

'I/We' declare that I have been done reading this report
And in my opinion, this report fulfill the condition in all
Aspect that must be in poject writing as need in partial fulfillment
For Bachelor Mechanical Engineering (Thermal-Fluids)

Signature :
Supervisor Name I : Mr. SUHAIMI BIN MISHA
Date : 7 APRIL 2010

DEVELOPMENT OF A MINI TURBINE TO GENERATE
ELECTRICITY

MOHD FAHMI BIN ABD. MAJID

This report had been done
In partial fulfillment
For Bachelor Mechanical Engineering (Thermal-Fluids)

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

APRIL 2010

“I declare that this report had been done originally from me except some of them where I have been explain each one of them with its sources”

Signature :
Name : MOHD FAHMI BIN ABD MAJID
Date : 7 APRIL 2010

Especially to my beloved parents,
My respectfully lecturers,
Also my faithfully friends,
Your prayers always with me every way that I went...

ACKNOWLEDGEMENT

First of all, I would like to express my gratitude to the almighty Allah for his blessing in making me able to finish the PSM project. the idea, concept and everything which I got in this project making cannot be done without his blessing.

Secondly, millions of thanks to my supervisor, Mr. Suhaimi bin Misha, the head of the department Thermal-Fluids of Mechanical engineering for supervise me in this project making from the start until the end. Thank you for the time spend, knowledge given, idea shared and for the support given.

Thirdly, I would like to thank to all who were responsible in this project making either involved directly or indirectly. Without all the helps received, I have learned so much.

Last but not least, thank to my beloved parents who had give me encouragement until this project done. I hope that this report will be a guide and reference to other students and researchers soon.

ABSTRACT

This report majorly concerned about the development of mini turbine to generate electricity for home application. The idea is to use waste energy from the incoming water pipeline to rotate the turbine in order to generate electricity. This research and development had been made in order to define additional clean energy sources in decreasing the primary electrical sources which is majorly using a fossil fuel as sources of energy. The carbon dioxide produce from the combustion process had lead to greenhouse effect which is increasing the global temperature. The concept design of the system had been illustrated but there will be design considerations since the idea was based on theoretical and there might be changes in the experiment. The literature review section provides important knowledge of the topic study. It includes the turbine, electricity demand, past invention and the theoretical analysis. The methodology section stated the sequence of the project making from the proposal to the expected process. It make the project making process become smoothly and will increase the possibility of success. The experimental result section provides the related data regarding to the experiment includes data, procedure and the process of manufacturing. The analysis and discussion section provides the detailed explanation and discussion related to the data and the subject study. Finally the discussion and recommendation section provides the overall conclusion based on the overall study and all the weaknesses found in the study will be recommend for a further improvement in the next study.

ABSTRAK

Laporan ini berkaitan dengan pembikinan turbin mini untuk menghasilkan elektrik untuk kegunaan rumah. Idea yang digunakan adalah untuk mengaplikasikan tenaga terbuang daripada paip air masuk untuk menggerakkan turbin bagi menghasilkan elektrik. Kajian dan penghasilan projek ini adalah bertujuan untuk mencari alternatif tenaga tambahan bagi mengurangkan penggunaan sumber elektrik utama yang mana kebanyakannya bergantung kepada minyak mentah sebagai sumber kuasa utama. Karbon dioksida yang dihasilkan dalam proses pembakaran membawa kepada kesan rumah hijau dan akan meninggikan suhu global. Konsep reka bentuk telah dilakar tetapi reka bentuk pertimbangan akan diadakan kerana idea asal adalah berdasarkan data teori dan mungkin akan ada perubahan dalam eksperimen yang sebenar. Seksyen kajian ilmiah menyediakan ilmu-ilmu penting yang berkaitan dengan topik yang dikaji. Ia berkaitan dengan turbin, permintaan elektrik, ciptaan lepas dan teori analisis. Seksyen kaedah kajian pula menyatakan turutan proses dalam pembikinan projek daripada projek cadangan hingga kepada proses jangkaan. Proses ini menyebabkan proses pembikinan projek menjadi lebih teratur dan kebarangkalian untuk berjaya adalah lebih tinggi. Bahagian keputusan eksperimen menunjukkan data hasil dari eksperimen yang dilakukan termasuk data, prosedur dan proses pembikinan untuk eksperimen. Bahagian analisis dan perbincangan menunjukkan penjelasan terinci dan perbincangan yang berkaitan dengan data dan subjek kajian. Akhir sekali ialah bahagian kesimpulan dan penambahbaikan secara keseluruhan berdasarkan keputusan kajian keseluruhan dan kelemahan-kelemahan yang terdapat di dalam kajian ini di beri cadangan untuk penambahbaikan dalam kajian yang selanjutnya.

