

**DESIGN AND DEVELOPMENT OF SIMPLE PELTON WATER TURBINE
FOR PICO HYDRO GENERATION SYSTEM**

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WATER TURBINE FOR PICO HYDRO GENERATION
SYSTEM**

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**This report is submitted in accordance with requirement of the Universiti
Teknikal Malaysia Melaka (UTeM) for the Bachelor of in Electrical
Engineering with Honours.**

Faculty of Electrical Engineering

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DECLARATION

I hereby, declared this report entitled “Design and Development of Simple Water Turbine for Pico Hydro Generation System” is the results of my own research except as cited in references.

Signature :

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Date :

Dedicated to my beloved mother, father and my elder sisters

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Firstly, I would like to thank from deepest of my heart and gratitude to Allah SWT who gave me strength to bear all circumstance and obstacles during finishing my final year project. Next, not to forget my supervisor who guided me with his knowledge and experience Mr Mohd Zulkifli Bin Ramli from the beginning of the report until completion. Moreover, special thanks first go to my family, who over the duration has been neglected even ignored, during my deepest concentrations.

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ABSTRACT

Hydro energy is one of the renewable energy that can be fetch and harvest from the flow of water by using the appropriate mechanism and system that can generate efficiently of electricity. There are many types of hydro energy which are large hydroelectric, small hydroelectric, micro hydroelectric and pico-hydroelectric. Each type generates different amount of output energy that can be consumed as utility. Now days, many rural places lack of electricity utilities and left out due to the cost and geography condition. So, the hydro energy is oftentimes considered to be called green energy because there is no emission of gas that give greenhouse effects related with the output of the electricity. Pico hydroelectric size is selected in this project because it can utilize even a small flow of water to generate electric. Those small flow of water is used to rotate hydro's pelton turbine to drive the mechanical shaft that connected with generator. This mechanical power is then being used to drive a generator in order to generate electrical power. Extensive study on generator, buck boost, turbine component, and the system circuit are the core for this development. During the development of this pico hydroelectric project, software such as Solid work is involve in designing the suitable pelton blade and wheel turbine. The designated model will be printed in 3D model parts, so that it can be assembled to become complete pico wheel water turbine. The purpose use 3D model because it made by light and strong material. The designed turbine should be capable to meet performance specification for hydropower generation, such as an adequate minimum rate of flow's water and the type of turbine design used. Besides, the technology is environmentally in term of pollution to nature, capital cost and life expectancy. This type of pico hydration commonly give output power below 5 kilowatts, nevertheless still there are various part of losses power occur in the process generating the output. Thus, affected the efficiency and output rate of the system. The expectation from this pico hydroelectric is it can supply current and voltage for small load such as resistor or charging purpose.

ABSTRAK

Tenaga hidro elektrik adalah tenaga yang boleh diperbaharui yang boleh dimiliki dan dituai daripada aliran air dengan menggunakan kaedah mekanisme dan sistem yang boleh menghasilkan elektrik. Tenaga hidro terdapat pelbagai jenis antaranya hidro elektrik besar, hidro elektrik kecil, hidro elektrik mikro dan hidro elektrik piko. Setiap jenis hidro elektrik menghasilkan jumlah tenaga elektrik yang boleh digunakan sebagai sumber elektrik. Pada masa kini, banyak kawasan pedalaman yang kekurangan kemudahan elektrik dan ketinggalan dari segi perkhidmatan tersebut ini disebabkan kos pembinaan dan keadaan geografi. Jadi, tenaga hidro seringkali di pertimbangkan untuk dipanggil sebagai tenaga hijau kerana tiada penghasilan gas yang memberi kesan kepada rumah hijau dengan tenaga yang dihasilkan untuk menjana elektrik. Hidro elektrik piko dipilih untuk projek ini kerana boleh menghasilkan elektrik walaupun aliran yang kecil. Aliran air yang kecil itu digunakan untuk memusingkan pelton turbin untuk memacu syaf mekanikal yang disambung kepada generator. Kuasa mekanikal ini digunakan untuk memacu generator untuk menghasilkan kuasa elektrik. Penyelidikan terhadap generator, " buck-boost", komponen turbin dan sistem lita adalah teras terhadap penghasilan projek ini. Dalam penghasilan projek hidro elektrik piko ini, perisian seperti "Solid Works" terlibat dalam mencipta bilah pelton yang sesuai dan roda turbin. Reka bentuk yang siap akan dicetak menjadi beberapa bahagian model 3D, oleh itu di pasang menjadi piko roda turbin yang lengkap. Tujuan menggunakan 3D disebabkan cetakan tersebut diperbuat daripada bahan yang kuat dan ringan. Reka bentuk hendaklah berlandaskan spesifikasi hidro elektrik piko tersebut seperti mencukupi tahap minimum aliran air dan jenis turbin yang digunakan. Disamping itu, teknologi adalah mesra alam dari segi pencemaran terhadap alam sekitar, kos pembinaan dan jangka hayat. Hidro elektrik piko ini, selalunya menghasilkan kuasa bawah 5 kilowatt, walaupun begitu, hidro elektrik piko masih ada lagi bahagian yang menyebabkan kehilangan kuasa yang berlaku dalam proses penghasilan tenaga elektrik. Oleh itu, kecekapan dan kadar janaan sistem akan terjejas. Jangkaan daripada hidro elektrik piko ini agar dapat menyalurkan arus elektrik dan voltan untuk beban yang kecil seperti perintang atau untuk tujuan mengecas.

