



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

IOT CONTROLLED HYBRID POWER SWITCHING

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology with Honours.

اونيورسي تيكنيكل مليسيا ملاك
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

by

MOHAMAD IZZAT SYAMIL BIN MOHD AZAHAR

B071710933

961112-11-5551

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING
TECHNOLOGY

2020

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: IOT CONTROLLED HYBRID POWER SWITCHING

Sesi Pengajian: 2020

Saya **Mohamad Izzat Syamil Bin Mohd Azahar** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

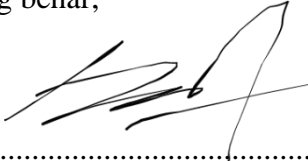
1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

SULIT*

Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972.

- Mengandungi maklumat TERHAD yang telah ditentukan oleh
- TERHAD* organisasi/badan di mana penyelidikan dijalankan.
- TIDAK TERHAD

Yang benar,



.....
Mohamad Izzat Syamil Bin Mohd Azahar

Alamat Tetap:
No. 67, Jalan Sari Ilham 1/3,
Taman Alam Sari,
43000, Kajang, Selangor Darul Ehsan.

Tarikh: 18/02/2021

Disahkan oleh penyelia:



.....
Encik Adam Bin Samsudin
Cop Rasmi Penyelia

Tarikh: 23/02/2021

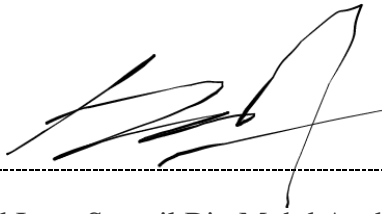


*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I declare that this thesis entitled IOT CONTROLLED HYBRID POWER SWITCHING is the result of my own research except as cited in the references.

Signature :



Name :

Mohamad Izzat Syamil Bin Mohd Azahar

Date :

18/02/2021



APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UteM) as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology with Honours. The member of supervisory is as follow:

Signature

:



Supervisor Name

:

Encik Adam Bin Samsudin

Date

:

23/02/2021



ABSTRACT

This thesis discusses the development system of IoT Controlled Hybrid Power Switching to provide consumer a system which allows them to managing their hybrid electricity sources. The generations of electricity can be produce by various of resources such as conventional and renewable resources. The existing method of generating electricity through renewable resources for instance a small scale of stand alone solar photovoltaic system or pico hydropower system gives consumer an ability to generate their own electricity source. In general, generated electricity from the resources are able to stored in energy storage devices such as rechargeable lead acid battery. The main reason of generating electricity from renewable resources is that to reduce consumer dependence on depleting conventional resources at the same time they can experience a monthly electricitiy bills saving. Without wasting the existed conventional resources, two different electricity generation can be combine thus creating a hybrid power system. The system is develope in order for consumer to consume both resources efficiently without producing any energy waste. The objectives development of IoT Controlled Hybrid Power Switching could help consumer to manage both their electricity generation and consumption more effectively thus able to reduce their monthly electricity bills with mor savings. This system provides flexibility for consumer to choose their options on how to consume electricity consumption. The available option are Auto-Mode and Manual-Mode. Both options using different method consuming generated electricity. The Auto-Mode implementing an IoT element that provides consumer an ability to control electricity consumption through Blynk application on smartphone. The switching between two sources are based on percentage level of batttery voltage capacity. For the Manual-Mode, the option give consumer a capability to control switching between two sources based on the time set by consumer. Both option able to deliver advantages to consumer in order managing their electricity consumption dynamically.

