

# THE DESIGN OF HYBRID SYSTEM FOR SMALL HOUSE APPLIANCE

by

ILI AZIM B MOHD YUSOFF

Report submitted in partial fulfillment  
of the requirements for the degree  
of Bachelor of Engineering



MAY 2011

**THE DESIGN OF HYBRID SYSTEM FOR SMALL HOUSE  
APPLIANCE**

**ILI AZIM B MOHD YUSOFF**

© This item is protected by original copyright

**SCHOOL OF ELECTRICAL SYSTEM ENGINEERING  
UNIVERSITI MALAYSIA PERLIS**

**2011**

## ACKNOWLEDGEMENT

Alhamdulillah, thank to Allah S.W.T for His bless, guidance, knowledge and the ability given to me. Without it, I would not have been able to come this far.

In preparing this thesis, I was in contact with many people. They have contributed towards my understanding and thought. In particular, I wish to express my sincere appreciation to my project supervisor, Prof. Dr. Ismail Daut for his encouragement, guidance, critics and friendship throughout this two semester period. I would like to extend greatest appreciation to Noor Syafawati bt Ahmad. It would be very difficult to complete this project without enthusiastic support, insight and advice given by them.

My greatest thanks to my family, especially both my parents whose has given a lot of love, courage, sacrifice and support. My gratitude to all my friends and colleagues who share their ideas, tips and spending their valuable time to help me.

Thank you all for you kindness and generosity. May Allah bless everyone.

## DECLARATION SHEET

I hereby declare that my Final Year Project Thesis is the result of my research work under supervision of PROF.DR. ISMAIL DAUT. All literature sources used for the writing of this thesis have been adequately referenced.

Name : ILI AZIM B MOHD YUSOFF  
Candidate number : 081091258  
Supervisor : PROF.DR. ISMAIL DAUT  
Title of thesis : THE DESIGN OF HYBRID SYSTEM FOR SMALL  
HOUSE APPLIANCE

Candidate's signature: ..... Supervisor signature: .....

Date: ..... Date: .....

## APPROVAL AND DECLARATION SHEET

This project report titled **The Design of Hybrid System for Small House Appliance** was prepared and submitted by **Ili Azim b Mohd Yusoff** (Matrix Number: **081091258**) and has been found satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirement for the **Bachelor of Engineering ( Electrical System Engineering )** in **Universiti Malaysia Perlis (UniMAP)**.

**Checked and Approved by**

---

**(Prof. Dr. ISMAIL DAUT)**  
**Project Supervisor**

**School of Electrical Syatem Engineering**

**Universiti Malaysia Perlis**

**April 2011**

## The Design of Hybrid System for Small House Appliance

### ABSTRACT

In recent year the demand for electricity power increase rapidly. Apart from this, there are still having areas that not fully grid connected electricity especially in the rural area. Throughout this matter, certain area had use photovoltaic as electricity source. In Malaysia, not only potential solar energy but also wind energy. The combination of these two sources can produce alternative electrical energy. This project is mainly focused on hybrid of wind and solar energy. The objective of this project is to design a hybrid system for small house appliance usage and develop the battery charger. Since these two sources are not constant, battery is needed as a backup source. Charging and discharging rate of battery is importance to ensure the life time of the battery. At the end of this project a battery charger for hybrid source is successful design. By using this charger controller the efficiency of the system will be increase about 40 % compare to if only use solar battery charge.

