Installation Of Flood Light Powered by Pico-Hydropower Generator in Pulong Mangga Caduang Tete Macabebe Pampanga

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Abstract: Energy generation creates a high impact on community where high prices of electricity occurs when time passes. Hydropower generator converts the kinetic energy of the water flow into a harvested electricity with the use of turbines and other types of hydropower generator that can be used in every house or in a small-scale usage. Pico-hydro generator usually generates under 5Kw of energy that usually used in small houses or other facilities that does not require a lot of power. Energy generation form a small place can have a lot of impact on the community itself or for individual use. Water flow is everywhere whether it is strong or weak that can be used as a source of energy. A particular place in Pampanga was known for its flooding problems that it can last up to months or even years and combined with dark surroundings that can create an accident. A floodlight that can brighten the surroundings will be used to lighten up a particular section of a place that is dangerous without light, like bridge where a wrong step can make you fall into the water and die. Lighting up a dangerous bridge powered by the water that was flowing from it can lessen the risk of accidents. Experiments in building a generator was executed including testing and improvement of the generator. The study revealed that the hydropower generator can supply electricity to floodlight that brighten the target place creating a safer passage for the residents.

Key Words: —*Hydropower, Hydro Generator, Pico-hydro, Vortex Gravity Turbine, Floodlight.*

I. INTRODUCTION

Due to the continued exploitation of natural resources, the conventional sources of electric energy, consisting of fossil fuels such as petroleum and coal are getting depleted. The number of countries that are suffering due to the lack of electric energy is increasing every day. With raising population means raising in energy demand with limited resources, energy supply will be depleted in the near future if people will continue to use non-renewable energy.

Typhoons and high tides are the common causes of floods in some places in Macabebe Pampanga. Due to its low-lying place, houses and other establishments are forced to raise their floor 2 feet higher from the ground.

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Pulong Mangga, Macabebe, Pampanga was a place where residents suffer from all day and all-night flood for the sake of other barangays, keeping the river water from spilling to the opposite canal making them looks like a small dam.

Hydroelectric generator is one of the renewable energy sources that energy can be harvested. Hydro generator works from force of water rotating the blades of the generator creating a rotation force to the motor that will create electricity. This type of generators used in dams and other bodies of water that has fast or one direction flow of water.

According to Wisconsin (2012), Hydropower plants capture the energy of falling water to generate electricity. A turbine converts the kinetic energy of falling water into mechanical energy. Then a generator converts the mechanical energy from the turbine into electrical energy. Hydroplants range in size from "micro-hydros" that power only a few homes to giant dams like Hoover Dam that provide electricity for millions of people.

Most conventional hydroelectric plants include four major components;

Dam. Raises the water level of the river to create falling water. Also controls the flow of water. The reservoir that is formed is, in effect, stored energy.

Turbine. The force of falling water pushing against the turbine's blades causes the turbine to spin. A water turbine is much like a windmill, except the energy is provided by falling water instead of wind. The turbine converts the kinetic energy of falling water into mechanical energy.

Generator. Connected to the turbine by shafts and possibly gears so when the turbine spins it causes the generator to spin also. Converts the mechanical energy from the turbine into electric energy. Generators in hydropower plants work just like the generators in other types of power plants.

Transmission lines. Conduct electricity from the hydropower plant to homes and business.

Pico-hydropower, electricity generation under 5kW, can be used where there is a stream or river flowing near to a community. Several countries, such as Nepal, Vietnam, Laos and Peru, have been exploiting Pico-hydropower for the past few decades as a way to provide electricity to rural locations Due to the location of the study, it was surrounded by bodies of water, researchers decided to use Pico-hydropower generator instead of solar flood lights. Solar flood lights can be used and install, but due to trees that occupies the street, solar flood lights might not get charged because of the shadow of trees. This tree holds the soil to prevent erosion because of the river.

