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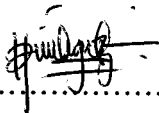
Design and develop a Pico hydro generation system using  
permanent magnet aternator / Mohammad Fakhri Abd  
Ghani.

**DESIGN AND DEVELOP A PICO HYDRO GENERATION  
SYSTEM USING PERMANENT MAGNET ATERNATOR**

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**MAY 2008**

“I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)”

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Date : 7 MAY 2008

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PERMANENT MAGNET ALTERNATOR**


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**This Report Is Submitted In Partial Fulfillment Of Requirement For The Degree Of  
Bachelor In Electrical Engineering (Power Industry)**

**Fakulti Kejuruteraan Elektrik  
Universiti Teknikal Malaysia Melaka**

**May 2008**

“I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the reference.”

Signature :  .....

Name : MOHAMMAD FAKHRI BIN ABD GHANI

Date : 7 MAY 2008

**Dedicated especially to my father  
and my beloved mom**

Dedicated especially to my father  
and my beloved mom

## ACKNOWLEDGEMENTS

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ  
نحمد الله العلي العظيم ونصلي على رسوله الكريم

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Last but not least, I take this opportunity to dedicate this thesis for all electrical engineering students. All suggestions for further improvement of this thesis are welcome and will be gratefully acknowledged.

## ABSTRACT

Hydroelectric is a renewable energy that most developed. It contributes about 97% of the total energy from others renewable energy. Many resources have been obtained easily and it environmental friendly operation put it as main choice among other salvage source of energy. The purpose of this project is to study and produce Pico hydro system using hydroelectric concept that able to supply energy to domestic consumer if any disruption occur in the Tenaga Nasional Berhad (TNB's) main supply system. The proposed design of Pico Hydro power generation system uses permanent magnet alternator as generator. The system has capacity to generate less than 1KW power (for home application) that able to charge the batteries for power storage. The proposed system can help consumers to reduce the monthly electricity bill by utilizing the energy from the battery bank for small loads. In addition, the proposed Pico Hydro system is also able to accommodate energy during power shortage condition. Result from this study can give contribution to the future Research and Development (R&D) particularly in the field of small scale hydroelectric generation.



## ABSTRAK

Hidroelektrik merupakan tenaga guna semula yang paling banyak dimajukan. Ianya menyumbang kira-kira 97% dari jumlah keseluruhan tenaga yang dihasilkan daripada tenaga guna semula dunia. Sumbernya yang banyak, mudah diperolehi dan pengoperasiannya yang mesra alam meletakkan ia sebagai pilihan utama dikalangan sumber tenaga guna semula yang lain. Projek ini bertujuan untuk mengkaji dan menghasilkan satu sistem janakuasa pico menggunakan konsep hidro elektrik yang mampu membekalkan tenaga kepada pengguna domestik (pengguna berkuasa kecil) seandainya berlaku gangguan bekalan pada sistem bekalan utama TNB. Sistem ini mempunyai kapasiti untuk menghasilkan kuasa keluaran kurang daripada 1KW (untuk kegunaan rumah) untuk mengecas bateri sebagai penyimpanan tenaga. Tujuan system ini adalah untuk mengurangkan kadar bil bulanan elektrik dengan menggunakan tenaga yang disimpan daripada bateri untuk kegunaan beban kecil. Tujuannya juga adalah untuk menampung tenaga semasa pengecasan bateri. Tujuannya juga adalah untuk menampung tenaga semasa pengecasan bateri. Hasil daripada kajian ini dapat membantu untuk kerja-kerja pada masa akan datang terutamanya dalam penghasilan hidro elektrik yang berskala kecil.

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## LIST OF ABBREVIATIONS

PMA	- Permanent Magnet Alternator
Vrms	- Root Mean Square Value
PV	- Photovoltaic
MW	- Mega Watt
KW	- Kilo Watt
MGD	- Minerals and Geosciences Department Malaysia
SHP	- Small Hydropower
DC	- Direct Current
AC	- Alternating Current
MIG	- Metal Inert Gas
RPM	- Rotation per Minutes
O	- Flow Rates
H	- Head
g	- Gravity
HP	-Horse Power

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Figure 1.1 above shows the hydro system using Low Head System. A low-head system moves larger amounts of water, and is more likely to encounter surface debris. For this reason a Banki turbine, a pressurized self-cleaning crossflow waterwheel, is often preferred for low-head Pico hydropower systems. Though less efficient, its simpler structure is less expensive than other low-head turbines of the same capacity. Since the water flows in, then out of it, it cleans itself and is less prone to jam with debris. Pico hydro systems complement photovoltaic solar energy systems because in many areas, water flow, and thus available hydro power, is highest in the winter when solar energy is at a minimum.