ABSTRAK

Tesis ini membincangkan tentang pengembangan sistem IoT Controlled Hybrid Power Switching untuk menyediakan pengguna sistem yang membolehkan mereka menguruskan sumber elektrik hibrid mereka. Generasi elektrik dapat dihasilkan oleh pelbagai sumber seperti sumber konvensional dan sumber yang boleh diperbaharui. Kaedah yang ada untuk menjana elektrik melalui sumber yang boleh diperbaharui misalnya sistem fotovoltaiik solar berskala kecil atau sistem piko kuasa-hidro memberi pengguna kemampuan untuk menghasilkan sumber elektrik mereka sendiri. Secara amnya, elektrik yang dihasilkan dari sumber tersebut dapat disimpan dalam peranti penyimpanan tenaga seperti bateri asid plumbum yang boleh dicas semula. Sebab utama penjanaan elektrik dari sumber yang boleh diperbaharui adalah untuk mengurangkan pergantungan pengguna pada menghabiskan sumber konvensional pada masa yang sama mereka dapat mengalami penjimatan bil elektrik bulanan. Tanpa membuang sumber konvensional yang sedia ada, dua penjanaan elektrik yang berbeza dapat digabungkan sehingga menghasilkan sistem kuasa hibrid. Sistem ini dikembangkan agar pengguna dapat menggunakan kedua-dua sumber dengan lebih cekap tanpa menghasilkan lebih pembaziran tenaga. Antara objektif membangunkan IoT Controlled Hybrid Power Switching adalah untuk membantu pengguna menguruskan penjanaan dan penggunaan elektrik dengan lebih berkesan sehingga dapat mengurangkan bil elektrik bulanan mereka dengan penggunaan tenaga yang lebih menjimatkan. Sistem ini memberi fleksibiliti kepada pengguna untuk memilih pilihan mereka mengenai cara menggunakan penggunaan elektrik. Pilihan yang ada adalah Auto-Mode dan Manual-Mode. Kedua-dua pilihan menggunakan kaedah yang berbeza dalam menggunakan elektrik yang dihasilkan. Auto-Mode menerapkan elemen IoT yang memberikan kemampuan kepada pengguna untuk mengawal penggunaan elektrik melalui aplikasi Blynk pada telefon pintar. Peralihan antara dua sumber berdasarkan tahap peratusan kapasiti voltan bateri. Untuk Manual-Mode, pilihan ini memberikan pengguna kemampuan untuk mengawal pertukaran antara dua sumber berdasarkan waktu yang telah ditetapkan oleh pengguna. Kedua-dua pilihan dapat memberikan kelebihan kepada pengguna untuk menguruskan penggunaan elektrik mereka secara dinamik.

DEDICATIONS

To my beloved father and mother

To who believes in dreams. Keep persuing



ACKNOWLEDGEMENTS

Firstly, I would like to thank to Allah s.w.t for giving strength and opportunity to complete my Final Year Project successfully. Moreover, I also would like to thank and express my appreciation to my supervisor lecturer and co-supervisor lecturer Sir Adam Bin Samsudin and Ts. Mohd Hanif Bin Che Hasan to guide and encourage me to help me finish my both in Final Year Project 1 & 2.

Next, sincere thanks to all the lecturers that held seminar sessions every week in order to expose students about correct way of writing final year project report. In addition, thank you to my friends who gave some useful comments and suggestions regarding this work.

Thanks to my parents and family for encouraging and motivating to complete the Final Year Project 1 & 2 smoothly. Lastly, a big thank you for everyone who have helped me directly or indirectly in completing this project.



TABLE OF CONTENTS

TABLE OF CONTENTS.....	X
LIST OF TABLES AND GRAPHS	XIII
LIST OF FIGURES & DIAGRAMS	XIV
LIST OF ABBREVIATIONS, SYMBOLS, AND NOMENCLATURE	XVI
LIST OF APPENDIX	XVIII
CHAPTER 1 INTRODUCTION.....	1
1.1 Background	1
1.2 Problem Statement	2
1.3 Objective	2
1.4 Scope of Project	3
1.5 Significance of Study	3
CHAPTER 2 LITERATURE REVIEW.....	4
2.0 Introduction.....	4
2.1 Utility Grid Network.....	5
2.2 Stand-Alone Power System.....	6
2.3 Hybrid Power Source	8
2.3.1 Application of Hybrid Power System	9
2.4 Solar Photovoltaic Panel	11
2.4.1 Monocrystalline Solar Panel	12
2.4.2 Polycrystalline Solar Panel.....	14
2.4.3 Thin Film Solar Panel	15
2.5 Microcontroller.....	16
2.5.1 Arduino Uno.....	17
2.5.2 Raspberry Pi	19