1.1 Statement of the Problem

The bridge in Pulong Mangga was actually a small dam to keep the other barangay free from flood. But due to high tides and typhoons, overflowing occurs creating a strong current and making the floor slippery because of moss with addition of dark surroundings, accidents happen that leads to death. With the help of interview, researchers found out that accidents happened in this bridge. Several people including a motorcycle was also fell in to the water because of dark surroundings, and 2 people died, tripped and fell in water.

For this study, the researchers enumerated the following possible problems:

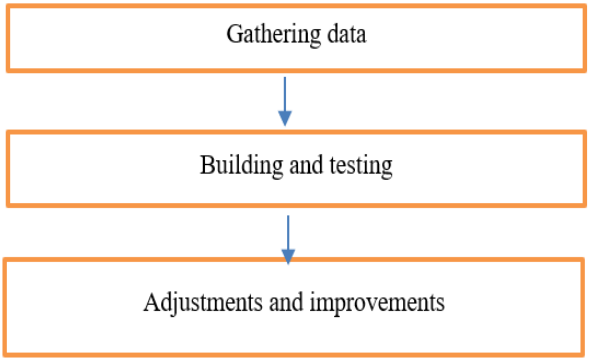
- Can the generator power up the battery?
- Can the flood light brighten the surroundings to avoid accidents?

1.2 Setting of the Study

Fig.1. Flooded Bridge

1.3 Conceptual Framework

Table.1. Conceptual Framework



This framework was made with three stages that can ensure the quality, efficiency and availability of the project. First stage is gathering of data that ensures the possibility of the generator to function. Building and testing the generator was the main task to do because it is where the researchers will get results that can improve the project. Adjustments and improvement will be the last task to complete to achieve the maximum efficiency and the best results.

II. LITERATURE REVIEW

Pico hydro is a term used to distinguish very small-scale hydropower with a maximum electrical output of five kilowatts (5 kW). It is a good technique of providing electricity to the off-grid remote and isolated regions that suffer energy deficit. Typical Pico-hydro generator is designed and supported by electrical converting system, batteries and safety equipment so that it can be installed at the residential water pipeline. In Pico-hydro generation, the environmental impact is negligible since large dams are not

involved, and the schemes can be managed and maintained by the consumer. This paper is reviewing the application of hydro generation and particularly focusing on the implementation of Pico-hydro generation system Pico Hydro Power Plant (PHPP) is a hydroelectric power plant with a scale below 5 kW. This technology is suitable to be applied to areas that have many rivers with sloping slopes. The PHPP applied in this research utilized the river flow and then flowing the water through a water channel with a slope angle around 10 degrees. Due to this sloping angle, it is necessary to modify the turbine intake to produce a more rapid water flow so that the turbine can rotate faster. The modification is made by designing and making a spiral vortex hydro turbine, where the intake is designed to resemble a snail house or a whistle to produce a spiral vortex to drive a turbine. The results show that the spiral vortex hydro turbine can produce faster turbine rotation, compared with a conventional water intake. The speed of the portable spiral vortex hydro turbine in this research can reach 90 rpm. Then, the turbine is coupled with a generator to produce electricity, through a pulley system. The faster the turbine rotation, the higher the generator output voltage. The highest output voltage of the generator is 27.5 Vdc at the speed of 293 rpm. In addition, the device is easy to move and maintain due to its portable design with a weight of 22 kg.

According to Castaldi et al. (2003), the energy released by falling water is captured and used to generate electricity. In the simplest words possible, when water falls owing to gravity, kinetic energy is transformed into mechanical energy, which can then be converted into a type of usable electrical energy. Even 2,000 years ago, the Greeks employed wooden water wheels to transform kinetic energy into mechanical energy.

According to Kaunda et al. 2012, hydropower can be utilized to generate energy, run machinery, or do both at once. The automated this is especially true for small-scale hydropower facilities, where the energy produced powers a variety of small-scale mechanical tools and equipment used in pressing, milling, grinding, and sawing operations. In some cases, the result the small-scale hydropower turbine's shaft is extended in both directions to create space for both the production of mechanical power and electricity. According to some sources, hydropower is the world's largest source of renewable energy; in 2009, it generated 3,329 TWh of electricity, or about 16.5% of all the electricity produced globally. It is one of the most significant sources of energy in many nations; the World Energy Council's 2010 Report estimates that hydropower accounts for around 160 of the world's nations' national electricity generating mixes.