TABLE OF CONTENT

CHAPTER	TITLE	PAGE
	DECLARATION	
	DEDICATION	
	ACKNOWLEDGEMENT	
	ABSTRACT	
	ABSTRAK	
	TABLE OF CONTENT	
	LIST OF TABLE	
	LIST OF FIGURE	
	LIST OF SYMBOL	
	LIST OF APPENDIX	
CHAPTER I	INTRODUCTION	1
	1.1 Introduction	1
	1.2 Objectives	4
	1.3 Scope	4
	1.4 Problem Statement	5
	1.5 Methodology	6
CHAPTER II	LITERATURE REVIEW	8
	2.1 Introduction to Water Turbine	8
	2.1.1 History of Water Turbine	8
	2.1.2 Water Turbine and Its Application	11
	2.1.2.1 Impulse Turbine	12
	2.1.2.1.1 Pelton Turbine	12
	2.1.2.2 Reaction Turbine	15
	2.1.2.2.1 Francis Turbine	16
	2.1.2.2.2 Kaplan Turbine	18
	2.1.3 Selection of Turbines	21

2.2	Electricity Demand	26
2.2.1	World Electricity Demand	26
2.2.2	Renewable Energy Sources	29
2.2.2.1	Hydro Electricity	29
2.3	Past Invention	31
2.3.1	Mini Hydro Turbine	31
2.4	System Design	33
CHAPTER III	METHODOLOGY	35
3.1	Introduction	35
3.2	Flow Chart of the Methodology	36
3.3	Explanation of Methodology	38
3.3.1	Identifying Objectives, Scope and Problem Statement	38
3.3.2	Literature Review	38
3.3.3	Collecting Information Regarding the Project	38
3.3.4	Design the Concept of the System	39
3.3.5	Select Material and Component	39
3.3.6	Start Building the System	41
3.3.4.1	Designed Consideration	41
3.3.5	Run Experiment	42
3.3.6	Problem Analysis	42
3.3.7	Suggestion for Improvement	42
CHAPTER IV	EXPERIMENTAL RESULT	43
4.1	Introduction	43
4.2	First Method	44
4.3	Second Method	45
4.4	Process of Modification	46
4.5	Procedure of Experiment	47
4.6	Experimental Data	50
4.7	Experimental Disclosure	51

CHAPTER V	ANALYSIS AND DISCUSSION	52
5.1	Capability of Turbine to Produce Electricity Over time	53
5.2	The Capability of Electricity Generated to be used for Appropriate Application	56
5.3	The Electricity Estimated Can be Saved for a Single Unit House	58
5.4	The Electricity Estimated Can be Saved from the Global Consumption	61
CHAPTER VI	CONCLUSION AND RECOMMENDATION	63
	Conclusion	63
	Recommendation	64
	REFERENCES	66
	BIBLIOGRAPHY	67
	APPENDICES	68