2.5.3	Nanode	20
2.6	Switching Source Circuit	21
2.6.1	Relays for Supply Switching.....	22
2.6.2	4 - Channel 5V Relay Module.....	23
2.6.3	Electromechanical Relay	24
2.6.4	Solid State Relays.....	25
2.7	Timing Monitoring System	26
2.7.1	DS1307 Real-Time Clock (RTC) Module	26
2.7.2	Interfacing On and Off Relay State Based on Time.....	28
2.8	Measuring Voltage Source using Voltage Sensor Module	29
2.9	Monitoring Data via Blynk IoT Platform.....	31
CHAPTER 3 METHODOLOGY		34
3.0	Introduction	34
3.1	Methodology Procedure	35
3.2	General Process	35
3.3	Project Characteristics	36
3.3.1	Polycrystalline Solar Panel.....	38
3.3.2	Power Inverter	40
3.3.3	Solar Lead Acid Battery	42
3.3.4	Real-Time Clock (RTC) 1307 Module	43
3.3.5	4-Channel 5V Relay Module.....	44
3.3.6	Arduino Mega 2560 R3 Microcontroller	46
3.3.6	4 x 3 Membrane Keypad	47
3.3.7	Voltage Sensor Module.....	48
3.4	Working Mechanism of Project	49
3.4.1	Project Flowchart	54
3.5	Expected Result.....	57

3.6	Gantt Chart.....	58
CHAPTER 4 RESULT AND DISCUSSION.....		60
4.1	Introduction.....	60
4.2	Initial Menu System.....	60
4.3	Analysis Result Manual Mode of Hybrid Power Switching.....	61
4.4	Analysis Hardware Manual Mode of Hybrid Power Switching.....	64
4.5	Analysis Hardware Auto Mode of Hybrid Power Switching.....	71
4.6	Results implementing system in real life application.....	78
4.7	Discussion.....	79
CHAPTER 5 CONCLUSION AND RECOMMENDATION.....		81
5.1	Introduction.....	81
5.2	Conclusion.....	81
5.3	Recommendation.....	82
REFERENCES.....		84
APPENDICES.....		86



LIST OF TABLES AND GRAPHS

Graph 2.8 I-V: Characteristic and P-V Characteristic using voltage sensor module...	30
Table 3.6: Pins Description of RTC 1307 Module	44
Table 3.7: Specification 2-channel 5V relay module.....	45
Table 4.2: Declaration of Integers and Arduino Pins	62
Table 4.3: 4x3 Keypad input for interact the menu	66
Graph 4.1: Battery voltage capacity against discharge time in hours.....	73
Graph 4.2: Percentage (%) VS battery voltage capacity (V).....	74
Graph 4.3: Comparison between monthly electricity bills without the system and with the system.....	79



LIST OF FIGURES & DIAGRAMS

Diagram 2.1: Power Distribution System	6
Diagram 2.2: Grid Connected Solar PV System.....	7
Diagram 2.3: First Generation of Toyota Prius	10
Diagram 2.4: Assembly of PV cells.....	12
Diagram 2.4.1: Layers of Monocrystalline Solar PV	14
Diagram 2.4.2: Polycrystalline Silicon	15
Diagram 2.5: Types of Microcontroller	17
Diagram 2.5.1: Arduino Family.....	18
Diagram 2.5.2: Arduino Uno circuit.....	18
Diagram 2.5.3: Raspberry Pi OS.....	19
Diagram 2.5.4: Raspberry Pi 3 Board.....	20
Diagram 2.5.5: Nanode Microcontroller Board.....	21
Diagram 2.6.1: 2-Channel 5V Relay Module	24
Diagram 2.6.2: Electromechanical Relay	25
Figure 2.7.1: 128x64 Graphical LCD displaying desired output.....	27
Figure 2.7.2: RTC DS1307 Module.....	28
Figure 2.7.3: Relay turning on the LED with LCD displayed as “device is ON”	29
Figure 2.9: Monitoring the status of each Smart Capsule.....	32
Figure 2.9.1: Blynk application interface for IoT Based Smart Home	33
Diagram 3.2: Methodology Flow Chart.....	35
Diagram 3.3: Polycrystalline Solar Panel	39
Diagram 3.3.1: Datasheet of Polycrystalline PV Panel	40
Diagram 3.4: Power Inverter.....	42
Diagram 3.5: Solar Lead Acid Battery	43
Diagram 3.6: RTC 1307 Module	44

