STUDY ON MICRO HYDRO POWER PLANT AS A SITE LABORATORY IN UNIVERSITI TEKNOLOGI MALAYSIA

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Special for:

My beloved wife

Madihah Md Rasid

My soon to be born child

My father and my mother …

Anuar Sulaiman

&

Ruhani Ab. Rahman

My father and mother in law

Md Rasid Suib

&

Kalsom Raduan

also to my brothers and sisters…

In thankful appreciation for support and encouragement to

my supervisor…

Dr. Yanuar Z. Arief

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ABSTRACT

As the price of fossil fuels is increasing daily, the need for cheaper electricity generation rises. The most efficient and environmental friendly is generated from mega hydro power plant. However, due to large area needed, a smaller hydro plant is more suitable. A prototype of a smaller scale hydro plant known as Micro Hydro Power Plant (MHPP) is trying to be built in this project. This project is initiated since there is no available prototype to be used as site laboratory in Universiti Teknologi Malaysia (UTM). This project will be the catalyst for further research regarding the MHPP. It also supports the fifth fuel policy introduced by Malaysia in 8th and 9th Malaysia plan. Firstly, this project identifies the feasibility of site in UTM. Site visits and data gathering are done at all seven locations. Then, gathered data are calculated based on the formula found during literature review. The results show which site is the most suitable based on the output power calculated. The site with the highest output power is chosen as the trial site. Design stage begins once the site has been chosen; design is suited with the requirements of the chosen site. Six items are considered in the design stage. A prototype is then being built based on the design that has improves the reference model obtained during literature review stage. Experiments are done at the early construction stage to know the functionality of the prototype. Once the prototype is ready, trials are done to measure its performance. During trials, prototype constructed is capable of generating electricity. Objectives of the project are achieved and this project is a success.

ABSTRAK

Dengan kenaikan harga bahan api fossil setiap hari, keperluan untuk menjana elektrik dari sumber yang lebih murah menjadi semakin tinggi. Loji janakuasa berasaskan air adalah paling cekap dan mesra alam. Namun begitu, disebabkan cara ini memerlukan tanah yang amat luas bagi membina empangan. Disebabkan ini, pembinaan loji janakuasa berasaskan air berskala kecil adalah lebih sesuai. Prototaip loji janakuasa kecil akan dibina didalam projek ini. Projek ini diilhamkan kerana tiadanya prototaip yang dapat digunakan sebagai makmal sementara di Universiti Teknologi Malaysia (UTM). Projek ini diharapkan akan menjadi pemangkin kepada penyelidikan pada masa hadapan. Projek ini turut menyokong polisi minyak kelima yang diperkenalkan oleh Malaysia di dalam Rancangan Malaysia ke 8 dan ke 9. Projek ini akan mengenalpasti tapak yang sesuai di dalam UTM. Lawatan tapak dan pengumpulan data akan dijalankan di kesemua tujuh lokasi. Pengiraan berdasarkan formula dan data yang diperolehi akan dilakukan. Keputusan dari pengiraan akan menunjukkan kesesuaian lokasi. Lokasi yang mempunyai kuasa keluaran yang tertinggi dipilih sebagai tapak percubaan. Fasa reka bentuk akan bermula setelah tapak percubaan dipilih, reka bentuk akan mempertimbangkan keperluan di tapak percubaan. Enam perkara direka di fasa ini. Prototaip akan dibina berdasarkan model rujukan yang telah diperbaiki. Eksperimen dijalankan semasa pembinaan untuk mengetahui tahap keberjayaan fasa pembinaan. Setelah prorotaip siap dibina, percubaan di tapak yang telah dipilih akan dilakukan bagi mengenal pasti kuasa keluarannya. Percubaan menunjukkan prototaip yang dibina mampu menjana elektrik. Semua objektif projek dicapai dan projek ini dianggap sebagai berjaya.

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LIST OF ABBREVIATIONS

UTM	-	Universiti Teknologi Malaysia
MHPP	-	Mini Hydro Power Plant
TNB	-	Tenaga Nasional Berhad
JUPEM	-	Jabatan Ukur dan Pemetaan Malaysia
UMP	-	Universiti Malaysia Pahang
FKE	-	Fakulti Kejuruteraan Elektrik
FRP	-	Fiberglass Reinforced Plastics
FKA	-	Fakulti Kejuruteraan Awam
FKSG	-	Fakulti Kejuruteraan Sains Gunaan
RPM	-	Rounds Per Minute

LIST OF SYMBOLS

P	-	Power
P	-	Rho
g	-	Gravity
Q	-	Water Flow Rate
h	-	Head
η_o	-	Efficiency
e	-	Efficiency
m	-	Mili
π	-	Pi
µ	-	Mikro
%	-	Percentage
S	-	Speed
T	-	Number of Teeth
k	-	Kilo
A	-	Ampere
V	-	Volt
M	-	Mega
W	-	Watt

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CHAPTER 1

INTRODUCTION

1.0 Introduction

19% of the world's electricity power is contributed from the hydropower, making it the most widely used of renewable energy [1, 2]. This includes power generated from both large and small power plants. In addition to that, hydropower contributed around 6% of total world energy demand [3]. In Malaysia, the electricity generation that utilizes the hydropower started in July 1900 with the construction of a small hydroelectric plant by the Raub-Australian gold mining company at the bank of Sempam River near Raub, Pahang [4, 5]. According to [4], electricity was only commercially available around 1970s to be supplied to domestic use. Nevertheless, Malaysia have come a long way to generate more electricity, to date, there are twelve large scale hydropower plant and fifty mini scale hydropower stations in progress. Bakun project which one of the large scale project that is still in progress can generate electricity up to 2 400 MW. In 2009, 18 500 MW of Malaysia's electricity demand is generated from hydropower and this number represents 20% of Tenaga Nasional Berhad (TNB) generating capacity [6, 7].

