DESIGN AND DEVELOPMENT OF MICRO HYDROPOWER FOR UNDERSERVED COMMUNITIES

Mohamad Ridhzan Bin Roslan

Bachelor of Engineering with Honours
(Electronics and Computer Engineering)
2009

UNIVERSITI MALAYSIA SARAWAK

R13a

BORANG PENGESAHAN STATUS TESIS

Judul: **DESIGN AND DEVELOPMENT OF MICRO HYDROPOWER FOR UNDERSERVED COMMUNITIES**

SESI PENGAJIAN: 2009/2010

Saya **MOHAMAD RIDHZAN BIN ROSLAN**
(HURUF BESAR)

mengaku membenarkan tesis * ini disimpan di Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hakmilik Universiti Malaysia Sarawak.
2. Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Membuat pendigitan untuk membangunkan Pangkalan Data Kandungan Tempatan.
4. Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
5. ** Sila tandakan (✔) di kotak yang berkenaan

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972).
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/ badan di mana penyelidikan dijalankan).
☑	TIDAK TERHAD	

Disahkan oleh

(TANDATANGAN PENULIS) (TANDATANGAN PENYELIA)

Alamat tetap: No. 173, Lorong 4A6
Tabuan Laru, 93350, Kuching, Sarawak

DR. AL-KHALID HAJI OTHMAN
Nama Penyelia

Tarikh: 12 APRIL 2010 Tarikh: 12 APRIL 2010

CATATAN
***** Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah, Sarjana dan Sarjana Muda.
****** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT dan TERHAD.

This Final Year Project attached here:

Title : Design and Development of Micro Hydropower for Underserved Communities

Student Name : Mohamad Ridhzan bin Roslan

Matric No : 16647

has been read and approved by:

_____ _____

Dr. Al-Khalid Haji Othman Date

(Supervisor)

DESIGN AND DEVELOPMENT OF MICRO HYDROPOWER FOR UNDERSERVED COMMUNITIES

MOHAMAD RIDHZAN BIN ROSLAN

Thesis is submitted to

Faculty of Engineering, Universiti Malaysia Sarawak

in partial fulfilment of the requirements

for the degree of Bachelor of Engineering

with Honours (Electronic and Computer Engineering) 2010

Dedicated to my beloved family

ACKNOWLEDGEMENT

This project has been made possible as a result of the co-operation and support rendered by several individuals. While it is impossible to list down all of them, I am very grateful for their assistance.

Firstly, I would like to extend a very special note of appreciation to my supportive Final Year Project supervisor, Dr. Al-Khalid Haji Othman who has put so much effort in coordinating this project. I am thankful to his patience, advices, comments and guidance throughout the course of this project. His patience and guidance throughout this project is greatly appreciated.

I would also like to thank to lecturers in Electronic Department who have offered their advice. Their advice and help was especially helpful in improving this thesis. Grateful gratitude also dedicated to anyone who directly or indirectly helps in making this project success.

Lastly, I would like to thank my family and friends for all their love, care, support and companion that had helped me in sailing through the many hard days in lives and studies all these while. Thank you.

ABSTRACT

Micro hydropower is a mean to generate power with water as its source. This system is useful in generating electrical energy at places with no connection to the national power grid and located near a river or waterfall. This thesis describes the design and development of micro hydropower system for the underserved community. This thesis will cover the design aspects of the intake weir, penstock, water jet nozzle and turbine of the micro hydropower system. This system will be implemented at a village called *Kampung Semulong Ulu* in Sarawak, Malaysia. This thesis will explain how to implement micro hydropower system with improvisation made to suit the material available locally. Besides that, a more cost effective method is also introduced so villagers can maintain and implement this system. This thesis hopefully will be informative and lightening.