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LIST OF ABBREVIATIONS

CHAPTER	CONTENT
P_{gross}	Gross Power
P_{net}	Net Power (power usefully delivered)
η	Efficiency
P	Power
g	Gravity
H	Head
HP	Horse Power
PMDC	Permanent Magnet Direct Current Generator
Q	Flow Rates
RPM	Rotation per Minutes
KW	Kilo Watt
MW	Mega Watt
DC	Direct Current
AC	Alternating Current
m	Mass
V	Volume of Water
H_{gross}	Vertical Distance
a	acceleration
ρ	Density
mg	Weight

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CHAPTER 1

INTRODUCTION

1.1 Project Background

There are many sorts of renewable-energy resources that can be utilize in this world but there is one most power renewable energy that has successful and proven track record which is hydroelectric power. This type of renewable energy is the most demanding for utility system and capable to generate until 10GW. The main reason why this hydro generation is so desirable is due to the environmental friendly. The operation of hydro output generation is does not contribute atmospheric pollution. The term that refer to its clean energy is “Green Energy”. The hydro generation system consists of two parameter that usually exist in the system that is the amount of water flow or called flow rate of water and the vertical height. The name pico hydro is a term used for hydroelectric power generation within 5kW. Although, the pico hydro power could achieve 5kW, in this project the target output is less than 1000W. The pico hydro power can be implemented in small communities or remote area that far away from utility service. It can provide those places with small amount of electricity for example to power up one or two fluorescent light bulbs and other electrical appliances. This Final Year Bachelor Project is entitling Design and Development of Simple Pelton Water Turbine for Pico Hydro Generation Using Low Flow Water Resources. The purpose of this project is to develop and produce a hydro generation system that can provide clean and sufficient energy for small scale area or small community that required for the target area based on flow rate of water. Flow rate is main component of the hydro generation electric. Water quantity is defined as water flow rate. Based on the journal Basar, M.F et al., (2011) it is the volume of water passing per second and it can be expressed as volume per time, with the unit of cubic per meter second.

1.2 Project Motivation

The rural areas always outreach from the electricity; thus, it is motivated as people living in society it feels responsible to study and start this project to create a renewable energy at minimum level of cost so that it can be installed especially at remote location. Nowadays, transferring energy to the rural places are difficult due to costing and generally the electricity generation comes with a big size that will install permanently in the specific area. The solution to handle for those places that lack of power generation is by developing and designing a low cost and handy renewable energy generator which is pico hydro system. The existence of 3D printer allows this project to utilize the machine in order to realize the Industrial Revolution 4.0 by printing the solid model of pico wheel and pelton turbine.

