



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**SOLAR POWERED SMARTPHONE CHARGING**

**STATION**

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

by

**LUQMAN NAIM BIN KAMARUDDIN**

**B071610876**

**940515-14-5883**

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING

TECHNOLOGY

2019

**BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA**

Tajuk: 46TSOLAR POWERED SMARTPHONE CHARGING STATION

Sesi Pengajian: 2019

Saya **LUQMAN NAIM BIN KAMARUDDIN** 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.

TERHAD\*

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

TIDAK

TERHAD

Yang benar,

Disahkan oleh penyelia:

.....

LUQMAN NAIM BIN KAMARUDDIN

.....

TS. DR. ALIZA BINTI CHE AMRAN

Alamat Tetap:

Cop Rasmi Penyelia

PT 11755 (Lot 36318)

Jalan Belimbing

Kg Sg Buah

43800 Dengkil

Tarikh:

Tarikh:

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

## DECLARATION

I hereby, declared this report entitled 46TSOLAR POWERED SMARTPHONE CHARGING STATION is the results of my own research except as cited in references.

Signature: .....

Author : LUQMAN NAIM BIN KAMARUDDIN

Date:

## **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 (Industrial Power) with Honours. The member of the supervisory is as follow:

Signature: .....

Supervisor :      TS. DR. ALIZA BINTI CHE AMRAN

Signature: .....

Co-supervisor:      AMALIA AIDA BINTI ABD HALIM

## ABSTRAK

*Tujuan utama projek ini adalah bagi membangunkan stesen pengecasan telefon pintar menggunakan tenaga solar yang boleh digunakan oleh orang ramai. Pada masa kini, kesedaran yang ada pada masyarakat Malaysia mengenai tenaga yang boleh diperbaharui adalah tinggi tetapi tidak banyak yang menggunakannya. Selain daripada itu, telefont pintar telah terkesan melalui peningkatan teknologi yang mana ia menyebabkan penggunaan tenaga bagi telefon pintar meningkat secara mendadak. Maka bagi menyelesaikan masalah yang telah disebutkan di atas, stesen pengecasan telefon pintar menggunakan tenaga solar akan direka, dibangunkan dan dipasang di sesuatu tempat seperti perhentian bas dan taman-taman bagi mempromosikan penggunaan tenaga yang boleh diperbaharui sambil orang awam boleh mengecap telefon pintar.*

## **ABSTRACT**

The main goal for this project is to develop a solar powered smart phone charging station that can be used by the public. Nowadays, most of people have aware regarding renewable energy (RE) but not many have implemented RE in their daily life. Other than that, cell phone has affected by technology that became more advanced which left drawback to the cell phone that causing cell phone energy consumption increase rapidly. To overcome the problems which have been stated earlier a smart phones charging station using solar energy as source electricity will be designed, developed and installed in certain places such as bus stop or park in order to promote renewable energy while the public can charge their smart phone.

## **DEDICATION**

This project is lovingly dedicated to my parents Kamaruddin Bin Abd Ghani and Rafiah Husain who have been my constant source of inspiration. They have given me the drive and discipline to tackle a task with enthusiasm and determination. Without their love and support this project would not have been made possible.



## ACKNOWLEDGEMENTS

First and foremost, praises and thanks to Allah S.W.T for the showers of blessings throughout my project work to complete the project successfully. I would like to express my special appreciation and thanks to my final year project supervisor Ts. Dr. Aliza Binti Che Amran, Co-Supervisor Madam Amalia Aida Binti Abd Halim and other lecturer Madam Emy Zairah Binti Ahmad. Without their assistance and dedicated involvement in every step throughout the process, this project would have never been accomplished. A special thanks to my family. Words cannot express how grateful I am to my father, mother and sibling for all the sacrifices that they have made on my behalf. Their prayer for me was what sustained me thus far. Last but not the least, I would like to thank my course mate for their support and help in completion of this project. With their knowledge and brilliant comment, I manage to complete the project.