ABSTRAK

Kuasa hidro mikro adalah cara untuk menjana kuasa daripada air sebagai puncanya. Sistem ini adalah berguna untuk menjana tenaga elektrik di tempat - tempat yang tidak sambungan kepada grid kuasa national dan juga terletak di lokasi berdekatan dengan sungai atau air terjun. Tesis ini menerangkan tentang rekaan dan melaksana system kuasa hidro mikro untuk komuniti luar bandar. Tesis ini akan merangkumi aspek rekaan untuk *bendung* kemasukan, saluran paip, *muncung* air jet dan turbin untuk system kuasa hidro mikro. System ini akan dilaksanakan di Kampung *Semulong Ulu* di Sarawak, Malaysia. Tesis ini akan menerangkan cara – cara untuk melaksanakan sistem kuasa hidro mikro dengan membuat mengikut bahan – bahan yang terdapat di pasaran tempatan. Selain itu, cara yang lebih jimat kos juga telah di perkenalkan supaya penduduk tempatan dapat menyelenggara dan melaksanakan sistem ini. Di harap agar tesis ini akan member banyak manfaat.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATION

RES	-	Rural Electrification Scheme
ELC	-	Electronic Load Controller
UNIMAS	-	Universiti Malaysia Sarawak
HDPE	-	High Density Polythylene
PVC	-	Poly Vinyl Chloride
MCB	-	Miniature Circuit Breaker

CHAPTER 1

INTRODUCTION

This chapter will be an overwiew of the micro hydropower system and its significance for underserved communities. Besides that, the project background and its objectives are also discussed. Furthermore, the expected project outcomes and its contribution will be explained.

1.1 Introduction

Electricity has become one of our important needs since its discovery. Its discovery has sparked a rapid evolution in our technology that it affects our everyday

life be it good or bad. However, not all of us humans have the privilege to benefit from this commodity [1].

In Malaysia, although most of the advertisements show that we are a developed country, in reality there were underprivileged community that resides on the outskirts of big cities who does not have the chance to experience electricity [1].

To extend the use of electricity to these communities, the Malaysian government has introduced the Rural Electrification Scheme which purpose is to introduce electricity to these communities. However, the implementation of this scheme is slow and would cost millions as the geographical and logistic factors are a lot because most of the communities without electricity are not easily accessible [2].

In order to compete with developed nations, Malaysia must utilize and implement the current ever growing technology. However, in order to optimize the capability of Malaysia, no community must be left behind in the race. Therefore, measures must be taken to give opportunity for this underserved community to join the effort to further develop Malaysia [1, 2].

This project is intended to design and implement a micro hydropower system that would be efficient and at a reasonable cost. A case study is made on a village called *Kampong Semulong Ulu* located in Sarawak where the system was implemented.

The micro hydropower system consists of intake weir, penstock, nozzle, turbine, drive system, electric generator and load controller. This project will focus more on the design aspects that is needed to develop a micro hydropower system and means of implementing the system with the current resource available at hand. Certain modifications to current standard design to compensate to the limited resource will also be discussed.

1.2 Statement of Problems

Most underserved communities dwelling in the outskirts of Malaysia do not have access to electricity. As the city dwellers becomes more advance with new technologies, these underserved communities lives a fulfilling life without knowing their potential to advance.

Without any knowledge or awareness of the importance of electricity, these communities will not demand to have electricity. With no demand, there will not be any effort to acquire electricity for these communities.

Most underserved communities are the ones that does not have proper way of transportation to a major city. This factor would further impair efforts to develop the area. Waiting for a path or road to the closest city would take years.

Ways to reach these communities may be costly and time consuming. For this reason, the community is isolated from the outside world. If these communities stay isolated for too long, they may not catch up to the advancements in science and technology.

Although underserved communities are said to have no electricity, there are some fortunate ones that have a taste of electricity. But the problem is, these communities are using diesel generator to power up their village. By doing so, the cost of operation is high and inclining due to the increasing price of diesel.

Distribution cables and poles for electricity from the main power grid are expensive. Besides that, the underserved communities are usually at places that are hard

to be reached. In order to connect these villagers to the national power grid, sections of the jungle needs to be cleared. These factors, combined with the uneven geographical topology and low population would make the extension of distribution cables from the main power grid not economically wise.