LIST OF FIGURES

NO.	TITLE	PAGE
1.1	CO ² Production for last 1000 years (Source: http://planetforlife.com/gwarm/glob1000.html)	2
1.2	Hydro Turbines of three Gorges Dams in Construction (Source: http://www.trelleborg.com/)	3
1.3	Hydro Turbine Systems (Source: http://www.absak.com/)	3
1.4	Flow Chart of PSM I	6
1.5	Flow Chart of PSM II	7
2.1	Ancient Illustrated Water Wheels (Source: http://www.top-alternative-energy-sources.com/water-wheel-history.html)	9
2.2	Modern Water Turbine Design (Source: http://www1.eere.energy.gov/windandhydro/hydro_rd.html)	10
2.3	Types of Water Turbine	11
2.4	Section View of Pelton Turbine (Source: http://www.dermediamatiker.ch)	13
2.5	Pelton Turbine Runner (Source: http://www.geppert.at/)	14
2.6	Working Principle of Pelton Turbine (Source: http://electricalandelectronics.org/2008/09/24/constituents-of-hydro-electric-plant/)	15
2.7	Cut-Section of Francis Turbine (Scope: http://www.tfd.chalmers.se/~hani/phdproject/proright.html)	16
2.8	Runner of a Francis Turbine (Source: http://www.topomatika.hr/Applications/Images/Big/turbine_09-b.jpg)	17
2.9	Working Principle of Francis Turbine (Source: http://www.rise.org.au/info/Tech/hydro/image007.jpg)	18

2.1	Cut-Section of Kaplan Turbine (Source: http://www.tfd.chalmers.se/~hani/phdproject/kaplanfoto.gif)	19
2.11	Propeller of a Kaplan Turbine	20
2.12	Kaplan Turbine Working Operation (Source: http://re.emsd.gov.hk/english/other/hydroelectric/images/image008.gif)	21
2.13	Application Range of Hydraulic Turbine (Scope: Fundamental of Turbomachinery)	22
2.14	Efficiency versus Specific Speed of hydro turbines (Sources: Fundamental of Turbomachinery)	23
2.15	Relationship between specific diameter and specific speed of hydraulic turbines (Source: Fundamental of Turbomachinery)	24
2.16	World Electricity consumption (Source: http://www.indexmundi.com/world/electricity_consumption.html)	26
2.17	Energy Sources (Source: http://en.wikipedia.org/wiki/File:2004_Worldwide_Energy_Sources_graph.png)	27
2.18	Mean Temperature of Earth during 1999-2008 Source: http://en.wikipedia.org/wiki/File:Global_Warming_Map.jpg)	28
2.19	Global Temperature Increasing (Source: http://en.wikipedia.org/wiki/File:Instrumental_Temperature_Record.png)	28
2.2	Classification of Energy Sources in Producing Electricity (Sources: http://en.wikipedia.org/wiki/File:2004_Worldwide_Energy_Sources_graph.png)	29
2.21	Renewable Power Capacities during 2004-2008 (Source: Renewable Global Status Report 2009)	30
2.22	Mini Hydro Turbine by Jin Woo Han (Source: http://www.jinwoohan.com/miniturbine.html)	31
2.23	Mini Hydro Turbine with the Turbine Side shown (Source: http://www.jinwoohan.com/miniturbine.html)	32
2.24	Mini Hydro Turbine with Complete Part shown (Source: http://www.jinwoohan.com/miniturbine.html)	32
3.1	Flow Chart of PSM Methodology	37
3.2	Concept Design of the System	39
3.3	Pump Aquarium used as a Turbine	40
3.4	Emergency Lamp used in a System	40

4.1	Joining Process between the elbow and the tap	46
4.2	Nozzle Connected	47
4.3	Installation of the Hydro turbine to the system	48
4.4	The process of reading the battery voltage	48
5.1	Various House Build from 1995 to 2009 (Source: http://www.globalpropertyguide.com/template/assets/img/CO-MYP-F06.gif)	60

LIST OF TABLES

NO.	TABLE	PAGE
2.1	Range of Specific Speed (Source: Fundamental of Turbomachinery)	24
2.2	Water Storage Requirements in Various buildings (Source: Plumbing: Mechanical Services, G.J Blower)	34
4.1	The specification of the experiment	50
4.2	Voltage Value of the Battery	50
4.3	Battery State Measurement	51
5.1	Average Water Consumption Rate According to House Type	53
5.2	Average Water Consumption Rate According to the Daily Activity	53
5.3	Average Water Consumption Rate/day for a single story house	54
5.4	Specification of the Emergency Lamp	56
5.5	Tariff Electrics from TNB Standard (Source: http://www.tnb.com.my/tnb/tariff/newrate_domestic.htm)	58