## TABLE OF CONTENTS

	<b>PAGE</b>
<b>DECLARATION</b>	
<b>APPROVAL</b>	
<b>ABSTRAK</b>	<b>vi</b>
<b>ABSTRACT</b>	<b>vii</b>
<b>DEDICATION</b>	<b>viii</b>
<b>ACKNOWLEDGEMENTS</b>	<b>ix</b>
<b>TABLE OF CONTENTS</b>	<b>x</b>
<b>LIST OF TABLES</b>	<b>xv</b>
<b>LIST OF FIGURES</b>	<b>xvi</b>
<b>LIST OF APPENDICES</b>	<b>xviii</b>
<b>LIST OF SYMBOLS</b>	<b>xix</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xx</b>
<b>CHAPTER 1      INTRODUCTION</b>	<b>22</b>
1.1      Background	22
1.2      Problem Statement	23
1.3      Objective	24
1.4      Scope	24

<b>CHAPTER 2</b>	<b>LITERATURE REVIEW</b>	<b>26</b>
2.1	Introduction	26
2.2	Solar Energy	26
2.3	Solar Energy Collector	27
2.3.1	Solar Thermal System	27
2.3.2	Photovoltaic Technology	28
2.4	Solar Cell	28
2.4.1	Working Principle of Solar Cell	29
2.4.2	First Generation of Solar Cell	29
2.4.3	Second Generation Of Solar Cell	31
2.4.4	Third Generation of Solar Cell	34
2.5	Solar Panel	36
2.5.1	Shading Effect	37
2.5.2	Tilt Angle of Solar Panel	37
2.6	Battery	37
2.7	Solar Charge Controller	38
2.8	Review of previous research	38
2.8.1	Review of Solar Powered Standing DC Fan	38
2.8.2	Review of Solar Two Wheeler	41
2.8.3	Review of Solar Charging Station	42

2.8.4	Comparison of Past Studies	43
<b>CHAPTER 3</b>	<b>METHODOLOGY</b>	<b>45</b>
3.1	Introduction	45
3.2	Project Flow Chart	45
3.3	System Block Diagram	47
3.4	Hardware Specifications	47
3.4.1	Solar Module	48
3.4.2	Solar Charge Controller	49
3.4.3	Battery	49
3.4.4	Inclinometer	50
3.4.5	DC Power Meter	50
3.5	Software	52
3.6	Project Design	53
3.6.1	Theoretical Calculation	53
3.6.2	Design of The Solar Powered Smartphone Charging Station	55
3.7	Complete Development of Solar Powered Smartphone Charging Station	57
3.8	Experiment Set Up	58
3.8.1	Site Measurement	57
3.8.1.1	Inclinometer Calibration	57
3.8.1.2	Measure Solar Module Angle	58

3.8.1.3	Solar Module Orientation	59
3.8.2	DC Power Meter Connection	61
3.8.2.1	Measure Power Generated by Solar Module and Battery Charging	61
3.8.2.2	Battery Discharging	60
<b>CHAPTER 4</b>	<b>RESULTS &amp; DISCUSSION</b>	<b>64</b>
4.1	Introduction	64
4.2	Results	64
4.3	Analysing Result	66
4.3.1	Average Power Generated for 9 Hours	66
4.3.2	Average Power Generated per Hour	67
4.3.3	Battery Charging	69
4.3.4	Battery Discharging	72
<b>CHAPTER 5</b>	<b>CONCLUSION &amp; RECOMMENDATIONS</b>	<b>75</b>
5.1	Introduction	75
5.2	Project Overview	75
5.3	Objective Overview	75
5.4	Methodology Overview	76
5.5	Result Overview	76

5.6	Limitation and Recommendations	77
	<b>REFERENCES</b>	<b>77</b>
	<b>APPENDIX</b>	<b>83</b>

## LIST OF TABLES

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
Table 2.1	Past Studies Comparison	42
Table 3.1	Electrical Characteristic of PV Module	47
Table 3.2	Inclinometer Specification	50
Table 3.3	150A High Precision Watt Meter and Power Analyser	51
Table 4.1	Power Generated from Solar Module with 5° and 10° Tilt Angle	64
Table 4.2	Power Generated from Solar Module with 15° and 20° Tilt Angle	65
Table 4.3	Average Power Generated for 9 Hours	66
Table 4.4	Average Power Generated per Hour	68

