# Faculty of Electrical and Electronic Engineering Technology

# DEVELOPMENT OF RAINWATER SOURCED PICO-HYDRO GENERATOR POWERED WATER FILTER

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**Bachelor of Electrical Engineering Technology with Honours**

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# DEVELOPMENT OF RAINWATER SOURCED PICO-HYDRO GENERATOR POWERED WATER FILTER

**MASHILA BINTI AMILLUDIN**

**A project report submitted**
**in partial fulfillment of the requirements for the degree of**
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I declare that this project report entitled "**Development of Rainwater Sourced Pico-Hydro Generator Powered Water Filter"** is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : 13 JANUARY 2023

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## APPROVAL

I hereby declare that I have checked this project report, and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of **Development of Rainwater Sourced Pico-HydroGenerator Powered Water Filter.**

Signature :

Supervisor Name : Dr. Azhan bin Ab. Rahman

Date : 27/1/2023

# ABSTRACT

Malaysia is a country, which receives a lot of rains and up to an extent that it is one the cause of flash flood. At the same time, the increase of electricity bill is also a main concern. To make use of both issues, rainwater sourced pico-hydro generator powered water filter is proposed in this project. This project utilized the rainwater to move a pico-hydro generator, which produces electricity to power a water filter. Proteus software is used to simulate the process and development of the hardware part, which mainly consists of recycled material, is carried out. Hardware testing results showed that the pico-hydro generator was able to generate more than 5 V of voltage to supply electricity to the water filtered water pump. The functionality of the project is justified by the positive results from three types of analysis, namely, optimum head distance, optimum water level and optimum flow rate determination. The three different analysis produced three distinct equations that can be used to make an estimation of ideal settings that to design a more efficient pico-hydro generator system. It is expected that this design can be applied in any domestic household especially in the rural area

# ABSTRAK

Malaysia adalah sebuah negara, yang menerima hujan yang lebat dan sehingga satu tahap yang menjadi salah satu punca banjir kilat. Pada masa yang sama, kenaikan bil elektrik juga menjadi kebimbangan utama. Untuk memanfaatkan kedua-dua isu, penapis air berkuasa penjana pico-hidro air hujan dicadangkan dalam projek ini. Projek ini menggunakan air hujan untuk menggerakkan penjana pico-hydro, yang menghasilkan tenaga elektrik untuk menggerakkan penapis air. Perisian Proteus digunakan untuk mensimulasikan proses dan pembangunan bahagian perkakasan, yang kebanyakannya terdiri daripada bahan kitar semula, dijalankan. Keputusan ujian perkakasan menunjukkan penjana pico-hydro mampu menjana lebih daripada 5 V voltan untuk membekalkan elektrik kepada pam air ditapis air. Kefungsian projek ini dibenarkan oleh keputusan positif daripada tiga jenis analisis, iaitu jarak kepala optimum, paras air optimum dan penentuan kadar aliran optimum. Tiga analisis berbeza menghasilkan tiga persamaan berbeza yang boleh digunakan untuk membuat anggaran tetapan ideal untuk mereka bentuk sistem penjana pico-hidro yang lebih cekap. Reka bentuk ini diharapkan dapat diaplikasikan dalam mana-mana isi rumah domestik terutamanya di kawasan luar bandar

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# TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

**FIGURE** **TITLE** **PAGE**

## LIST OF SYMBOLS

| | | |
|---|---|---|
| $\rho$ | - | Density |
| m | - | Meter |
| A | - | Ampere |
| M | - | Mega |
| Pa | - | Pascal |
| W | - | Watt |
| V | - | Voltage |
| % | - | Percentage |
| HP | - | Horsepower |

## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| $V$ | - | Voltage |
| HP | - | Hydro Power |
| PHP | - | Pico-Hydro Power |
| IT | - | Impulse Turbine |
| PT | - | Pelton Turbine |
| RT | - | Reaction Turbine |
| DC | - | Direct Current |
| AC | - | Alternating Current |
| CFL | - | Compact Fluorecent Lamp |

# LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

According to the World Economic Forum, based on the official data, which is from the June report by the Indian government, India is facing the worst water crisis in its history [1]. This crisis has affected most of the nation's areas. In 2021, this crisis also happened in Selangor, Malaysia for three days. During the difficult days, the community needed to ask for help because of the lack of clean water used for drinking and daily household chores. Also, the rural areas, especially in Sarawak and Sabah, which are in Malaysia, are mostly exposed tohuge scale water sources but it is difficult to get electrical sources compared with peninsular Malaysia [2]. The issue of energy poverty is centered in rural areas, where 1.6 billion of the people lack access to electricity and 0.2 million of people in Malaysia do not have electricity [2]. Figure 1.1 shows the cooking style in the rural area without facilities.