Besides that, the not uniform topological geography of the Malaysian land causes implementation a power plant design to be variable. Optimum design of an electric power plant for the underserved community in general may not be achievable.

1.3 A Solution: Micro Hydropower Electric Generator

As seen in the problem statement, underserved communities are in their state because of the fact that they are isolated. Bear in mind that this isolation is not because of other population cannot accept them, but actually it is the geographical and transportation factor.

A micro hydropower may be the ideal solution for those problems. Logically, if people were to establish a settlement, they would first find an area with water source. This is due to the fact that water is the very source of life. When there is water, animals would flock the area, plants will grow – ideal place to start a village. Hypothetically speaking, the underserved community who establish their settlement away from the city should have at least a water source nearby, hence, a possibility to set up a micro hydropower system.

Once the system has been deployed, the capability of the community will be increased because they will be introduced to the usage of television and radios that

would open up their world. This hopefully would spark a renaissance in their lifestyle that would propel their living status.

A micro hydropower electric generator has a range from 5kW to 300kW [3]. This is suitable because it is not too small and could power up a small village. The cost for the implementation of this system also is an added plus because it is cost effective to establish a micro hydropower scheme in the middle of the often unreachable places rather than taping from the country's main power grid.

1.4 Aims and Objective

The aim of this thesis is to design and develop a micro hydropower system. The design of this system will be analyzed and studied. Therefore, building a prototype of this system is achievable. Besides that, the micro hydropower system that will be designed and developed must be reasonable in cost and maintainability, thus making it versatile and easily deployed.

The objectives of this thesis are to:

- Study on the parts and functions in a micro hydropower system.
- Design and develop a micro hydropower system that is able to generate = 5kW of electrical power for rural home use.
- Make alteration to commonly used designs to suit the availability of materials while keeping the efficiency at an acceptable rate.
- Be able to apply the micro hydropower system efficiently given the different scenarios of flow rate and head height.

- Build a working hardware that would be able to generate up to 5kW of electrical power to simulate a proof of concept for the design made for a micro hydropower scheme.

1.5 Benefits on Project Applications.

This project is made to contribute into the micro hydropower field. Besides that, this project can also be a project guide for implementing a micro hydropower based project. On top of that, this project will also show alternative method in implementing the micro hydropower project. This project will contribute for a more efficient use of hardware and resources for implementing the micro hydropower system for the underserved communities.

The implementation of the system would also help the underserved communities to have electricity. This is possible due to the low cost method provided and improvisation of locally available parts. Besides that, micro hydropower system does not disturb the ecosystem. Fossil fuel usage to generate electricity would also be decreased, thus making this system environmentally friendly.

1.6 Expected Outcomes

The expected outcome for this project is a working micro hydropower system that can successfully generate 5kW power of electricity. This amount of electricity is

enough to power up a small settlement with basic electrical appliances. To generate 5kW power, the design should take into account the head, flow rate, intake weir, penstock and turbine design. These designs are to achieve the required 1500rpm for common electric generator to generate 50 kHz of 5kW electricity. On top of that this project would also come up with solutions to limited resources available for these underserved communities. Furthermore the environmental factors that would make the implementation of an ideal micro hydropower system would also be highlighted.

1.7 Thesis Structure

Chapter 1 reviews the potential and benefits of implementing micro hydropower system to generate electricity for underserved community. On top of that, this chapter also shows the current problems and a brief rundown of the proposed solution.

Chapter 2 will include all the important principals, research and information about the designing process for a micro hydropower scheme. Besides that, each part of the system will be broke down for further understanding and the clarification of the subject.

Chapter 3 will describe the design methodology for this project. It will show from the designing strategies and a description on designs used. The procedures for the proof on concept test will also be described in this chapter.

Chapter 4 will describe about the implementation of this project. Aspects of its design will also be discussed in this chapter.