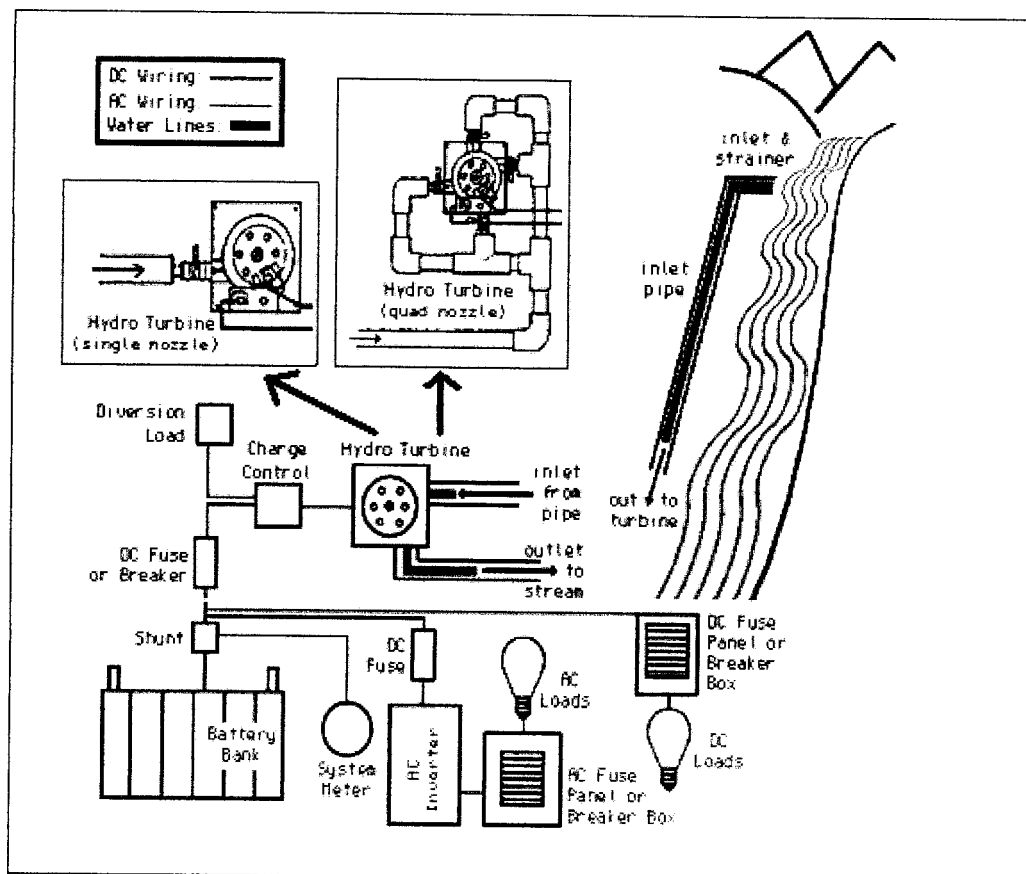


Figure 1.2: Example of Pico Hydro power system

Figure 1.2 shows an example of Pico Hydro power system with necessary protection devices, battery storage, inverter and etc. The most important parts to create the electricity are power source (water), turbine, nozzle, pulley system and alternator. In general, this system will operate using upper water reservoir which is a

few meter high from ground. Water from the reservoir flows downhill through the piping system. This downhill distance is called “head” and it allows the water to accelerate for prime moving system. Thus, the turbine will rotate the alternator to produce electricity. In cold climates, the inlet pipe should be well insulated, and even buried underground if possible, to minimize the chance of freezing. A small, one-nozzle turbine can operate well with a 2" diameter pipe, while a larger 4 nozzle turbine would require a 4" pipe to allow sufficient water flow to reach the generator wheel. Smaller diameter penstock would cause excessive friction and energy loss as the water flowed through the pipe.

## **1.2 Project Objective**

Based on problem statement that has been discussed, the objectives of this project are:

1. To determine appropriate features and specification to be used for Pico hydro system.
2. To develop a system of Pico hydro that can operate as an alternative power generator.
3. To analyze the performance of the proposed Pico hydro system.
4. To introduce an alternative way in reducing utilization of presents energy system and help consumers in reducing the monthly electricity bill.

## **1.3 Project Scope**

This project is conducted to design and develop a Pico hydro power generation system using permanent magnet alternator. The system has capacity to generate less than 1KW power (for home application) that able to charge the batteries for power storage. The proposed system can help consumers to reduce the monthly electricity bill by utilizing the energy from the battery bank for small loads. In addition, the proposed Pico hydro system is also able to accommodate energy during power storage condition.

## **1.4 Project methodology**

### **1.4.1 Study on fundamental of Pico Hydro System**

The first method is to make a utility study on the fundamental of Pico Hydro System which includes the application and generation system. In addition, make a detail study on the designing of Pico hydro system which focuses on the turbine made and battery charging system.

### **1.4.2 Project Design**

This method is to design the Pico hydro system in order to generate the electricity less than 1KW power. The design also can operate for battery charging purpose.