Figure 1.1 Cooking Style in the rural area [2]

Then, based on the figure 1.2, due to the climate in Malacca, Malaysia, for the last 5 years, there has been the lowest rainfall distribution from 2015 until 2019 at the Malacca Dam, which is in 2019. At the lowest year of rainfall distribution, Malacca state needs to restrict water use due to the lack of a water source for 3 days. For the next 3 days, society will need to depend on its own tank storage. They need to minimize water use for the three days. Then also, there are a limited number of household chores that use water, for example, washing clothes, doing dishes, and drinking water. Otherwise, they need to buy drinking water at the store due to the restricted water use.


Figure 1.2 Statistics of Average Annual Rainfall Distribution (mm)



With the advancement and sophistication of technology that exists today, researchers, engineers, and others who are related are attempting to find a solution to the crisis. One of the ideas is a hydropower system. Hydropower converts the water's energy to generate electricity through the natural water-moving concept. Hydropower is also one of the most important systems that can generate electricity using renewable resources. This project isfocusing on pico-hydro power.

## 1.2 Problem Statement

Nowadays, all the latest news and information are mostly based on electronic media communication, which is done through television, gadgets, and smart phones. All these devices need electricity to keep functioning all the time. Then, for the rural areas, there is a lack of electricity sources to keep getting the latest and most important information, especially on the pandemic COVID-19 and heavy flood information .

Then, in the rural areas, there are huge sources of water, for example, from the river and lake, but they are still getting less clean water for humans and animals due to the lack of awater management system. As of today, the total population is increasing, and they need the proper water management system, especially for the youth growing phase. They are entitledto get a clean lifestyle and proper utility services like in the town.

These days, having a proper management system for electricity is like having air for breathing; it is essential for everyone. For example, people need data for searching for a job, for online business, and most importantly, for educational purposes, especially in pandemics.

By developing a rainwater-sourced pico-hydro generator powered water filter, rural areas will get clean water and electrical supply. This will produce huge significance for society.



## 1.3 Project Objective

The main aim of this project is to propose a systematic and effective system to developrainwater sourced pico-hydro generator powered water filter.

a) To perform analysis in terms of varying the head and penstock length.

b) To perform analysis in term of water level

c) To perform analysis in term of water flowrate.

a) To determine the design combination that produces the best optimum output.

## 1.2 Scope of Project

a) The project's rainwater-sourced pico-hydro generator-powered water filter is a system that generates electrical power for home low-power-usage appliances.

b) A pico-hydro generator is a small turbine that converts the energy from water flow into electrical energy for less than 5 KW output power, which is called pico-hydro.

c) The water filter is used to produce clean water and can be indirectly used as drinking water but needs to boil the water first to make it more secure.

d) The storage of rainwater needs to be higher from the ground to maintain pressure for water flowing, because when the pressure is high, the speed of the wheel of the turbine will increase and produce a higher current.

e) The analysis for heads distance are 2 cm, 4 cm, 6 cm, 8 cm, and 10 cm.

f) The analysis for water level is 2 L, 4 L, 6 L, 8 L and 10 L.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

A literature review is part of a report that focuses on the journal, article, and book that the previous works of research reference, which are the main ideas that the author focused on. All the data is simplified based on the title, abstract, introduction, conclusion, and full text. All the information that is focused on the same or different objective can be used as a comparison, which can make the outcome project better. Examples of the research that can be used as a reference for this project are Pico hydropower (PHP) development in Malaysia, Pico-Hydro Electric Power in the Nepal Himalayas, Investigation on the Performance of Pico-Hydro Generation System Using Consuming Water Distributed to Houses, etc. All the quests are limited to English-version papers.



## 2.2 Background of Pico-Hydropower

### 2.2.1 History of Hydropower

The main idea of hydropower is the process's flow from kinetic energy from the water's flowing process to electrical power. In the hydropower system, there are two types of process water cycle which are natural cycles and the second is the cycle that occurs within the hydropower station. The purpose of hydropower generation is to create electricity from renewable sources. It is a highly precious and sought-after resource. The world is currently concerned about the depletion of fossil fuels. at the same time, faces the detrimental impact of rising and concerned about oil prices. As a result, numerous countries, including Malaysia, are attempting to integrate renewable energy.

sources such as mini, micro, and pico-hydro [4]. Figure 2.1 shows that the classification of the hydropower.

