Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF SOLAR PHOTOVOLTAIC WATER PUMPING SYSTEM

MUHAMMAD SYAHMI BIN TAQIYUDDIN

Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

2023

DEVELOPMENT OF SOLAR PHOTOVOLTAIC WATER PUMPING SYSTEM

MUHAMMAD SYAHMI BIN TAQIYUDDIN

A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek :

Sesi Pengajian :

Saya Muhammad Syahmi bin Taqiyuddin mengaku membenarkan laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

☐	**SULIT***	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD***	(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	**TIDAK TERHAD**	

Disahkan oleh:

(TANDATANGAN PENULIS)
Alamat Tetap: NO. JALAN PINGGIRAN PUTRA 5/34, DESA PINGGIRAN PUTRA, 43000, KAJANG, SELANGOR.

(COP DAN TANDATANGAN PENYELIA)
Ts. Dr. MOHD HATTA BIN JOPRI
Pensyarah
Jabatan Teknologi Kejuruteraan Elektrik
Fakulti Teknologi Kejuruteraan Elektrik dan Elektronik
Universiti Teknikal Malaysia Melaka (UTeM)

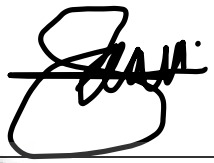
Tarikh: 23.12.2022

Tarikh: 23.12.2022

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

DECRALARATION

I declare that this project report entitled Development Of Solar Photovoltaic Water Pumping System is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Student Name : MUHAMMAD SYAHMI BIN TAQIYUDDIN

Date : 23.12.2022

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours.

Signature : 

Supervisor Name : DR. MOHD HATTA BIN JOPRI

Date : 23.12.2022

Signature :

Co-Supervisor Name :

Date :

DEDICATION

To my beloved supervisor, Ts. Dr. Mohd Hatta bin Jopri, who helped me throughout this final year project 2. To my beloved parents, family, and friends that helped me to complete this report

ACKNOWLEDGEMENT

In the name of Allah S.W.T, thankfulness to the Almighty who gave me the ability to carry out and completes this Final Year Project 2. First of all, I would like to thanks my family for all their support and prayer for me for 14 weeks for me to complete my report for this Final Year Project 2.

Next, I would like to thanks and appreciate to my respect supervisor Ts. Dr. Mohd Hatta bin Jopri for giving me the chance to do this project under him. A big respect and thanks to Ts. Dr. Mohd Hatta bin Jopri for his guidance, encouragement, advice and a lot of ideas that have been devoted to me during the time that had been given to me to complete this Final Year Project 2. A very helpful supervisor that always help me and my other members to complete this report. All the knowledge and lot of experience in engineer technologist field that has been given to me and all my members even though he also busy with his work really help me to overcome my problem and create something very useful for my project. Thank you for willing to take me as his candidate under his wings. Without his help and guidance, I will not get this lot of knowledge and experience about this project that I had done.

I also would like to express my thankful to Pn Kamilah binti Jaffar and Che Wan Mohd Faizal bin Che Wan Mohd Zalani for be the panel for my Final Year Project 1 and also be the panel for my presentation day for my Final Year Project 2. Their comments and guide really help me to improve my idea and received a very good comment and reaction from them for my presentation. Even though they also busy with work they also teach and give me some ideas about my project that useful as addition knowledge for me to complete my task. Last but not least, thank you to all individual that take part in helping me since the first day me start this project until finished the project and report directly and indirectly especially to my beloved members. Thank you.

ABSTRACT

Agriculture has taken the role of being the backbone and driving force behind Malaysia's economic strength and prosperity. The agriculture sector has experienced a new trend in the development on off-grid solar powered construction concepts throughout the world over the last decade, with significant endorsement from influential organisations and the implementation of PV powered solar panels. Nowadays, the conventional ways has switched over to renewable sources such as solar system. A benefit of using solar energy to power agricultural water pump systems is that increased water requirements for livestock and irrigation tend to coincide with the seasonal increase of incoming solar energy. When properly designed, these PV systems can also result in significant long-term cost savings and a smaller environmental footprint compared to conventional power systems. A prototype of this PV water pumping system will be demonstrated throughout this project as the load to the system. In this research, a monocrystalline solar panel will be used to measure their efficiency and determine the best installation of solar panel semiconductor type. A solar energy storage plays an important role as an dependency for the supply during the unavailabilty of sunlight. Hence, the installation of solar energy storage leads to identify the best solar controller in order to get a maximum electrical generation output from the solar panel to charge the battery.