Diagram 3.7: 4-Channel 5V Relay Module	45
Diagram 3.8: Example Coding using Arduino IDE.....	46
Diagram 3.8.1: Arduino Mega 2560 R3 Board.....	46
Diagram 3.9: 4 x 3 Membrane Keypad Hardware	47
Figure 3.9: Voltage sensor module with label	48
Diagram 3.8: Block Diagram of Stand-Alone Solar System	49
Diagram 3.9: Main System Flowchart	51
Diagram 3.10: Auto Mode Flowchart.....	52
Diagram 3.11: Manual Mode Flowchart.....	53
Figure 3.9.1: Project Flow Chart.....	56
Diagram 3.11: PSM 1 Gantt Chart.....	58
Diagram 3.12: PSM 2 Gantt Chart.....	59
Figure 4.0: Displaying Initial Menu.....	60
Figure 4.1: List of Libraries	62
Figure 4.2: Declaration of Integers and Pins Arduino Pins	63
Figure 4.3: Displaying current time on i2C 16x2 LCD and current time	64
Figure 4.4: Interacting the “ON” and “OFF” value using the 4x3 keypad.....	65
Figure 4.5: Connections of the 4 Channel 5V Relays.....	67
Figure 4.6: LCD displaying current time 20 : 33 : 2020, ON : OFF : 1715	68
Diagram 4.7: Timeline to Guide User in Controlling the Switching Timing	69
Figure 4.7: Connection between voltage sensor, 12V lead acid battery and Arduino..	72
Figure 4.9: C++ code converting battery voltage capacity into percentage value.....	74
Figure 4.10: Percentage representation for each 10 LEDs	75
Figure 4.11: Widgets used in the Blynk application.....	76
Figure 4.12: Result switching process when consumer select V1	77
Figure 4.12 Hardware Development of IoT Controlled Hybrid Power Switching.....	80

LIST OF ABBREVIATIONS, SYMBOLS, AND NOMENCLATURE

PSM	-	Projek Sarjana Muda
PV	-	Photovoltaic
GND	-	Ground
V	-	Voltage
A	-	Ampere
HRS	-	Hours
I2C	-	Inter-Integrated Circuit
LED	-	Light Emitting Diode
kWh	-	Kilo-Watt Hours
AC	-	Alternating Current
DC	-	Direct Current
TNB	-	Tenaga Nasional Berhad
SS	-	Serial Input
IDE	-	Integrated Development Environment
OS	-	Operating System
I/O	-	Input or Output
NO	-	Normally Open
NC	-	Normally Close
SDA	-	Serial Data
SCL	-	Serial Clock
RTC	-	Real-Time Clock
SSO	-	Switch Socket Outlet

L	-	Live Terminal
N	-	Neutral Terminal
UI	-	User Interface
W	-	Watt (Power)
#	-	Hash-key
*	-	Asterisk-key
IoTCHPS	-	IoT Controlled Hybrid Power Switching



LIST OF APPENDIX

Appendix A : Programming in Arduino IDE.....	86
Appendix B : Solar PV Panel Specification Sheet.....	89
Appendix C : Tenaga Nasional Berhad Electric Bill Tariff Rates.....	90



CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, there is two elements of electrical sources that had been consume by majority people around the globe. It can be categories into two category which are the conventional power source and renewable energy source. The conventional power source which basically the main supply comes from power distribution grid line a generation from coal or hydropower plant. As the renewable energy resource, the electrical energy comes from the harvesting of solar energy, wind energy, hydropower and biomass. These two power sources have been a huge dependency for human as a electricity consumption.