LIST OF SYMBOLS

ϕ	= Flow Coefficient
ψ	= Energy Coefficient
Π	= Power Coefficient
η	= Efficiency
Q	= Flow rate, m^3/s
ω	= Rotational speed, rad/s
D	= Diameter, m
G	= Gravity, m^2/s
H	= Head, m
ρ	= Density, kg/m^3
W	= Watt
f	= Frequency, Hz
P	= Power, W
V	= Voltage, V
h	= Hour, h
kWh	= KiloWattHour
s	= Second

LIST OF APPENDIXES

NO.	APPENDIXES	PAGE
1	Gantt Chart PSM I	68
2	Gantt Chart PSM II	69
3	Risk of Global Warming	70
4	Past Invention of Jin Woon Han	71
5	Picture of Project	72

CHAPTER I

INTRODUCTION

1.1 Introduction

According to the definition, Global Warming means the increase in the average temperature of the Earth/s near-surface air and oceans since the mid-20th century and its projected continuation. The IPCC (Intergovernmental Panel on Climate Change) stated that the main factors of the increasing heat on earth was because of the increasing greenhouse gas concentrations resulting from human activity such as fossil fuel burning and deforestation caused most of observed temperature increase since the middle of the 20th century.

Fossil fuels had been the most sponsored share in primary energy production in the world resulting almost 86% which are consists of petroleum, 36.8%, coal 26.6 & natural gas 22.9%. Most of the energy production was to create electricity. The burning of fossil fuels produces around 21.3 billion tons of Carbon Dioxide per year, but it is estimated that natural processes can only absorb about half of that amount. So, there is an estimation of net increase of 10.65 billion tones of atmospheric carbon dioxide per year. World energy consumption was growing about 2.3% per year. Other 23% from the energy production was based on the renewable energy. One of it is hydroelectricity which produces 6% of the global energy consumption and 15% of global electricity generation. Hydroelectricity is a clean and a renewable energy sources. Using it for

every day will not reduce its capacity as the other non-renewable energy. The production of power is through the use of the principle of gravitational force of falling or flowing water.

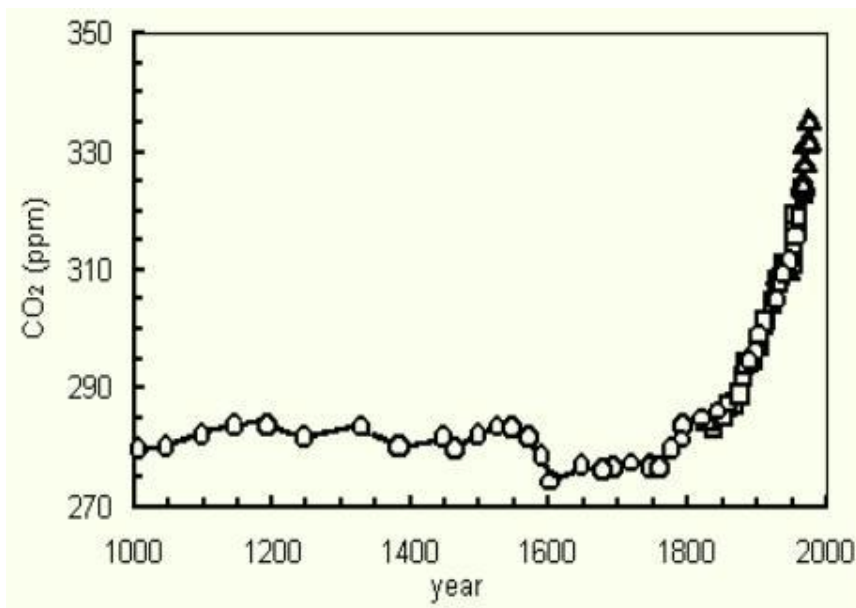


Figure 1.1: CO₂ Production last 1000 years

(Source: <http://planetforlife.com/gwarm/glob1000.html>)