According to Iglesias et al. (2021), hydropower is a well-known technology used to generate electricity from renewable sources is hydropower. Some researchers have begun to examine its application to already-existing urban water systems within the current framework in order to capture excess energy that would otherwise be lost. Hydropower is a well-known technology for renewable energy generation for electricity supply and more recently has started to be studied at a small-scale as a possible solution for energy recovery at existing water systems.

According to Macovoy (2012), the energy released by falling water is essentially captured by hydroelectric power facilities. And convert this energy into usable electricity by passing it through a vertical distance. Usually, falling water is directed via a turbine, which transforms the energy of the water into mechanical power. A generator that generates power is connected to the rotating water turbines.

According to Paul Coughlan (2016) Gravity vortex hydropower exploits the energy available in a vortex flow. A vortex is generated, typically in a circular basin with a tangential inlet and a central outlet. A vertical axis turbine is placed in the center of the vortex, where the rotational speed is the highest. The turbine rotates with the swirling flow, thus generating mechanical energy which can be converted to electrical energy using a generator. As detailed in Section II, there have been few research studies or commercial projects on this concept to date.

III. METHODS

3.1 Research Design

This research is to propose a hydropower generator that can charge the floodlight to increase the safety in the target place. The experimental research design was employed in this study by the researchers to carry out experiments in an instructive cost- and time-effective manner. When these procedures are used in product development, they have the potential to both speed up the development of hydropower generators and other areas of the research while also helping to improve the quality of the product. The findings and data that the researchers gathered throughout experimentation will serve as the foundation for the study's conclusion and suggestions.

3.2 Participants

All residents in Pulong Mangga are the participants in this research due to small population consisting of 30 houses with almost 50 adult persons who will benefit from this research.

3.3 Instrument

In order to gather data and information that will be used in this research, days of planning and observation was made to the area. Measuring the height of overflowing water for a week with the use of tape measures and other measuring instruments. Researchers interviews the residents about history of the bridge. And other collection of data was done with the help of parents and families in the community.

3.4 Gathering of data

In this study, researchers will collect data and information regarding the water system in Pulong Mangga Caduang Tete Macabebe Pampanga. It can be done by interview, measuring the canal, monitoring the water and assessing the collected data.

Even if the country is still in its summer season, floods continue to occur in the area. When the rainy season arrives, higher floods may occur, which might activate the generator and be used in the event of a power outage. The table below shows the time where flood occurs creating an overflow of water flowing to the canal creating a force that the generator needs to operate.

Table.1. Time of Overflowing Water

DAY	TIME	HEIGHT
MONDAY	9:00 AM – 8:00 PM	1 FT
TUESDAY	9:00 AM – 7:30 PM	1 – 2 FT
WEDNESDAY	10:00 AM – 7:00 PM	1 FT
THURSDAY	11:00 AM – 10:30 PM	2 FT
FRIDAY	10:00 AM – 9:00 PM	1 - 2 FT
SATURDAY	11:00 AM – 10:00 PM	1 FT
SUNDAY	12:00 AM – 11:00 PM	1 FT

Table.1. shows the time where the water will overflow and was determined for a week of observation. The data shows that the water is overflowing for 9 to 11 hours and most of it was in day time so the researchers determined that the battery will be needed supply the lights at night when the generator is not operating.