1.3 Problem Statement

The remote and rural place are always left behind in term of utilities and technologies. The places also less develop due to cost and structure of land condition. Normally cost is main factor in determine the optimum hydro system for specific location. If the location or place to put the pico hydro system is promising, thus the cost in developing the optimum hydro system will be in sensible range. Next, to design a good water turbine the mechanical and electrical relationship are important and must be taken into account in Designing and Development of Simple Pelton Water Turbine for Pico Hydro Generation. Chosen of turbine and design are the most essential parameters to be determined in designing the low cost and portable pico hydro turbine, which is either to use the reaction turbine or impulse turbine. Generator also a main factor in developing in this project. The appropriate type of turbine will give affect the output power generates, so, selection of generator must be considered either it can generate power at the determine rate.

For those reasons, during process of designing, it is essential to develop a great generator and turbine at smaller size with an efficient operational system, reliable, affordable, economically viable and socially acceptable to ensure it will generate a smooth mechanical rotation and output.

1.4 Objectives

The main objective for this project is to design and develop an electrical generation system based on hydro power. The objectives of this project are listed below and must be achieved and fulfilled to complete this project.

1. To design and develop a low-cost pelton hydro turbine using 3D Printer
2. To analyse the performance of the Pico-hydro system in terms of input and output efficiency.
3. To identify the possibility of the pico hydro turbine to generate electricity in certain speed.

1.5 Scope of Work

This project is conducted to design and develop hydro generation system which capable to produce range between 0 - 1000W of power generation. Hence, the appropriate component and method used during designation process plays a significant role in obtaining the water power which refers as the flow of water.

1.6 Final Year Project Outline

Chapter 1 elaborates the problem statement, objective, project motivation and scope of this project.

Chapter 2 explanation the literature study related to this project. Study on previous research by other researcher, project design and system are conducted to ensure the successfulness of the project. This chapter also describes the part and component comparison that suitable use for this project.

Chapter 3 describes the methodology to determine head, water flow, losses in pipeline system, components used and calculation output power from the system.

Chapter 4 discusses the result and analysis from the performance test of the system. A few calculations have been done to execute this system.

Chapter 5 provides conclusion and recommendation for further work of this project

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Hydroelectric is one of the most electric power generating that does not give effect on the greenhouse and environmentally. It is produced by change of potential vitality of a mass of water streaming in a waterway or stream with particular vertical fall. Alluding from (Pico hydro 2003) it is the broadly utilized type of sustainable power source, representing 16 percent of worldwide power age. Hydroelectric power is the reasonable, least expensive wellspring of vitality, sustainable and less contamination amid operation

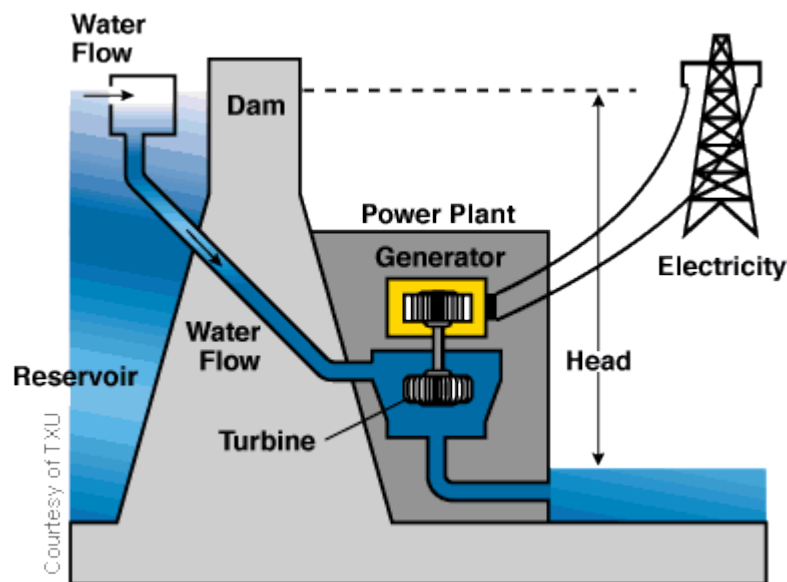


Figure 2.1: Hydro Power Plant

(Source: <http://gemasaintifika.blogspot.my/2012/07/>)

