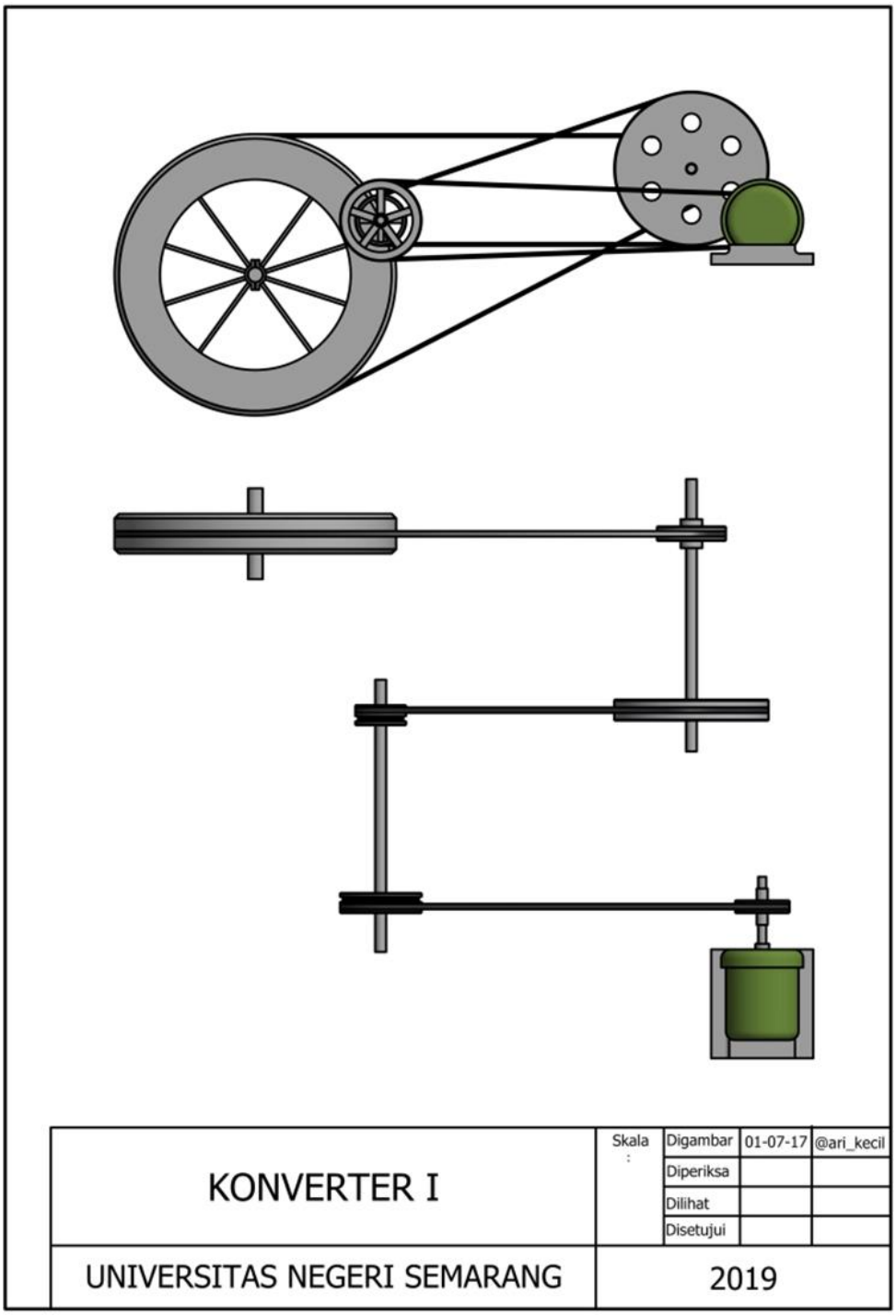


**Figure 2.** Convert the Wheel from Windmill to Dinamo

**Dinamo Circuit Design**

Dinamo is a conversion of kinetic energy into electrical energy. In the construction of MHPP dynamo that are already on the market are used. The dynamo used in the MHPP in Kwadungan is the dynamo which has a standard rotating speed equal to 1800 RPM. MHPP 1 uses a 5000 watt dynamo, MHPP 2 uses an 8000 Watt dynamo and MHPP 3 uses a 3000 Watt dynamo.

The power of the dynamo installed on the MHPP is adjusted to the estimated potential energy obtained from water discharge and height differences.

**Design Of Conductor Networks From MHP To Residents' Homes**

The conductor network of MHPP to houses made of insulated electric cables with a conductor diameter of about 1.0 mm. The required electrical cable length is around 2000 m. In addition to the conductor cables, supporting poles are needed so that they are not harmful to the community. The support poles are made of parallels with a diameter of 3 inches and height ranges from 2 to 3 meters in which they are filled with cast concrete. The cost of making these poles is much cheaper than those made of iron or wood. picture of the design of the network of conductors from the MHPP to houses is presented in the image below.

**Figure 3.** Conductor Networks from MHPP to Homes

## CONCLUSIONS

The prototype design of MHPP is as follows. MHPP for small water discharges (less than 10 liters per second) based on windmills. The use of these wheels is a solution so that the MHPP prototype has high sustainability that is durable not easily damaged by flooding. Evidence that MHPP is based on waterwheel is more durable, ie prototypes MHPP one, two, and three have been used for more than 9 years and still produce stable and undamaged electricity. The MHPP component of the millwheel consists of six components, namely: 4-5 meter diameter, the reversing wheel from the mill to the dynamo is named "converter", Dinamo, the house where the MHPP prototype is, the Conductor Network from MHPP to the houses, and the safety cistern and conduit.

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