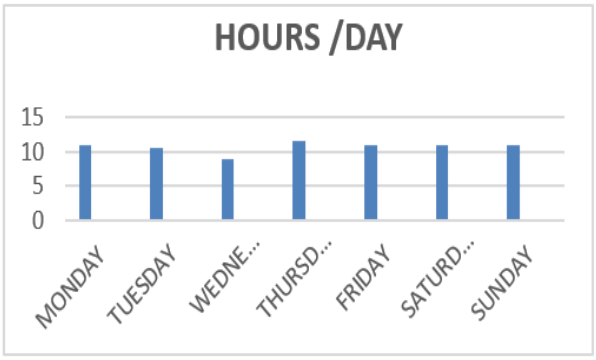


Fig.1. Hours of Overflow

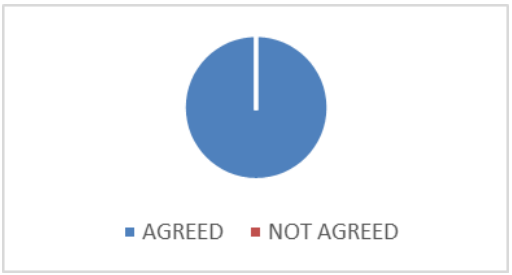


Fig.2. Number of Respondents Agreed to Hydro Powered Flood Light

Figure.2 shows that all of the residents of Pulong Mangga was agreed to have a hydro powered flood light. Researchers conducted a house-to-house interview or question if the residents are agreed to install a flood light in the bridge and every house that interviewed are happily agreed to this project. Almost 30 houses and almost 100 persons agreed.

IV. Building And Testing The Device

Table.2. Materials and description

Materials	Description
Turbine	Turbine is a device that catches kinetic energy from flowing water that turns the generator
Generator	Generator will create electricity that was powered by the turbine

Flood light	flood light with built in battery can be recharge by external source or by using hydro power generator

Turbine: The researchers are testing a small portable turbine that uses siphon effect using large PVC tubes and a turbine in the middle.

4.1 Siphon turbine

Fig.3. *Siphon Turbine*

Researchers used the siphon turbine to reduce the cost of building. Materials used was 4" PVC tubing, generator and the turbine blade. The blade was placed inside the tube where all the water was flowing creating a rotation to generator.

4.2 Generator

Fig.4. Flywheel and Stator

Generator nowadays are expensive and researchers wants to reduce the cost of building that is why researchers used a motorcycle alternator from a stocked and not functioning motorcycle. This motorcycle will be sold to a junk shop so the owner is willingly giving the alternator for free, reducing the cost of the generator.

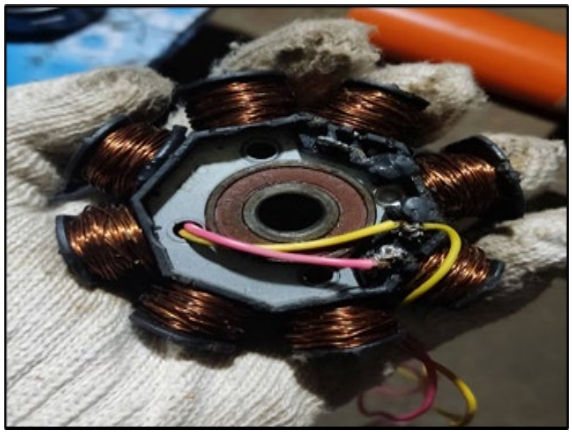


Fig.5. Rewind stator

Due to stocked and not functioning stator, the researchers was forced to rewind the coils in stator to make it functional and to be used.

The stator is consisting of 8 coils and the first rewinding wires used was a 24-gauge magnetic wire or 0.02 inches / 0.51 mm in diameter with 150 turns each coil. The output was recorded and consist of maximum 78.3V and maximum current of 2.58 A. This generator was operated using a hand drill to determine the maximum output of the generator.

4.3 Flood light

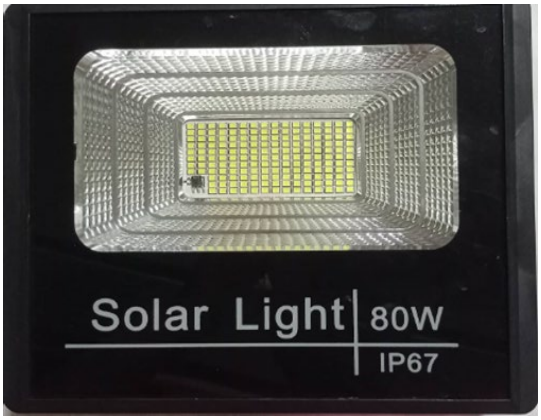


Fig.6. 80 watts flood light

An 80-watt floodlight was used in this project due to low power requirement to charge its batteries. This type of floodlight has 170 pcs of LED and only requires 6V/6W of power to charge. 4-6 hours of charging and a light time of 10 – 12 hours capable of lighting the bridge all night.

