

# Faculty of Electrical and Electronic Engineering Technology



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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**Bachelor of Electronics Engineering Technology (Telecommunications) with Honours** 

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# DEVELOPMENT OF IOT-BASED POWER OUTAGE MONITORING SYSTEM WITH RENEWABLE ENERGY INTEGRATION FOR SMART AGRICULTURE

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A project report submitted in partial fulfillment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours



# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

#### **DECLARATION**

I declare that this project report entitled Development of IoT-Based Power Outage Monitoring System with Renewable Energy Integration for Smart Agriculture 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.



# 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 Electronics Engineering Technology (Telecommunications) with Honours.

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Date :

#### DEDICATION

This research is devoted in its whole to my dear parents who have continuously provided their moral, spiritual, emotional, and financial support, served as my sources of inspiration and strength when I felt like giving up.

To all of family members, friends, and classmates who offered their support and encouragement in order for me to complete my study. Finally, I would want to express my gratitude to the Almighty God for providing strength, mental power, protection, skills, and a long and healthy life to complete this project's thesis.

![](_page_4_Picture_3.jpeg)

#### ABSTRACT

Nowadays, living without electricity seems unimaginable, our existence would be impossible without the electricity supply from residential areas to industrial activities. However, heavy consumption of electricity can result in power outages, hence making the operation of the smart agriculture system, for instance to be inefficient. Besides, power failure can cost a lot of damage to production. Furthermore, unexpected power outages can also cost a thousand dollars in lost revenue. Since most of the current power failure events cannot be reported in time, therefore, in this work, an IoT-based Power Outage Monitoring System with Renewable Energy Integration has been developed for Smart Agriculture System. In this work, a solar energy is used to power up microcontroller in ESP32 while a current sensor is used to detect the presence of the current flowing to power up the electronic devices. Blynk application is used where the monitored data, such as the current value obtained from the current sensor, will be uploaded and updated to the Blynk server from time to time for monitoring purposes.

#### ABSTRAK

Pada masa kini, hidup tanpa elektrik tidak dapat dibayangkan, kewujudan kita tidak mungkin tanpa bekalan elektrik dari kawasan perumahan kepada aktiviti perindustrian. Walau bagaimanapun, penggunaan elektrik yang banyak boleh mengakibatkan bekalan elektrik terputus, justeru menjadikan operasi sistem pertanian pintar, contohnya menjadi tidak cekap. Selain itu, kegagalan kuasa boleh menyebabkan banyak kerosakan kepada pengeluaran. Tambahan pula, gangguan bekalan elektrik yang tidak dijangka juga boleh menyebabkan kehilangan hasil beribu-ribu dolar. Memandangkan kebanyakan peristiwa kegagalan kuasa semasa tidak dapat dilaporkan tepat pada masanya, oleh itu, dalam kerja ini, Sistem Pemantauan Gangguan Kuasa berasaskan loT dengan Integrasi Tenaga Boleh Diperbaharui telah dibangunkan untuk Sistem Pertanian Pintar. Dalam kerja ini, tenaga suria digunakan untuk menghidupkan pengawal mikro ESP32 manakala sensor arus digunakan untuk menghidupkan di mana data yang dipantau, seperti nilai semasa yang diperoleh daripada sensor semasa, akan dimuat naik dan dikemas kini ke pelayan Blynk dari semasa ke semasa untuk tujuan pemantauan.

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First and foremost, All Praise be to Allah for all the good health and strength that He has showered upon me. With His countless blessings, I was able to accomplish and committed fully to this project.

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Finally, I'd like to thank my family for their encouragement, support, and prayers for me during my studies. Not to mention my thankfulness to my close friends for constantly providing me with motivational thoughts.

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![](_page_12_Picture_1.jpeg)

# LIST OF SYMBOLS

- $\Omega$  ohm
- μ micro

![](_page_13_Picture_3.jpeg)

# LIST OF ABBREVIATIONS

V - Voltage

![](_page_14_Picture_2.jpeg)

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![](_page_15_Picture_2.jpeg)

#### **CHAPTER 1**

#### **INTRODUCTION**

#### 1.1 Background

Electricity is the most amazing and life-changing in human invention and it has contributed to the reduction of darkness and the development of human activity. Electricity is frequently used in factories, schools, and hospital hence benefit everyone. Nowadays, living without electricity seems unimaginable, our existence would be impossible without the electricity from home to industrial activities. However, heavy consumption of electricity can result in power outages and make things more difficult to operate.