ABSTRAK

Pertanian telah mengambil peranan sebagai tulang belakang dan penggerak di sebalik kekuatan ekonomi dan kemakmuran Malaysia. Sektor pertanian telah mengalami norma baharu dalam pembangunan konsep pembinaan kuasa solar luar grid di seluruh dunia sepanjang dekad yang lalu, dengan sokongan daripada organisasi berpengaruh dan pelaksanaan panel solar berkuasa PV. Pada masa kini, cara konvensional telah beralih kepada sumber boleh diperbaharui seperti sistem solar. Faedah menggunakan tenaga suria untuk menggerakkan sistem pam air pertanian ialah peningkatan keperluan air untuk ternakan dan pengairan cenderung bertepatan dengan peningkatan bermusim tenaga suria yang masuk. Apabila sistem direka dengan betul, sistem PV ini juga boleh menghasilkan penjimatan kos jangka panjang yang ketara dan jejak alam sekitar yang lebih kecil berbanding sistem kuasa konvensional. Prototaip sistem pam air PV akan ditunjukkan di dalam projek ini sebagai bebanan sistem. Dalam penyelidikan ini, sebuah monohablur akan digunakan untuk mengukur kecekapannya dan menentukan pemasangan terbaik jenis semikonduktor panel solar. Storan tenaga suria memainkan peranan penting sebagai pergantungan untuk bekalan semasa ketiadaan cahaya matahari. Oleh itu, pemasangan storan tenaga suria membawa kepada mengenalpasti pengawal cas suria yang terbaik untuk mendapatkan pengeluaran tenaga yang maksimum daripada panel suria untuk mengecas bateri.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

η	-	Efficiency
$\bar{X}$	-	Mean

LIST OF ABBREVIATIONS

V	-	Voltage
A	-	Ampere
W	-	Watt
PV	-	Photovoltaic
W_p	-	Watt peak
Si	-	Silicon
DC	-	Direct Current
AC	-	Alternating Current
PWM	-	Pulse Width Modulation
MPPT	-	Maximum Power Point Tracking
COM	-	Common
NC	-	Normally Closed
NO	-	Normally Opened

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

All around the world, farmers have struggled to water their crops during the dry season since they must utilize well-water. Farmers' work in creating agricultural items is ineffective when it comes to irrigating farmland by using his power to lift water to agricultural grounds. Many people are unable to utilize water pumps on their farmland because they are without access to electricity. Alternative energy sources such as solar water pumps can help solve these problems. This article is going to calculate the solar data in comparison of two main solar panels which commonly used nowadays. In this comparison, some analysis will be conducted to observe their efficiency during the availability of sunlight. A types of mainstream PV modules were selected in this study which is Monocrystalline to measure their efficiency. Mainly, this project purposes to draw water from underground source to fill up the tank storage without using utility grid. This project also pre-built with the connection to battery so that during the night, user still has an option to run the system normally.[1]

1.2 Problem Statement

There are some problems faced during the study of solar energy. The distribution of water resources is a critical challenge in improving such agriculture or crop result. Small-scale farmers desire to start with a low-cost, dependable technology for irrigating crops and increasing production. For many farmers around the world, a solar-powered water pump could be the answer for this solution.[2]

But, there is a problem would be faced when implementing this system which is the location factor. Nowadays, many peoples are desire to start their business in agriculture sector. But when it comes into a location factor, usually the farm or land is located far from the electrical grid supply. Besides that, at inner state people used water from well and pump it manually using their own energy. But, this method is not efficiently, waste time and it is not user friendly. That's why solar water pumping is important to replace this work to draw the water from the resource.[3]

The unpredictability of how much of the sun's rays will receive in solar panel, as weather might change at any time, poses a barrier for solar PV and during the night, while there is still a demand for electricity, sunlight is clearly unavailable. This would make a solar energy storage is so much dependable. The sizing of storage is needed to determine how much energy to store for future usage. Hence, a proper sizing of storage is also an important thing to provide a sufficient energy storage for a continuous usage to the users.[4] There's so much water pumping system available out there, where its operation doesn't have a self-monitoring system. When the motor pump either requires a manually switching on or off by the users, this creates an inconsistent situation where users cannot fully deal with the time to monitor the level of the water inside the storage. Hence, an automatic level monitoring system is so important to install towards this system.

A solar data without a statistical analysis would deteriorate the future estimation on the system. This is because, solar panel performance mostly effected from the weather changes. Hence, knowing the pattern weather based on the statistical data is very crucial as a preparation of system sizing in term of solar storage and solar controller needed.[5]

1.3 Project Objective

The main aim of this project is to propose a comparative analysis of solar cell efficiency between Mono-crystalline and Poly-crystalline toward the water pump system. Specifically, the objectives are as follows:

1. To design a dependable of solar energy storage based on its supply longevity**.** This project will calculate the sizing of minimum battery needed for load depend on the daily usage.
2. To install a self-monitoring water pumping system using solar photovoltaic powered. This project mainly to setup a standalone water pumping system without any supply from the electrical grid supply.
3. To analyze the solar data collection using the statistical method.

CHAPTER 2

LITERATURE REVIEW

2.1 Scope of Project

To avoid any uncertainty of this project due to some limitations and constraints, the scopes of the project are defined as follows:

a) Calculate the solar efficiency which can be generated by 50W_p Monocrystalline solar cell panel.

b) Generate the power supply from the solar panel into the load in direct current.

c) Coding the operation of relay as a switch using Arduino UNO R3.