As decades has past, the conventional electrical power source as in Tenaga Nasional Berhad (TNB) already had an organization that able to manage or organize the activity for the electric generation and consumption. However, the management is not applicable for electricity generated by renewable energy resources. The system is standalone, only fully controlled by the user itself. These proven that the usage of conventional electrical power and standalone renewable energy electric generator aren't connect or communicate with each other. Hence, an appropriate system is needed to able a switching activity between these 2 power sources efficiently controlled.

The consumption of renewable energy resources as an alternative electric power generation meant to reduce the consumer electric bill monthly. As follows, a device is needed for any household or building that consume both conventional electricity and electricity generation from renewable energy resources. The device could able deliver a system that able the consumer to monitor and switching between these 2 sources directly or indirectly.

In other word, without using an impropriate device or any system implementation to manage the consumption flow of 2 electricity sources, it might be a result of inefficiency

consumption of these sources. Particularly, the utilization of a switching device would tackle the waste of energy problem happened day by day of these sources. Thus, creation of the device or system would leads to able of reduce the monthly electricity billing and waste of renewable energy electricity generation.

1.2 Problem Statement

The usage of conventional energy and renewable energy resources as to generate electricity becoming a norm these days. These two energy resources contribute much in electricity generations either residential or building units. To overcome the issue of excessive waste of electricity especially generated by renewable energy resource, a switching system device need to be implemented. A switching system that able the user to switch between using electricity from main supply or generated by renewable energy as supplying their units. Besides that, implementation of this project also focusing on consumers who are completely depending consume electricity generated through conventional resources. Thus, the main objective of the project is to design and construct an auto switching device controlled by IoT that able to do switching between 2 electricity resources as purpose for user to save their monthly electricity bill.

1.3 Objective

There are three objectives as following: -

1. Construct and develop the IoT Controlled Hybrid Power Switching system using Arduino IDE software and hardware components
2. To test the developed system functionality and efficiency with a real situation.
3. Analyze the capability of the product to tackle the stated problem efficiently.

1.4 Scope of Project

The scopes of this project are: -

1. This project is implementing automatic switching technique between main supply and renewable energy electricity generation.
2. This system will consist of a few relays, an Arduino microcontroller, Real-Time Clock (RTC) module and execution of IoT used for monitoring and controlling the switching system.
3. User able to control directly or indirectly of the switching system based on the timing setting.

1.5 Significance of Study

The IoT Controlled Hybrid Power Switching is recommended mainly for users that are consuming both main supply and electricity generated from renewable energy resources. Commonly, users consume both supply at their permises as a purpose to save their monthly electricity bill. The development of the IoT Controlled Hybrid Power Switching will help the user to manage both energy consumption efficiently without any waste of energy occur. For a bigger scale perspective, this project also could be implemented in industrial field to power up machinery and power tools.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Generating electricity by using renewable energy resources has been widely used around the globe. Nowadays, the implementation of consuming renewable energy resources to generate electricity can be seen at all premises either residential or industrial level. Besides that, not to be forgotten that electricity generated by conventional resources are still extensively implemented these days. According to an article written by *TheStar (2015)* on how electricity generated in Malaysia, within this country itself, the combustion of limited fossil fuel resources such as coal, natural gas or oil are primarily used in generating electricity in term of conventional resources (TheStar, 2015). Therefore, installing renewable energy system at premises could help user not depend too much on limited conventional resources to generate electricity as their supply. Hence a problem will arise when it comes to managing two electricity sources supply from grid connected main supply and renewable energy generation .

This chapter described briefly and concisely about automated power switching system between two different supply sources. The discussion will be cover on the existed research and work results related to automated power switching topic. Also discussed about the component or hardware that have been used to make the system more efficient and able to deliver desire results. A long this chapter, there are a few sources have been taken to be as a main reference such as journals, articles, websites, preceding research or thesis writing and textbooks.

2.1 Utility Grid Network

A utility grid network or electricity grids consist of generation, transmission, and distribution of electricity produced at the generator and provided to the load. Based on a journal written in 2016 title *Power Generation Sources in Malaysia: Status and Prospects for Sustainable Development*, mention that in Malaysia, the most resources used in electric power generation depends on three major which is fossil fuel sources, namely coal, natural gas and fuel-oil. These consumption of fossil fuel in electricity generation causes negative impact of environmental aftermath and depletion of fuel reserves (*Samsudin, Rahman, & Wahid, 2016*). The journal able to prove that behavior of depending much on conventional resources aren't sufficient enough for a long term generating electricity such that the resources could depleting and limited day by days. By fully getting rid of the way using conventional resources from generating electricity isn't a good option for a reason the resources need to be fully utilized.