A power outage is a temporary or permanent loss of electric power in a specific area or segment of a power grid. Depending on the extent of the damage caused by the outage, it could affect a single house, a single building, or a whole city. A power outage is also known as a power loss, or blackout. In other words, it is the interruption of an end user's electrical power network supply [1].

There are many factors that need to be examined to determine the system's constraints and to identify the most efficient strategies for resolving problems [2]. Therefore, this prevention strategy can also improve the system stability, reliability, and security of the system. In this work, an IoT-based Power Outage Monitoring System with Renewable Energy Integration has been developed for Smart Agriculture System. Moreover, a solar energy is used to power up the system with microcontroller in ESP32 while a current sensor is used to detect the presence of the current flowing to power up the electronic devices. Blynk application is used where the monitored data, such as the current value obtained from the

current sensor, will be uploaded, and updated to the Blynk server from time to time for monitoring purposes.

#### **1.2** Problem Statement

Inappropriate load voltage, voltage collapse, voltage instability in transmission networks, dynamic or static stability loss, multiple tripping of overloaded lines, and other factors are among the causes of power system blackouts. Unexpected power outages and blackouts have a huge impact on businesses in the affected areas. When an unexpected power outage happens, it will affect and cause high cost and financial burden on the industries due to delays in productions. Besides, the backup generators require continuous maintenance and testing to ensure they will work in the event of a power outage [3].

Moreover, in a smart agricultural system, a power outage may affect the growth of the plants, hence reducing the quality of the plants. This is because, in a smart agricultural system, the power supply is important. If the power failure is not solved in time, it will affect or even generate serious economic losses to Smart agriculture system [4]. However, due to power outages, report cannot be on time and there is no back up due to this power loss situations. Therefore, in this work an IoT-based power outage monitoring system with renewable energy integration for a smart agriculture system has been proposed. A current sensor is used to detect the presence of the current flowing to power up the electronic devices. The system is also integrated with the cloud servers where the current values flow

to the electrical devices will be updated and stored in the cloud using BLYNK applications for monitoring purposes.

# **1.3 Project Objective**

The objectives of this work are as follows:

- a) To develop an IoT-based Power Outage Monitoring System with Renewable Energy Integration to monitor the power outage event for Smart Agriculture system.
- b) To develop a data logging system using Blynk application to update and store the status of the monitored devices.
- c) To evaluate the performance of the developed system in terms of its reliability.

# 1.4 Scope of Project

The scope of this project are as follows:

- a) Development of IoT-Based Power Outage Monitoring System with Renewable UNVERSITITEKNIKAL MALAYSIA MELAKA Energy Integration will be proposed for Smart Agriculture system.
- b) A current sensor will be used to detect the power outage of the system.
- c) The status of the power system will be updated in the cloud server via Blynk application every seconds for monitoring purposes.
- d) ESP32 will be used as a controller to control the overall system.

#### **CHAPTER 2**

#### LITERATURE REVIEW

#### 2.1 Introduction

In the past few years, there have been a lot of large-scale power outages all over the world. Most of the time, these accidents are caused by one or more faults that lead to a chain of other faults. Cascading failures in the power system happen when one part of the system breaks down, which then causes other parts to break down [1].

Power systems should be able to offer consumers with uninterrupted electricity supply under all conditions. However, because the networks cover such a broad geographical area, they are susceptible to a variety of defects. Moreover, extreme transmission failures resulting in blackout are caused by tripping of transmission lines due to short-circuit faults and protection device failures in lines. Additionally, generation failures are caused by generator overloading, which leads in a loss of power, as well as substation failures, voltage, and frequency instabilities, which result in power outages [5].

Since most of the current power failure event cannot be reported in time, therefore this project using Renewable Energy to generate power from a solar to powered up microcontroller in ESP32 and update the current values flowing from the electronic devices into cloud monitoring system to prevent further losses and troubleshooting. Therefore, this chapter provides an elaboration on the related previous past work causes of power outages and a few studies focused on the development of IoT-Based Power Outage Monitoring

System. The previous past research on the Renewable Energy for Smart Agriculture is also elaborated on this chapter.