2.2 Overview

This research uses a direct measurement method to compare the performance of a mono-crystalline with a peak power of 50 W_p. Mono-crystalline materials were compared in terms of efficiency to achieve this goal. To observe the characteristics of different Si-based solar PV systems under various conditions, environmental parameters such as solar radiation and temperature are varies from time to time.[6]

Solar panels with a power capacity and a peak power capacity of 50 W_p is using a direct measurement approach in this study. These areas are arranged in order to show the information about the process of decision making about the project. It is important to obtain clear data and must use the precise and strong database. This chapter was divided as below into Section 2.2 Type of Solar Panel, Section 2.3 Type of Water Motor Pump, Section 2.4

Type of Microcontroller, Section 2.5 Type of Charge Controller, Section 2.6 Type of Sensor, Section 2.7 Type of Battery, Section 2.8 Type of Switch.

2.3 Type of Solar Panel

2.3.1 Monocrystalline Solar Panel

Figure 2.1: Monocrystalline Solar Panel

Most photovoltaic cells are made of crystalline silicon because it is non-toxic, unlike cadmium or selenium. It also has high conversion efficiencies and makes up about 28% of the bark of terrestrial plants in the form of compounds (silicates and silica), making it a source that is almost impossible to run out of.

When exposed to light, the semiconductor solar cell is a device that sends an electric current to an outside load. The way it works is when a photovoltaic cell is exposed to sunlight, the energy of the photons that pass through the cell and into the junction is transferred to the atoms of the junction. If this energy is high enough, it can move the electrons from the valence band to the conduction band of the semiconductor material, making electron-hole pairs.

Then, an electric field, which is a potential barrier, keeps the electrons (which have N charges) and the holes (which have P charges) apart. If a charge is put across the cell, the

electrons in zone N connect to the holes in zone P through the external connection. This creates a potential difference, which makes an electric current flow.[7]

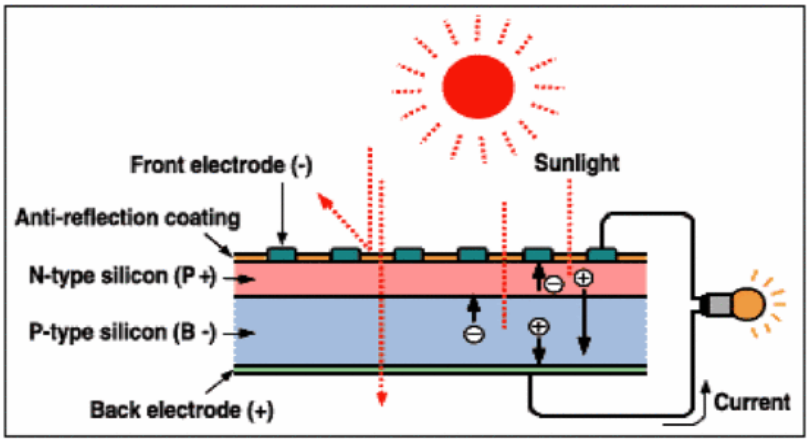


Figure 2.2: Cross-section of Monocrystalline Solar Panel

Monocrystalline solar panels contain monocrystalline solar cells. The term comes from a cylindrical silicon ingot made from high purity single-crystal silicon. As a single crystal cell, electrons have greater space to move, improving electrical flow. Ingots are broken into wafers and assembled into cells. Circular wafers are wire-cut into octagonal shapes to improve cell usefulness.

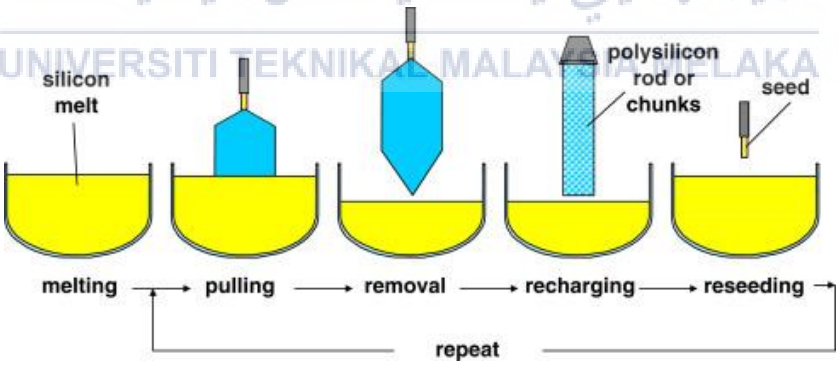


Figure 2.3: Czochralski method

Monocrystalline solar panels are built differently. Each solar cell has a single-crystal silicon wafer. The Czochralski procedure requires inserting a 'seed' crystal in liquid pure silicon at a high temperature. Molten silicon produces a single crystal around the seed. The ingot is