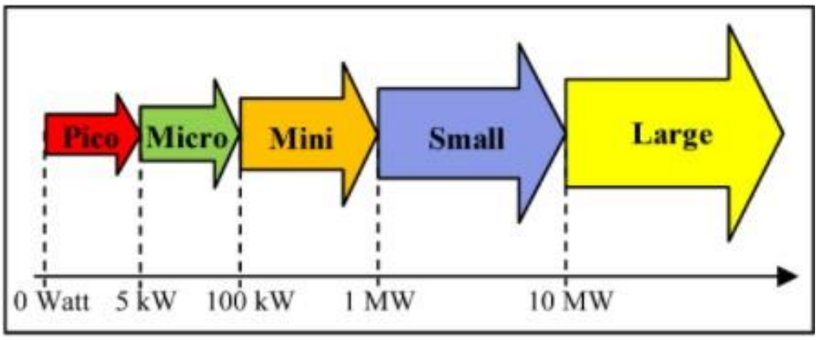


Figure 2.1 Classification of hydropower

### 2.2.2 Concept of Pico-Hydro Power System

According to the Cambridge Dictionary, a generator is a machine that can assemble electrical power, and pico-hydro is a renewable energy that requires a minimal input of electrical power which is less than 5KW to generate electricity. Thus, a pico-hydro generator is a machine that generates electrical power from renewable sources and outputs electricity. This system is converted from kinetic power to electrical power. Pico-hydro power is also known as a subset of small hydropower system. Pico-hydro is gaining popularity for off-grid applications in low-income locations. Pico-hydro systems are often low-cost due to the lack of major construction required to install them. These systems also have less environmental implications because they are consumer-managed and do not interrupt animal habitats or produce pollutants. The main objective of this system is focusing on the small communities [4].

In Malaysia, the utilization of pico- hydro systems is still in its early stages. The current state of technology can be described as both the beginning and the end. The majorityare imported from other countries. Nonetheless, the government was aware of the impact and significance of pico-hydro to the environment nation, particularly in inland areas. As result in 2010, The Ministry is developing a new renewable energy policy, energy, green technologies, and water, is designed to make better use of local resources and to contribute Security of national electrical supply and long-term viability. The government has established a vision, with 2020 as the target year. The contribution of small hydro (mini, micro, and pico-hydro) will be up to 500MW to the global power supply [4]. Figure 2.2 shows the basic of pico-hydropower system [5].

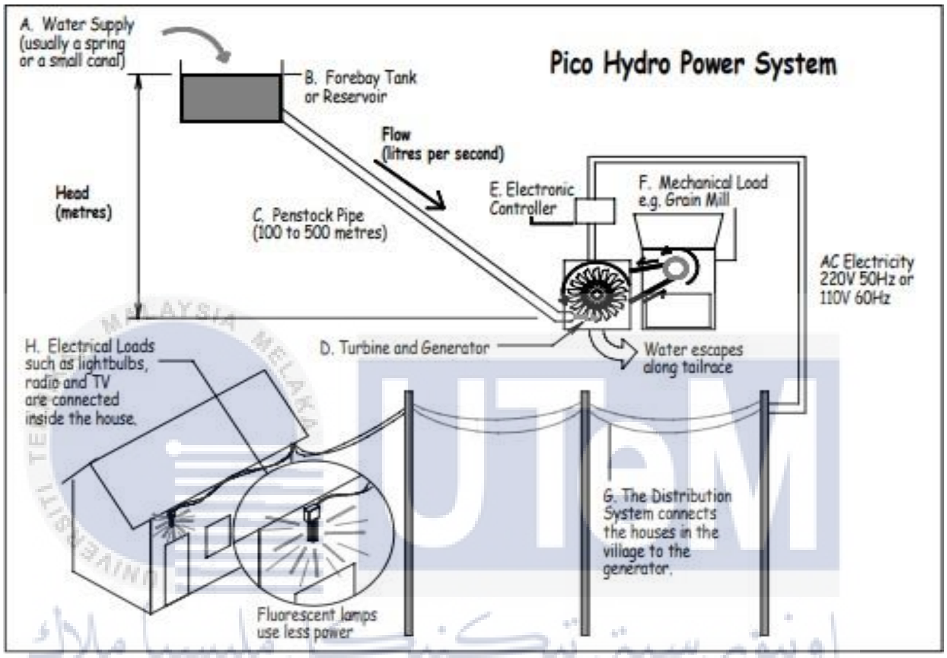


Figure 2.2 (Basic pico-hydropower system)



The flow of the process based on Figure 2.2 is from A to H. This figure explainsthat the flows begin from the water supply that has been stored in the place that is called a reservoir. The water flows down through the penstock and the water flows to the generator andconverts energy from kinetic energy to electrical energy. The energy that has been produced will be used to power the electrical loads such as lightbulbs, batteries, etc.