## ABSTRAK

Sejak kebelakangan tahun ini permintaan terhadap elektrik meningkat mendadak. Tetapi masih ada tempat yang tidak mempunyai kemudahan elektrik terutamanya di kawasan pedalaman. Disebabkan perkara ini lah sesetengah tempat menggunakan photovoltad sebagai sumber elektrik. Di Malaysia bukan sahaja tenaga solar berpotensi menjadi sumber penjanaan tenaga tetapi juga udara. Cantuman kedua-dua sumber tenaga ini boleh menghasilkan sumber tenaga alternatif. Projek ini mengfokuskan campuran dua sumber tenaga iaitu udara dan solar. Objektif projek ini ialah untuk membina sistem hybrid yang boleh menjanakan elektrik untuk kegunaan rumah. Memandangkan kedua-dua sumber tenaga tidak tetap, jadi system ini memerlukan sokongan daripada bateri. Kadar cas dan nyah cas bateri adalah penting untuk memastikan jangkahayat bateri itu. Dengan menggunakan charger kontroler kadar cas dan nyah cas dapat di kawal. Menggunakan charger controller ini kadar efisiensi meningkat kepada 40 % berbanding menggunakan solar charger sahaja.

## TABLE OF CONTENTS

	<b>Page</b>
<b>ACKNOWLEDGMENT</b>	<b>i</b>
<b>DECLARATION SHEET</b>	<b>ii</b>
<b>APPROVAL AND DECLARATION SHEET</b>	<b>iii</b>
<b>ABSTRACT</b>	<b>iv</b>
<b>ABSTRAK</b>	<b>v</b>
<b>TABLE OF CONTENTS</b>	<b>vii</b>
<b>LIST OF TABLES</b>	<b>x</b>
<b>LIST OF FIGURES</b>	<b>xi</b>
<b>LIST OF SYMBOLS, ABBREVIATIONS OR NOMENCLATURE</b>	<b>xiv</b>

### CHAPTER 1 INTRODUCTION

1.1	Background Study	1
1.2	Objective	2
1.3	Scope of the Project	2



1.4	Problem Statement	3
1.5	Project Overview	4
1.6	Thesis Organization	5
1.7	Summary	6

## CHAPTER 2 LITERATURE REVIEW

2.1	Hybrid System	7
2.2	Load	8
	2.2.1 Load Analysis	9
2.3	Photovoltaic	10
2.4	Wind Generator	14
2.5	Charger Controller	17
2.6	Electronic Component	19
	2.6.1 Voltage Regulator	19
	2.6.2 Dual Operational Amplifier	21
	2.6.3 NOR Gate	22
	2.6.4 MOSFET	23
	2.6.5 Diode	24
	2.6.6 Dummy Load	24
2.7	Battery	25
2.8	Inverter	28

2.9	Summary	29
-----	---------	----

### **CHAPTER 3 METHODOLOGY**

3.1	Introduction	30
3.2	Flow chart of the project	31
3.3	Understanding the Requirement of Hybrid System	33
3.4	Wind Turbine	34
3.5	Photovoltaic	35
3.6	Charger Controller	35
3.7	Battery	39
3.8	Inverter	40
3.9	Measurements and Testing	41
3.10	Summary	41

### **CHAPTER 4 RESULT AND DISCUSSION**

4.1	Introduction	42
4.2	Simulation	43
4.3	Prototype	44
4.4	Actual Circuit	45
4.5	Simulation of the Hybrid System	46
4.6	Summary	56

## **CHAPTER 5 CONCLUSION**

5.1	Conclusion	57
5.2	Recommendation for Future Project	58
5.3	Commercialization Potential	58

<b>REFERENCES</b>	<b>59</b>
-------------------	-----------

<b>APPENDIX A</b>	<b>PV PANEL AMORPHOUS SILICON THIN FILM DATA</b>	<b>61</b>
<b>APPENDIX B</b>	<b>6FM200D 12 V 200Ah BATTERY</b>	<b>62</b>
<b>APPENDIX C</b>	<b>1000W MAINS INVERTER 12 V DC TO 240 V AC</b>	<b>63</b>
<b>APPENDIX D</b>	<b>JOLIET 20kW CYCLONE WIND TURBINE</b>	<b>64</b>
<b>APPENDIX E</b>	<b>1N4001 RECTIFIERS</b>	<b>65</b>
<b>APPENDIX F</b>	<b>QUAD 2-INPUT NAND BUFFERED B SERIES GATE</b>	<b>67</b>
<b>APPENDIX G</b>	<b>LM 7812 VOLTAGE REGULATOR</b>	<b>76</b>
<b>APPENDIX H</b>	<b>QUAD 2-INPUT NOR GATE</b>	<b>82</b>
<b>APPENDIX I</b>	<b>IFR 540</b>	<b>89</b>
<b>APPENDIX J</b>	<b>LM 1458 DUAL OPERATIONAL AMPLIFIER</b>	<b>94</b>