## 2.2 Impacts and Causes of Power Outages

A temporary outage of the power supply will cause absolute chaos and disruption to many sectors. The lack of power supply and power interruptions cause industrial to experience rising economic damage. The economic loss of power outages must be analyzed in many circumstances, including power system design, economic and reliable operation of power systems.

As a result, one of the most essential phases to resolving the power loss problem is to ensure that the electrical system has blackout protection [6]. The major goal of a modern and developed electric power system is to supply clients with more economical, sustainable, and secure electricity. In this era of advanced technology, consumers believes that reliability mean consistent and high-quality electric power. When improving electric power reliability, more customers can receive the benefits.

To overcome this power outage issue there are several things that need to be done to limit disruption, including investigations, corrective actions, increased monitoring, diagnostics, and improved control center performance [7].

Another reason of this power shortage is when big loads are suddenly disconnected, and transmission lines are tripped due to system faults. The unstable power needed to be detected quickly, or else electrical equipment could be damaged and distance relay operations could be affected [8].

Next, because the modern society's operation is dependent on energy, longer blackouts cause widespread delays that lead to instability, including traffic disruptions, medical system failures, water supply and sewer system service interruptions, payment difficulties, and security system risk. As a result, the energy grid's resilience should be constantly maintained to increase its reliability [9].

In the case of a disturbance, power systems must maintain stability and assure continuous power delivery. As the power system spans broad regions, faults and breakdowns are common then unpredictable flaws and cascades occurrences can cause blackouts that disrupt modern living. In power systems, the most critical quantities to control are frequency, voltage, and rotor angle of synchronous generating units. Demand and generation imbalances impact frequency stability, while reactive power imbalances affect voltage [10]

In [11], reliability of power supply reflects the power grid system's continuous delivery capacity and is a quality measure. Power supply reliability can be determined by average user power outage times. The paper [12], [13] examines the shortcomings of the prior setting scheme for under-frequency load-shedding and automatic switching devices, particularly when large power shortages occur in an unstable network. The suggested technique intends to prioritise maintaining the unit's safety, improve the protection coordination scheme to achieve optimal unit safety, and assure the power supply's operation with zero loss.

The shortage of electricity supply and power interruptions cause rising economic loss for users. The economic loss of power outages must be evaluated in several situations, including power system planning, the economic and reliable operation of power systems, and the planning of power systems [14].

The failure rate of these power supply modules has increased. The expense of replacing failed power supply modules with new power supply modules will be considerable. To cut costs, efforts have been made to spend manpower in failure analysis and maintenance of failure modules, as well as collect a large amount of data in continuous repairing and preventative maintenance work [15].

In [16], transmission and generation outage data may be utilised to evaluate previous system performance or anticipate future system performance. A typical power flow case, load data, corrective measures accessible in the system, operational strategies, and component reliability indices computed from outage data are used to evaluate the predictive reliability of an electric power system in conceptual terms.

Lastly, companies operating in the impacted areas suffer a large loss of revenue due to power disruptions. Companies that using manual or automatic power backup may lose production hours when switching to it, resulting in production and revenue losses due to missed deadlines, unproduced and unsold products [17].

#### 2.3 Power System Blackouts

Several power systems blackouts have occurred all around the world which affected millions of people during the shortage of energy. In 2012, there was a 15-hour power outage that affected about 620 million residents of the north and east of India [8] The blackout was caused by the overloading of one of the 400 kV Gwali–Binar transmission lines, while the other transmission line was unavailable for maintenance. The system failed again the next day due to an imbalance between demand and generation, and about 32 GW of energy was disrupted affecting around 700 million people. This power outage affects the largest number of people ever recorded [5].

Next, in 2014, the Bangladesh Power System (BPS) went down completely for about 24 hours when the High Voltage Direct Current (HVDC) station went down without being planned. The situation got worse because the spinning reserve did not work, and some generators did not get enough maintenance. After all the under-frequency load shedding (UFLS) stages were turned on, the total amount of load shed was less than the disturbance, which caused the blackout [8].

Meanwhile, in the June 2016 Kenya blackout, the cascading event began with the tripping of the transformer owing to the animal led on it. Following the initial causes, the plant's generator tripped due to overload, Giatru lost 180 MW (MegaWatt), and a voltage drop caused the following transmissions to trip [7].