Hydro turbine was the mechanism used in the hydroelectricity concept. The flowing water will rotate into the turbine and will turn the blade which will produce energy before being converted into desired energy. It had been used for centuries, from the basic application of transferring fluid from one place to another and tills now to generate electricity. Developing a mini hydro turbine for home appliances was an idea to generate electricity at home by using waste energy. It's just like using energy to generate another type of energy. The additional energy can be used to support the energy required from the main energy sources. From that point of view, the rate of wasting can be reduced and it will save more cost.



Figure 1.2: Hydro Turbines of three Gorges Dams in Construction
 (Source: <http://www.trelleborg.com/>)

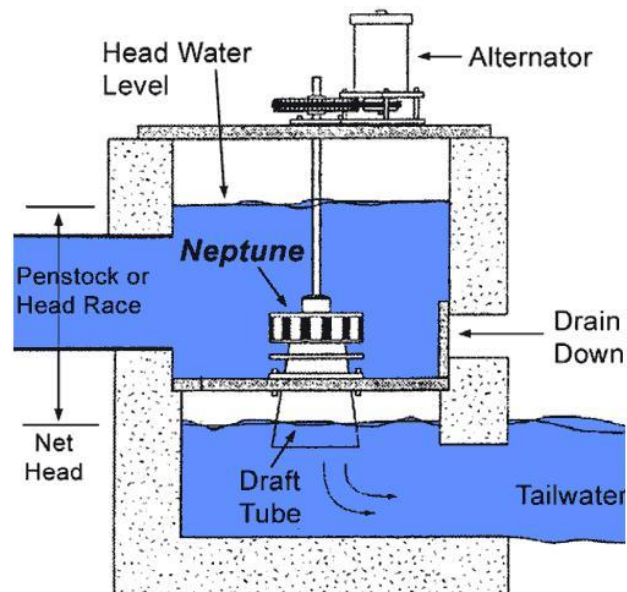


Figure 1.3: Hydro Turbine Systems
 (Source: <http://www.absak.com/>)

1.2 Objectives

The main objective of this study was to design, analyze and developing a mini hydro turbine for home appliances. The details are as listed below:-

- To fabricate mini turbine and installed at water pipeline to generate electricity.
- To study the capability of electricity power that generated by the mini turbine.
- To use the electrical power generated for the appropriate application.

1.4 Scope

The focus of this study is to do a researching and developing a mini hydro turbine in order to generate electricity at home. Basically, the system was designed to operate in the expected situation.

- a) The mini turbine will be installed at water tank outlet valve.
- b) The electricity generated will be used to charged the battery.
- c) The battery will be used for a simple application first, e.g light a lamp at night.

In this project making, there are several things which are been considerate and which are not and which are the high priority and which are the less one. The major priority of this study was to develop and installed the hydro turbine in the water flow system. The successful of this project was based on this part or the study will be regarded as failure. Then it will go on to study the capability and the efficiency of the hydro turbine in generating electricity. It is about whether it generates enough electricity to compare with the cost of building it. Studying the capability of the generated

electricity to power up appropriate application will also be included in this study. The less priority of this study will focus on the effect of the new mechanism to reduce the global warming effect. It will focus on how much the electricity can be generated and expected total can be generated in future to see how much the global electricity consumption can be reduced. The study of the electronic controller in the hydro turbine system, the project components manufacturing and several parts of electrical components calculations will not be included in this study.

1.5 Problem Statement

Nowadays, the global condition is really hard to predict, thanks to the increasing of the global temperature. There are lots of causes in the increasing of the greenhouse effect which led to the global temperature increased. One of the causes is the activity on burning the fossil fuels to generate the energy. Burning the fossil fuels will released the Carbon Dioxide gasses and will lead to the greenhouse effect if it's way too much. By developing the mini hydro turbine, we will use the waste energy from the pipeline to generate electricity for small applications. The idea was to install the hydro turbines in the incoming pipelines of the terrace house and using the excessive pressure which its way too much to rotate the turbine and then will generate the electricity. The idea was simple, placing the turbine into the pipeline and led the incoming flow to rotate the turbine.