The solar panel of the 80 watts flood light is capable of delivering an open circuit voltage of 6.5V and short circuit current of 0.8A in direct sunlight.

On-site testing day 1

Fig.7. Generator testing

Testing of siphon turbine has a negative result that is unable to achieve the required power to charge the flood light. Releasing a maximum of 14V and a current of 0.5A. The test made the researchers come up another design to achieve the desired output. Also, this test determines that siphon turbine has its advantage and disadvantages.

Table.3. Advantage and Disadvantage

ADVANTAGE	DISADVANTAGE
Portable	Requires much height differences
Small space	Small turbine
Easy to build	Low torque at low elevation

Table.3. Shows the advantages where the turbine can be built easily and it was portable that it can be brought to different places. But during testing, disadvantages occur, it requires much height differences where the location of the research only has 0.5 – 1 feet of water differences. Small turbine also was a problem because the PVC pipe used was only size 4 and the next size was too large to use. Due to small turbine and small height difference, low rpm was achieved during testing. That it can't supply the required energy to charge the floodlight.

V. Making Adjustments And Providing Improvement

5.1 Improving of turbine

Fig.8. Vortex turbine

The second turbine used was the gravity vortex turbine. The turbine was built using scrap metals and basin and other recycled materials to reduce the cost in building process. The turbine blade was made out of used PVC pipes that was used during the first testing of siphon turbine.

5.2 Improving the generator

Fig.9. Rewind stator

Since the voltage output is too high and the current output is too low in the first testing, the researches rewind it again to achieve the desired output for the flood light.

The second rewinding is consisting of 18-gauge magnetic wire or 0.04 inches / 1.02 mm in diameter. Twice the thickness of the first wire. Due to thickness of wire, the turns in each coil were reduced to 125 turns capable of generating maximum of voltage of 65V and maximum current of 4.5A.

Off-site testing day 2

Fig.10. Turbine testing

The second turbine used was the gravity vortex turbine. During testing, the turbine shows positive results that can be used for charging the flood light. The amount of water in off-site testing was slightly less compared to the actual site and still capable of generating maximum of 8.5V and a maximum current of 1A.

Offsite testing day 3

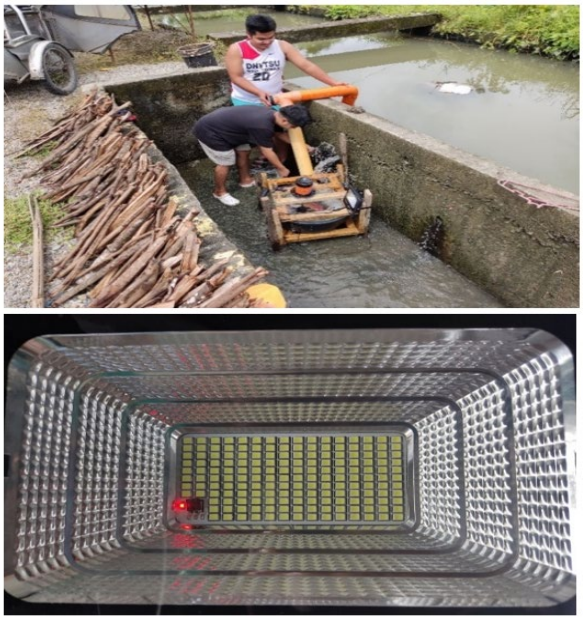


Fig.11. Flood light charging test

Offsite testing day 3 resulted in a successful testing. With small amount of water capable of delivering an open circuit voltage of 9V and short circuit current of 1.1A. a flood light was attached and was charging with voltage of 4.5V and current of 0.8A. Researchers determined that the floodlight was charging because of the indicator in front, where it will light up if it's charging.