Hydropower converts energy which available in falling water into electricity. The basic principle of hydropower is that by channeling the water from higher to lower level, the resulting potential energy can be used to do work. The water head is then used to move a mechanical shaft, which converts potential energy to mechanical energy. From here, the turbine is now moving and electricity is generated. This shows that hydropower is a clean source of energy and only uses water because no fuel is needed to be burnt and this means there are no effects to the environment when generating the electricity [3].

Eventhough hydropower is a clean source of energy when generating the electricity, there are other effect towards the environment resulting from the construction of the hydro power plant. The most significant effect towards the environment is due to the construction of the dam to provide water storage that will need to flood a large area. This step is crucial to make sure that a constant supply of electricity is possible. The plant is usually constructed in the rural which is the habitat of flora and fauna and flooding it means that their habitat will be destroyed. This raises a new problem to developers to build new dams because of opposition from the environmentalists and people living in the flooded area [3]. Due to this, the need for a smaller hydropower plant rises.

1.1 Background of Study

With the rising need for a smaller hydropower plant, the construction of Micro Hydro Power Plant (MHPP) is vital to cater the rising electricity demand. According to [8, 9, 10, 14], MHPP is categorized as plant that can generate power in the range of 5 kW to 100 kW. The construction of MHPP will also be beneficial to the people who are in the rural since the plant only needed a small area. With the construction of MHPP, the electricity can be made available to the rural and can help improve their lifestyle.

By observation, in Universiti Teknologi Malaysia (UTM) there are not less than seven locations that are suitable for the construction of MHPP. The resources such as water and land are readily available. With a few adjustment and enhancement, the available locations may be the best location to construct the MHPP.

The study is done to get the best design to generate the highest possible output based on the available resources in each location. Based on earlier study done by [12] and [13], the geographic of UTM which is hilly in nature is suitable for the MHPP site. In addition to that, according to the Metrological Department of Malaysia, the rainfall in Skudai is averaging at 250 mm. [9] has also done the research based on the data from the Metrological Department of Malaysia and Jabatan Ukur dan Pemetaan Malaysia (JUPEM) and based on their research, twelve sites are available for the construction of MHPP with the total estimated available power of 1,687.9 kW.

1.2 Problem Statement

According to research done, there are no MHPP to be used as site laboratory in Malaysia. However, according to [17], Universiti Malaysia Pahang (UMP) has done research to develop a pico hydro prototype. However, it was not for site laboratory usage. It is to be used as domestic and commercialized loads. This serves as proves that there are no site laboratory for MHPP is available in Malaysia as of now.

To help students to understand how the electricity generation works, this project is proposed. It is also hope that more research regarding the small hydro power plant will be done. This study will be a pioneer and a catalyst towards the future research and study in MHPP.

The current situation for UTM students is that they need to travel all the way to Kelantan or Terengganu to do site visit at a hydro power plant. This is a waste of money and time since the distance between UTM and these places are more than 500 kilometers. Not to mention that the equipments are expensive and very sensitive. It also generates power to for millions of Malaysians in real life. It means that during the visits, no changes can be made since it may affect the consumers; they can only look and see. With the construction of the prototype of MHPP as a site laboratory, since the load can be varied accordingly, the generation can also be varied this means that students and researchers can understand more with the changes being made at the generation and the load site. Another advantage of having the site laboratory is that it can be a pioneer so that improvements can be made in the design so that a more efficient, cost saving and environmentally friendly green energy source can be achieved.

In addition to that, “Fifth Fuel Policy” introduced by the Malaysian government in the eighth and ninth Malaysia Plan also includes hydro as one of the fuel towards generating energy [11]. With the Malaysia Plan as the backbone, by successfully constructing the prototype, it is believed that more research towards the small hydro power plant will be done.

1.3 Objectives

There are several objectives of this project which are:

1) To study and analyze the feasibility of sites in UTM to be the MHPP
2) To design the MHPP prototype based on the data gathered and calculation done
3) To construct a prototype of MHPP as site laboratory in UTM for educational purposes

As mentioned in the third objective, the prototype is for educational purposes only. Thus, the output of the prototype is not a big concern. However, the design stage will try to design the prototype so that the output can be in the required range of the MHPP classification that is between 5 kW to 100 kW.

1.4 Scope of project

To achieve the said objectives, this project will study and review previous papers and research to get the relevant formula and conclusive view of the MHPP. Once the formula has been identified, site visits will be done to gather the required data. The data gathering will be done using verified techniques to make sure that the data gathered are reliable. Once the required data are available, the calculations are done to get the probable output of each location. From the output calculated, the design will be constructed and to get the highest output possible, design improvements will be made based on the reference model. The last part is to construct the MHPP prototype and do trial at sites. The trial is very important to verify the calculation and to make sure that the prototype is well functional.

1.5 Thesis Organization

This thesis will be discussing in detail the design stages, the data gathered and the probable output based on the calculations done. This thesis will be divided into five chapters. Chapter one; Introduction, Chapter Two; Literature Review, Chapter Three; Methodology, Chapter Four; Results and Discussion and Chapter Five; Conclusion and Recommendations.

Chapter one; Introduction will be discussing the background of the study, objectives and scopes of study. Chapter two will discuss in detail the reviewed papers regarding the design of the MHPP and comparisons will be made to get the most suitable design to generate the highest output. This chapter will also identify the main formula of this project. The methodology chapter will be discussing the methods used in this project in order to get the final stage of constructing the MHPP prototype and doing the trial at sites.

Chapter four will then discuss the results obtained. Chapter four will also be discussing the reasons if there are differences between the design and the trial results. While in chapter five, conclusion and recommendations for future works are discussed.

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