By inventing the system, the electricity consumption from the primary source can be reduced, thus reducing cost of electricity per month. Even the electricity produce from the water turbine system is not enough to cover whole application for housing, but it still can be used for some small application. Imagine if whole people in the earth using the system in their house, there should be lots of electricity can be saved for year and thus, it can reduced the global warming.

1.5 Methodology

This section explaining the phase developed step by step for the PSM I. It listed the work done by phase complete with the explanation.

For PSM I:

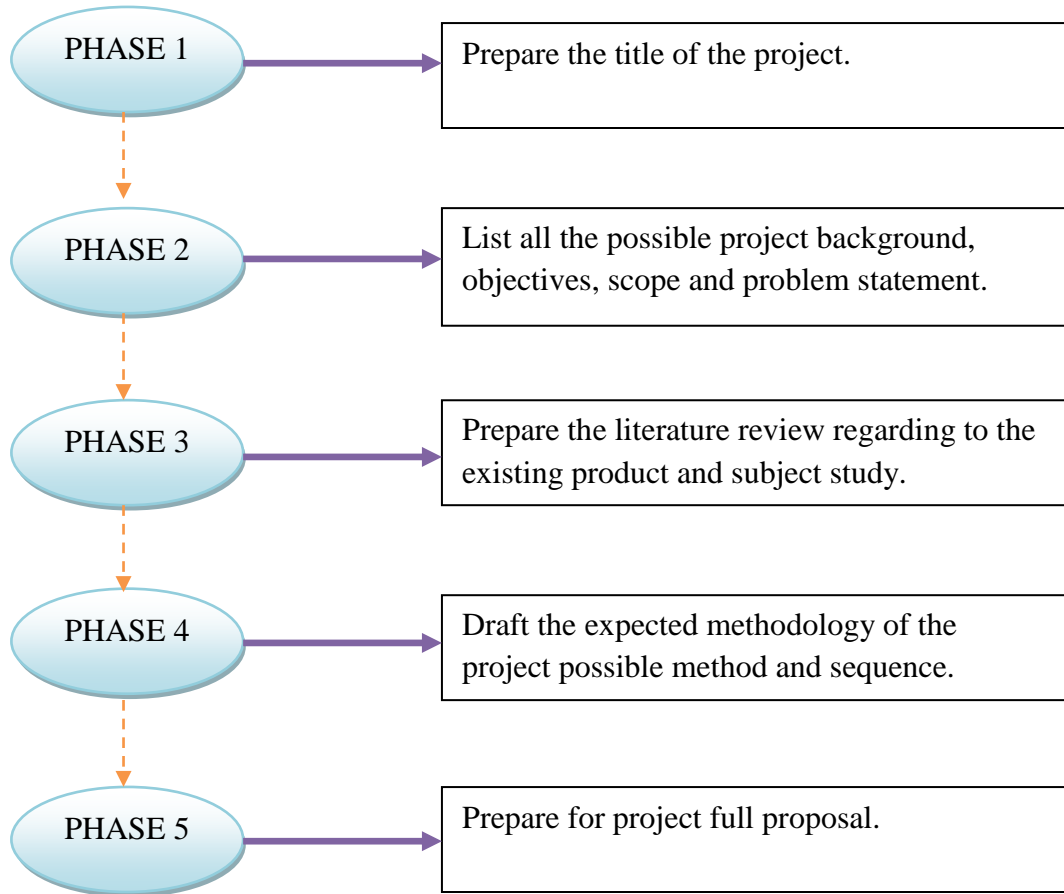
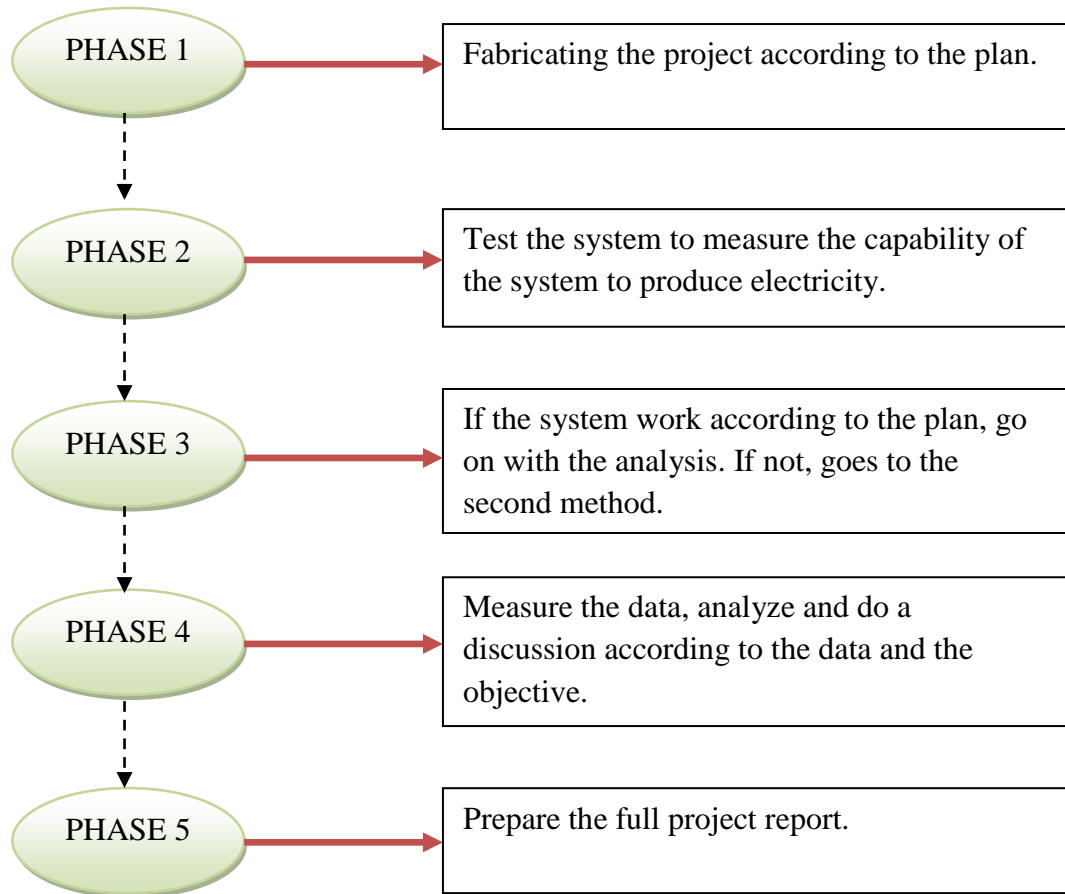


Figure 1.4: Flow Chart of PSM I

For PSM II:**Figure 1.5: Flow Chart of PSM II**

CHAPTER II

LITERATURE REVIEW

2.1 Introduction to Water Turbine System

2.1.1 History of Water Turbine System

Water turbine had been used for over centuries to convert freely available mechanical energy from rivers into useful mechanical work, usually through a rotating shaft. Water turbines mean a rotary engine that takes energy from moving water. Before the engines been invented, it is known as water wheels. Water wheels is a machine which converting the energy of flowing of falling water into more useful forms of power. It is quite same with the water turbines and it only differs at the engine part. The water wheels didn't have engine install in the system but the water turbines does have.

Water wheels had been used since middle ages where it was used as tools to power factories throughout different counties. The most common use of the water wheel was to mill flour in gristmills, but other uses included foundry work and machining, and pounding linen for use in the manufacture of paper. A waterwheel consists of a large wooden or metal wheel, with a number of blades or buckets arranged on the outside rim forming the driving surface. Most commonly, the wheel is mounted vertically on a horizontal axle, but the tub or Norse wheel is mounted horizontally on a vertical shaft.