![](_page_23_Figure_2.jpeg)

 Table 2.3.1 Major Electric Power System Blackout Causes[5]

	Table	2.3.2 Blac	ckout r	ound th	ne Globe	[5]	1. ·
1.1.1.1.1.1.1.1			C & X & X		A 1 1 1 1 1 1		A 1.7 A

I I I'V I V I I'V I'V I'V I'V I'V I'V I'	III IM KIIKAI BAALAYSI/	X B.A has 1 7X htt 7X
Region	Number of Power Outages	Duration of Each Power Outage
East Asia and Pacific	200	6.00
East Europe and Central Asia	100	6.50
Latin America and Caribbean	40	8.00
Middle East & North Africa	50	4.00
South Asia	1200	2.50
Sub Saharan Africa	210	7.50
The Rest of The Countries	250	5.00

#### 2.4 Introduction to Internet of Things (IoT)

The Internet of Things (IoT) connects computer devices embedded in everyday things to the Internet so that it can transmit and receive data. By using IoT, it is empowering the computers to acquire information about surrounding without relying on people to minimize excess, loss, and waste by analyzing the information collected. Moreover, IoT enables interaction between the physical and digital worlds. Sensors and actuators allow the digital and physical worlds to interact. These sensors gather data that must be stored and analyzed. Data processing might take place at the network's edge or on a distant server or cloud [18].

Manufacturers are embedding sensors in their devices' components so that they may transmit data regarding their performance. This can assist businesses in determining when a component is likely to break and replacing it before it causes damage. Companies may also utilize the data collected by these sensors to improve the efficiency of their systems and supply chains because they will have much more precise information about what is going on [19].

Additionally, given the ever-increasing number of connected devices, IoT continues its path of progress, adding new layers to the data that is already being processed and shared, and giving rise to complex algorithms that result in higher levels of automation. And because of the range of "things" that may be connected to it, the Internet of Things has enabled numerous applications for both individual users and large companies [20].

To be specific, in [21] applications of the IoT are not restricted to just one industry. It has demonstrated a substantial contribution from applications operating on a small scale to applications operating on a big scale, including as e-commerce, wearable devices, smart grids, laboratory monitoring, and agriculture.

#### 2.5 Cloud-based IoT Monitoring Application

In [22], the author focuses on Cloud-based IoT platform for power system real-time data storage, processing, and display. A power backup monitoring and logging system for Emergency Power Systems (EPS) decreases the danger of power outages. The reason for doing this system is because failure to provide regular maintenance to the EPS may result in disruption due to malfunctioning. Monitoring and logging systems are helpful in the reduction of such incidents. It monitors the EPS log based on selected criteria such as voltage, current, temperature, and load, and provides warnings if any of the selected parameters exceeds its safe range. EPS is widely utilised by industries all over the world to provide a smooth operation without the impact of power outages.

As cloud computing comprises the availability of IT resources via the internet, cloud computing is an appropriate option that provides unlimited storage and processing capacity due to the cloud's features and the demand to process and manage the collected data from the sensors [23]. To sum up, the author in [24] states that cloud computing is a methodology for providing on-demand network access to a shared pool of programmable computing resources that can be instantly supplied and released with no administration effort or service provider contact. Using cloud computing technology as an application for important facilities such as electrical power plants to evaluate equipment condition, detect future problems remotely and allow for the early detection of machine failure.

#### 2.6 Renewable Energy

Renewable energy refers to energy from natural sources that are continuous and easily accessible such as wind and sunlight. However, global warming and other global pollution are boosting the need for renewable energy technologies since it is less damaging to the environment. For this reason, implementing renewable energy as an alternative source for the industrial sector is beneficial since fossil fuels destroy natural environments and cost a lot of money [25].

As the amount of renewable energy continues to rise, the challenge of accommodating renewable energy becomes more significant, and the variability of renewable energy poses a danger to the safe and stable functioning of the power system. In recent years, energy storage has grown significantly as an efficient way to encourage renewable energy integration and enhance system flexibility [26].

Moreover, our fossil fuel supply is decreasing. This is due to the increasing energy consumption and manufacturing demands which have led to fossil fuel overuse. The increasing energy consumption has also increased carbon emissions, the main greenhouse gas. Therefore, switching to renewable energy sources is crucial to sustainable future growth for all countries, especially those dependent on coal, oil, and gas. On the other hand, energy like solar, wind, and hydroelectric power can complement energy and become the dominant source [27].