### **1.4.3 Hardware Development**

The most important part is to design the turbine which is can operate suitable with the Pico hydro system. Each turbine has it own characteristic. For this project turgo turbine is chosen.

### **1.4.4 Result and Analysis**

The calculation and experimental results are being analyzed. The comparison between both of results is properly performed.

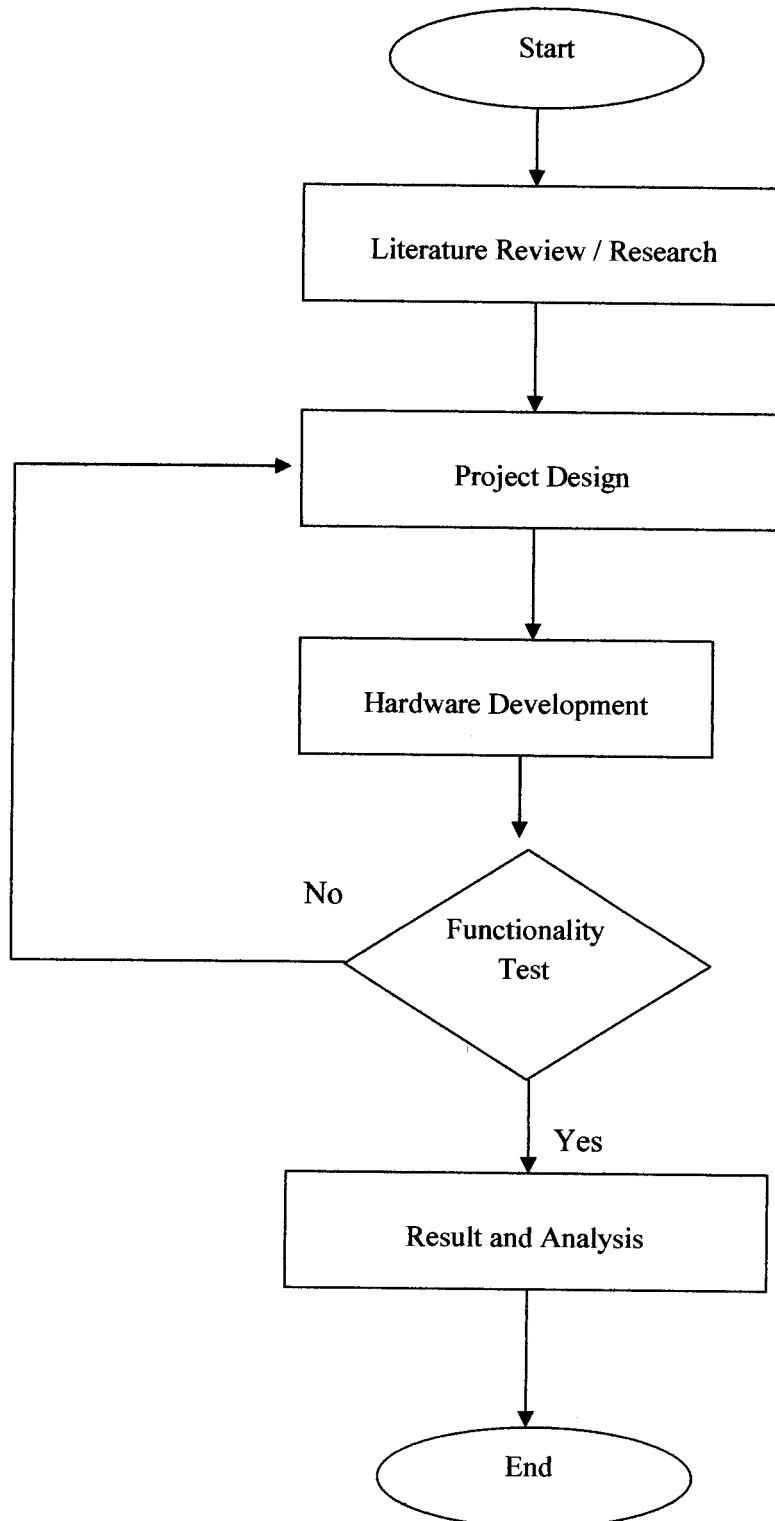


Figure 1.2: Activities flow chart

## 1.5 Thesis Outline

Chapter 2 discusses the literature study related to this project. Study on previous research by other researcher, turbine types and etc are conducted to ensure the successfulness of the project.

Chapter 3 describes the potential of alternative resources in Malaysia to be used for power generation. Types of alternative resources which are termed as renewable energy are briefly discussed in this chapter.

Chapter 4 discusses about to design and implement Pico Hydro System. This chapter shows how to make the turbine, shaft and casing for this system. It also describes about main part in Pico Hydro System such as permanent magnet alternator that used in this project.

Chapter 5 elaborates on Pico Hydro system using water jet and water pump as prime mover. Several analysis and calculation have been done to execute this system.

Chapter 6 discusses about recommendation for further work and conclusion of this project.