## LIST OF TABLES

### Tables no.

Table 2.0	Basic House Appliances
Table 2.1	Density of Dry Air at a Pressure of Atmospheres
Table 2.2	NOR Gate
Table 2.3	Rough comparison of battery characteristics
Table 4.0	Charger Controller Simulation Result
Table 4.1	Charger Controller Prototype Result
Table 4.2	PV Output
Table 4.3	Wind Output
Table 4.4	Total Electric Production
Table 4.5	Battery Bank State

## LIST OF FIGURE

### Figure No.

- Figure 1.0 Flow Chart
- Figure 2.0 Solar radiations by regions of the world
- Figure 2.1 Basic construction of PV cell with performance enhancing features (current collecting mesh, anti-reflective coating and cover glass protection)
- Figure 2.2 Several PV cells make a module and several modules make an array
- Figure 2.3 Global Air Circulation (a, b, c)
- Figure 2.4 Solar irradiation & Wind Speed
- Figure 2.5 Air and Ground Temperature
- Figure 2.6 Charger Controller of Hybrid Source
- Figure 2.7 Voltage regulator TO-263-3
- Figure 2.8 Dual Operational Amplifier
- Figure 2.9 IC 4001 Quad 2-input NOR Gate
- Figure 2.10 Internal Schematic Diagram

Figure 2.11	Battery cycle life vs depth of discharge based on a battery manufacturer's data sheet
Figure 3.0	Flowchart
Figure 3.1	Hybrid Systems of Wind And Solar
Figure 3.2	Cyclone 2kW
Figure 3.3	Charger Controller in Orcad Capture
Figure 3.4	The Circuit In The Prototype Stage
Figure 3.5	Actual Circuit
Figure 3.6	Battery 6FM200D 12 V 200 Ah
Figure 3.7	1000 W Inverter
Figure 4.0	Charger Controller in Multisim
Figure 4.1	Hybrid System Using HOMER Software
Figure 4.2	PV Input Data
Figure 4.3	Cyclone 20 kW Wind Turbine Input Data.
Figure 4.4	Batteries Impute Data.
Figure 4.5	Inverter Input Data.
Figure 4.6	Load Data.
Figure 4.7	Temperature Data
Figure 4.8	Solar Resource Data
Figure 4.9	Wind Resource Data
Figure 4.10	PV Output Per Year

- Figure 4.11      Wind Output Per Year
- Figure 4.12      Total Electric Productions
- Figure 4.13      Battery Input Power Per Year
- Figure 4.14      Battery State Of Charge Per Year

© This item is protected by original copyright

## LIST OF SYMBOLS, ABBREVIATIONS OR NOMENCLATURE

AC	alternating current
DC	direct current
am	ante meridiem
pm	post meridiem
W	watt
A	ampere
Ah	ampere hour
Wh	watt hour
V	volt
PV	photovoltaic
IR	rated current
MW	mega watt
s	second
m	meter



T , DR	temperature and discharge rate factor
EPIA	European Photovoltaic Industry Association
%	percentage
Pw	power in wind
$\rho$	air density
A	Cross-section area
V	Wind speed
$\Delta t$	time
°C	celsius
°F	fahrenheit
Kt	density ratio
Pb	Power extracted by the rotor blade
$\dot{m}$	The mass flow rate of air
$V_e$	Velocity of the wind
$v_d$	Downwind velocity
hr	hour
kWh	kilo watt hour
yr	year