## LIST OF FIGURES

<b>FIGURE</b>	<b>TITLE</b>	<b>PAGE</b>
Figure 2.1	Solar Cell Categories	28
Figure 2.2	Operation Principle of Solar Cell	29
Figure 2.3	Mono-Crystalline Solar Panel	30
Figure 2.4	Poly-Crystalline solar panel	30
Figure 2.5	Amorphous Silicon Foldable Solar Panel	31
Figure 2.6	Solar Powered Standing Dc Fan	40
Figure 2.7	Solar Two Wheeler	41
Figure 3.1.1	Flow Chart of Project	44
Figure 3.1.2	Block Diagram of the System	46
Figure 3.1.3	Solar Charge Controller 12V 10A	48
Figure 3.1.4	Solar Charge Controller Specification	48
Figure 3.1.5	Lead Acid Battery	49
Figure 3.1.6	Battery Specification	49
Figure 3.1.7	Inclinometer	50
Figure 3.1.8	Prototype Design in 2D Diagram	55
Figure 3.1.9	Prototype Design in 3D Diagram	55



Figure 3.2.1	Prototype Front View	56
Figure 3.2.2	Prototype Rear View	56
Figure 3.2.3	Reset Inclinometer to 0°	57
Figure 3.2.4	Solar Module with 5° Tilt Angle	58
Figure 3.2.5	Solar Module with 10° Tilt Angle	58
Figure 3.2.6	Solar Module with 15° Tilt Angle	59
Figure 3.2.7	Solar Module with 20° Tilt Angle	59
Figure 3.2.8	Solar Module Face to South Direction	60
Figure 3.2.9	DC Power Meter Connection (Generated Power and Battery Charging)	61
Figure 3.3.1	DC Power Meter Charging Connection Diagram	61
Figure 3.3.2	DC Power Meter Connection for Battery Discharging	62
Figure 3.3.3	DC Power Meter Discharging Connection Diagram	62
Figure 4.1	Bar Graph of Average 9 hours Generated Power	66
Figure 4.2	Graph of Average Power Generated Per Hour	68
Figure 4.3	Graph of Battery Charging 1 <sup>st</sup> Sample	70
Figure 4.4	Graph of Battery Charging 2 <sup>nd</sup> Sample	70
Figure 4.5	Graph of Battery Discharging 1 <sup>st</sup> Sample	72
Figure 4.6	Graph of Battery Discharging 2 <sup>nd</sup> Sample	72

## LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix A	Gant Chart	83
Appendix B	Solar Module Data Sheet	84
Appendix C	DC Power Meter	85
Appendix D	12V 8Ah Lead Acid Battery	86
Appendix E	Turn It In Result	87

## LIST OF SYMBOLS

<b>V</b>	-	Voltage
<b>I</b>	-	Current
<b>P</b>	-	Wattage
<b>Wh</b>	-	Watt-hour
<b>Ah</b>	-	Ampere Hour
<b>°</b>	-	Degree Angle

## LIST OF ABBREVIATIONS

<b>PV</b>	Photovoltaic
<b>LCD</b>	Liquid Crystal Display
<b>USB</b>	Universal Serial Bus
<b>FPC</b>	Flat Plate Collector
<b>ETC</b>	Evacuated Tube Collector
<b>CPC</b>	Compound Parabolic Concentrator
<b>PTC</b>	Parabolic Through Collector
<b>LFR</b>	Linear Fresnel Reflector
<b>CTC</b>	Cylindrical Through Collector
<b>p-Si</b>	Poly-crystalline Silicon
<b>m-Si</b>	Mono-crystalline Silicon
<b>a-Si</b>	Amorphous Silicon
<b>Cd-Te</b>	Cadmium Telluride
<b>CIGS</b>	Copper Indium Gallium Diselenide
<b>CIS</b>	Copper Indium Selenide
<b>DSSC</b>	Dye-Sensitized Solar Cell
<b>DSC</b>	Dye-Sensitized Solar Cell
<b>QDSC</b>	Quantum Dots Solar Cell
<b>QD</b>	Quantum Dots
<b>PSC</b>	Perovskite Solar Cell
<b>Li-ion</b>	Lithium-Ion