2.2 Hydropower

Hydropower is a power that form from a high potential energy which is running water or falling water. A previous century in early 19th century, the hydropower is early source to generate electricity. This shows the hydropower has long exist as the main generator to supply electricity to the community of human kind. The first ever built hydropower plant was at Niagara Falls in 1880. Nowadays, demanding in electricity due to increasing of human population showing massive interest in build a hydropower in order to use electricity un their daily life. [2]

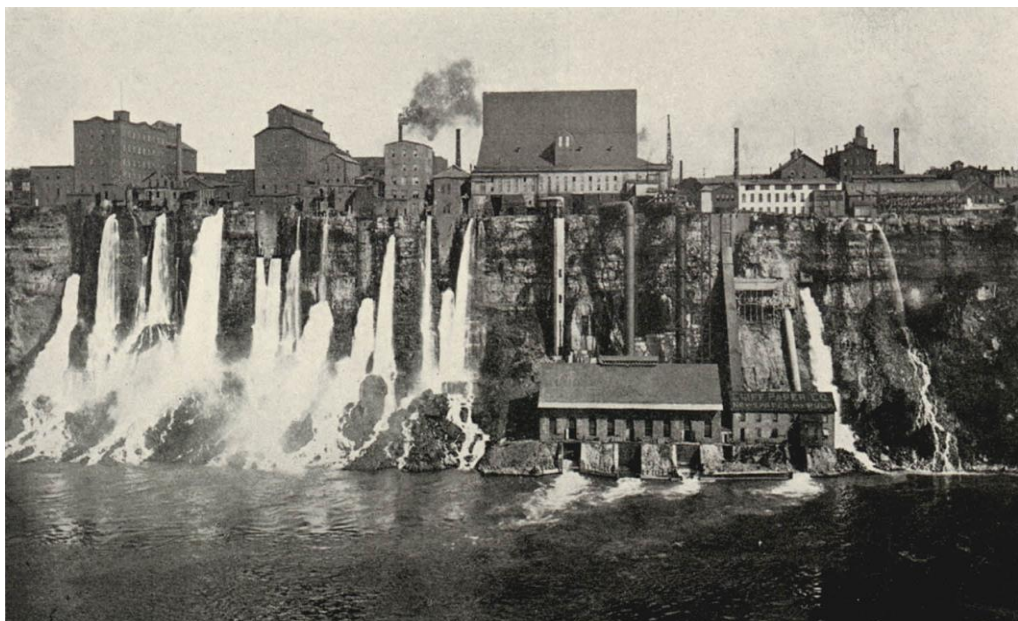


Figure 2.2: Hydro Plant at Niagara Falls

(Source: <http://www.teslasociety.com/exhibition.htm>)

2.3 Classification of Hydro Generation

There four types of scales in hydro generation:

i) Large

This scale hydroelectric power stations are predominant seen as the biggest power creating facilities on the planet, with some hydroelectric facilities equipped for producing more than double the introduced capacities of the current nuclear power stations. This large hydro

generation could create from over a couple of hundred megawatts to more than 10 gigawatts power. [4]

ii) Small

Small hydro is hydro power generation that normally to provide electricity for a small community areas or industrial plant. It can generate electricity within 10 gigawatts of power. This type of hydro plant will be connected to a conventional electrical distribution network as low cost renewable energy. The small hydro is often built at rural area that isolated from the national electrical distribution network which is difficult to get those utility services. As we know the small hydro plant normally requires minimal reservoir and hardware construction work, so the plant normally give low impact on surrounding ecosystem and better friendly environment compared to large type of hydro. [4]

iii) Micro

This hydro power can create 100kW of energy. This hydro power able to supply and give a very extensive of energy to an isolated house or little group of people or even can consider associating with electric power grid. This type of hydro system has widely used and installed around the world. Generally, countries that less fuel product are more likely to install this kind of hydro system, in order to reduce the purchase of fuel from third party country. [4]

iv) Pico

This kind of hydropower could generate under 5kW, due to the term given” pico” and small scale of hydropower mechanism. Thus, it could provide electricity in tiny, isolated communities that require only small use of power. Generally, this type of hydropower does not require reservoir, it can be set up a run of the river, with the small attachment of pipes that connect together to collect the flow of water and become one high potential

water energy which will going hit the turbine before returning to the stream.