5.3 Onsite testing

Fig.12. Onsite testing

Onsite testing was resulted to success installation of hydropower generator in Macabebe Pampanga. Due large amount of water unlike in off-site testing, the output of the generator was greatly higher. In offsite testing with only one size 4" PVC pipe was used as a source of water; onsite testing was 3 to 4 times more amount than off-site creating a large amount of electricity that the floodlight can handle. Overvoltage can occur that is why the researchers used a voltage regulator to regulate the voltage at a stable amount. The maximum voltage output of the generator is 21V and the short circuit current was 1.9A.

5.4 Schematic diagram

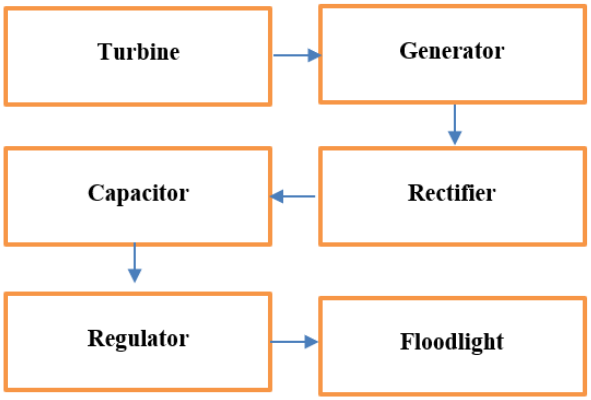


Fig.13. Schematic Diagram

AC generator will create electricity and the bridge rectifier will transform it into DC power. Capacitor was added for smoother flow of electricity. Since the output is too high for the flood light, a voltage regulator was added to maintain a desired voltage to safely charge the floodlight. The flood light will receive the energy from the generator capable of charging it's built-in battery to function at night without any source of electricity. The flood light has a built-in overcharge and over discharge safety which will make for the flood light safe from any internal damages.

VI. Results And Discussion

Table.4. Generator output

Open Circuit voltage	**21V**
Short Circuit Current	**1.9A**

Table.5. Week test of floodlight

DAY	RESULT
WEDNESDAY	GOOD
THURSDAY	GOOD
FRIDAY	GOOD
SATURDAY	GOOD
SUNDAY	GOOD
MONDAY	GOOD
TUESDAY	GOOD

Table.4. shows the result of the flood light that was powered by hydro-generator. The researchers conducted a test for a week, monitoring if the flood light was functioning. The food light was functioning every night from 7:00 PM to 6:00AM for a whole week that answered the question if the generator can power up the flood light. The day in table starts at Wednesday because researchers started conducting testing at Wednesday. The floodlight is also capable of turning on while it is charging incase the generator will operate at night.

Fig.14. before

Figure .14 show the situation without a light that was captured on the last test of floodlight Tuesday 8:08 PM that has a dark surrounding. The nearest light that was provided by local officials was too far to lighten the bridge and only the road was visible at night.

Fig.15. After

Figure.15 shows the floodlight operating at the same time and day resulting to fully bright and visible bridge.

VII. Conclusion

The researchers concluded that the generator can charge the floodlight from the result of observation that the floodlight is operating normally for a week without any issues or malfunctions. Creating an alternative source of energy from a flowing water and charging the floodlight that can help the community preventing accidents in the target place.

The floodlight height recommendation to install was 2 – 3 meters and researchers installed it at 2m due to small area and to highly brighten the surroundings for brighter view of the bridge. The bridge is successfully brightened up by the floodlight creating a safer way of passage for the residents.

Recommendation:

Because of high output of the generator and the floodlight only consumes small amount of electricity, the generator can

supply another floodlight if the residents want another surrounding to be brighten up. And if the flood light is not turning on at night because the generator is still operating, a remote control can be used to turn on the floodlight.

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