On top of that, utility grid network can be divided into three primary components which are generation, transmission and distribution, and consumption. For generation, it can has two types of generation which are centralized and decentralized. Firstly, centralized generation electricity attributes to the huge-scale generation of electricity which centralized at certain facilities. Such that these facilities are typically situated farther from end-users and linked to a high-voltage transmission network. This type also includes some resources consumption to generate electricity such as natural gas, hydro power, wind energy, coal and solar arrays farm. Differ from centralized generation type, a decentralized generation is electricity generation and storage is conducted by a various of small, grid-connected or transmission network linked devices referred to as distributed energy infrastructure. Secondly, other component for an electrical grid is transmission and distribution. A transmission is refer to power lines that transmit electricity from plant generator to the consumption level. A few transmission losses occur when distributing the electricity at high voltages due to the over long distances and resistive transmission lines. A transmission can accomplish by powerlines and can be appear as underground or overhead. Subsequently, the last main components of electrical grid is consumption. A consumers can be classified as industrial level, commercial and residential consumers. Each level of these consumers demands a different voltage kilovolts (kV) ratings. Such that for example an industrial level, it consume about 4.16kV to 34.5kV while for commercial and residential they consume about the same voltages rating which are 120V to 240V respectively.

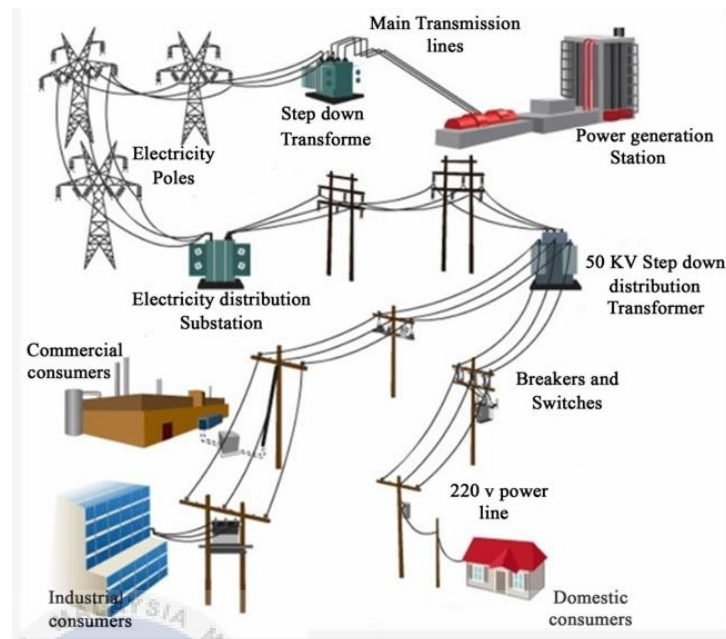


Diagram 2.1: Power Distribution System

2.2 Stand-Alone Power System

Generally, a stand-alone power system, also known as remote area power supply, is an off-grid electrical system for locations not equipped with a power distribution system. Commonly, the system includes one or more methods for generating electricity, storing energy and regulating it. The generation of electricity usually generated by a few procedures such as energy from a wind turbine, geothermal source, solar photovoltaic panels, hydropower, biofuel or diesel. A combination of these multiple sources to deliver non-intermittent electricity is known as hybrid power systems. The application of stand-alone power system are usually for a homes or small business premises that installing a small renewable energy system such that they are not connected to the electricity power grid. The system is so called stand-alone is due to it is not connected with any power distribution line. Besides that, these systems are also often been practise by citizens that residing outside the grid line and hoping to achieve independence from the electricity supplier and to show a dedication to non-polluting energy sources. Diagram 2.4.1 below shown an example of stand-alone power system setup generating electricity using solar photovoltaic panel.