[4]

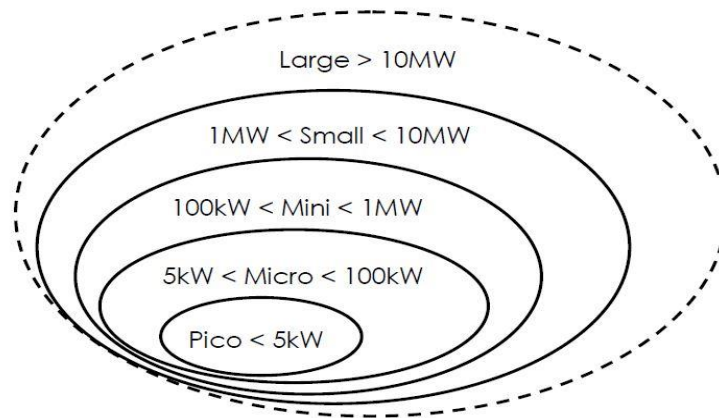


Figure 2.3: Classification of Hydro power plant based on the power output

(Source: M.B. Farriza)

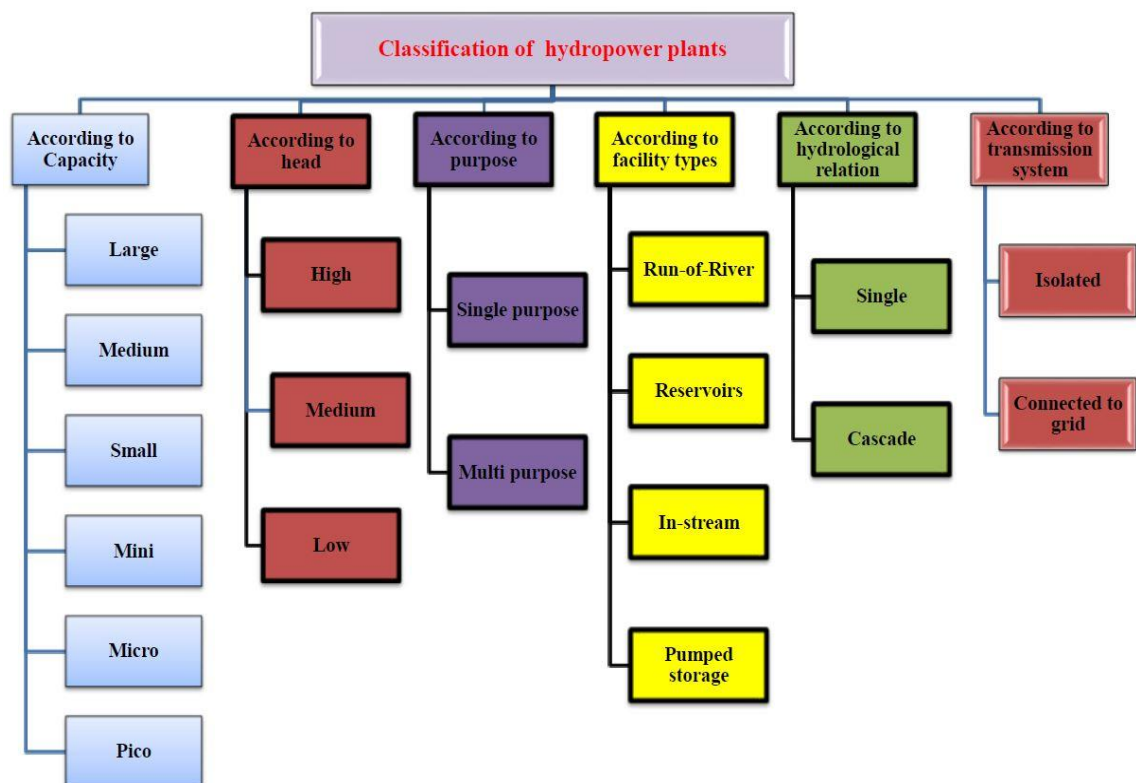


Figure 2.4: List all classification of Hydro power plants

(Source: Ganesh Kumar, www.slideshare.com)