<b>Ni-cd</b>	Nickel Cadmium
<b>Ni-Mh</b>	Nickel Metal Hydride
<b>PWM</b>	Pulse Width Modulation
<b>MPPT</b>	Maximum Power Point Tracking
<b>DC</b>	Direct Current
<b>AC</b>	Alternate Current

# CHAPTER 1

## INTRODUCTION

### 1.1 Background

The issue between energy and environment has been hotly debated over the past 20 years. Through the environment pollution, public have realized the important of renewable energy which can help to save the earth from pollution. Other than environment pollution, source of oil and natural gas which insufficient to meet future needs also have been one of the main factors which make the renewable energy is so important to use (Quaschnig, 2019). There are few natural sources that can generate energy such as wind, sun, tides and geothermal heat. For this project, sun is the source that will be focused on in generating electricity to charge smartphones. Using sun as source of renewable energy is called solar energy and it is one of the cleanest sources of energy. Basically solar energy is produce through the conversion of sun's energy to electricity by using photovoltaic or concentrated power (Gorjian, 2017).

Photovoltaic is categorized as direct solar power that converts solar radiation directly becoming electricity while concentrated power is categorized as indirect solar power which converts solar energy to heat and then to electricity. Photovoltaic (PV) system is divided into two categories which is stand alone and grid connected. The first category is called stand-alone PV system which is used for the small load electrical appliances such as street light and charge electronic device (smartphone, tablet and other USB interface electronic products) and it contains storage battery. For grid connected means that solar panel is connected to the electrical grid of the electrical utility company

and it does not contain storage battery (Rashad, El-Samahy, Daowd, & Amin, 2015). For this project, stand-alone PV system is used as the main objective is to charge smartphone.

In this era of technology, smartphone have become one of important thing in daily life activities and without smartphones the process of activity became difficult. As it is called era of technology, smartphones become open platform that provide many of third-party applications such as Instagram, Facebook, twitter, mobile legend game and many more. Many of these apps has caused the smartphones energy consumption is increased rapidly and as a result, the battery can last for a limited time only (Denzil Ferreira, 2011). Solar powered smart phone charging station that use photovoltaic to generate electricity were propose as an option for the public to charge their smart phone without using electricity source from national grid. The project consists of solar panel, solar charger controller, battery and voltage regulator. This product will be placed at locations that do not have electricity sources such as recreational parks, bus stations and many more. With the existence of this product, it could help public to solve their problem in finding places to charge smartphone while promoting renewable energy awareness.

## **1.2 Problem Statement**

Charging smartphones is a must for every owner that own smartphone and without charging the battery it become useless device. Increasing usage of social media and entertainment application is making the smartphone battery only last for couple of hours. Due to having drain battery, every smartphone owner will always have to prepare to recharge back their smartphone so that it can be use anytime. The main question is where the owner can recharge back their smartphone if they don't any electricity source for example during in public places such as recreational park or bus station. In Malaysia, awareness on Renewable Energy (RE) were quite high, however, not many is using the RE

technology (Kardooni, Yusoff, Kari, & Moeenizadeh, 2017). Therefore, with the implementation of this solar powered smartphone charging station system will be a jump-start for Malaysian people to use RE in their daily activities and be a problem solver for the public or community.

### **1.3 Objective**

Towards completion of this project, there are several objectives to be achieved:

1. To design solar powered smartphone charging station
2. To develop a solar powered smartphone charging station that can charge smart phones using solar module, solar charger controller, battery and other required circuit.
3. To analyse the performance of solar powered smartphone charging station.

### **1.4 Scope**

The target of this project to develop a smart phone charging station using renewable energy as source of electricity. The project focuses on generating electricity using solar energy that can be utilized by public to charge smart phone. Generating optimal electricity is the critical part to achieve but with consideration of few criteria it can be achieved. Type of solar module play an important role but different type of solar panel has different cost. The type of solar module will be choosing based on productivity and the least cost by doing past research. Other than that, amount of solar energy which include shading effect and angle & timing of sun also need to be considered in producing optimal electricity. Lastly, battery also needed to focus on, because it is to make sure that the system has a reliable back-up system.