The growth rate of alternative renewable energy sources was as high as 16.64 percent, which was about 11 times faster than the yearly growth rate of consumption of fossil fuels, indicating a strong growth pattern. The framework of the growth of renewable energy

sources such as wind, solar, biomass, geothermal, and hydrogen energy varies from nation to country. China's renewable energy offers a great deal of space for expansion [28].

Author in [29], due to rising global energy consumption and a lack of fossil resources, the energy crisis is a global concern. Many countries have worked to deal with these issues. Renewable Energy Source are an appropriate and efficient answer. Renewable energy is clean energy obtained from naturally replenished sources or processes. It is really considered as a future energy source. Renewable energy sources generate 15 to 20% of the world's energy. Since 2011, Renewable Energy has grown rapidly and increased in 2019.

Renewable energy power plants may achieve primary frequency control in two ways which is reserve power and Energy Storage System (ESS). Reserved electricity will lead to photovoltaic (PV) power abandon. Energy storage providing main frequency control for the system will play a vital role in the future smart grid [30].

#### 2.6.1 Solar Energy

Solar energy is produced by capturing the radiant energy of the sun and transforming it into heat and electricity. The advantage of solar energy is that sunlight is unlimited and helps to enhance public health and the environment instead of fossil fuels. Moreover, in many countries, the governments are also provided subsidies to encourage industries to use solar energy [31]. Solar power generation is characterized by volatility, and its largescale access will have a large impact on the safe and stable operation of the power grid.

#### 2.6.2 Wind Energy

Wind energy generates electricity by turning wind turbines. The wind pushes the turbine's blades, and a generator converts this mechanical energy into electricity. This electricity can supply power to homes and other buildings, and it can even be stored in the

power grid. Wind energy is a clean energy source since it does not produce carbon dioxide or other harmful pollutants that destroy the environment or have a negative effect on human health, as compared to smog, acid rain, or other greenhouse gases [31].

However, due to in comparison to other nations, Malaysia is described as having a low wind speed region. Because Malaysia's average yearly wind speed is under 2 m/s, wind energy has yet to be properly harnessed, as most wind turbines need a minimum wind speed of 4 m/s to generate power [32].

![](_page_28_Picture_2.jpeg)

# 2.7 Summarization of Past Related Paper

This subsection presents the works that had been done by previous researchers that relate on the development of the power outage monitoring system. Moreover, the summarization of work that considered the use of renewable energy in their system also presented.

# 2.7.1 Power Outages

Reference	Reliability	Stability	Real-time	Accuracy	Security	Efficiency
[6]	Str. W. LANAL	A ANEL				√
[7]	7	NA.				~
[9]	✓ 📃			<b>H</b>		
[10]	Samn .	$\checkmark$				
[11]	سبا ملاك	کل ملہ	تنكن	تى سىن	اونير	
[12]						
[13]	NIVEROIT		AL MALA	OTA MEL	1	
[14]		$\checkmark$				~
[15]						~
[16]	~					
[17]	1				~	~
This work	1					

Table 2.7.1 Summarization of Related Paper in Power Outage

# 2.7.2 Renewable Energy

Reference	Energy store	Optimizing	Stability	Reliability	Efficiency
[33]	$\checkmark$				$\checkmark$
[27]		$\checkmark$		$\checkmark$	
[28]				~	
[29]			$\checkmark$		
[30]	$\checkmark$			~	
This work	MALAYSIA			~	

Table 2.7.2 Summarization of Related Paper in Renewable Energy

2.8 Summary

There are many techniques that have been proposed to design an reliability for both Power Outages and Renewable Energy Source. Each of them has its own advantages and drawback, which is refined in this chapter. In this work, reliability of the power outage in a Smart Agriculture is studied.

#### **CHAPTER 3**

#### **METHODOLOGY**

#### 3.1 Introduction

According to definition of methodology in English from the Oxford dictionary, methodology is described as a set of approaches used to explore the concept or theories in a certain subject of research or activity. This chapter provides an outline of how the task is performed, starting from the beginning to the last step involved in the development of IoTbased Power Outage Monitoring System with Renewable Energy for Smart Agriculture.

## 3.2 Methodology

A flowchart is essential to explaining the sequence of steps required to complete the project. It makes use of symbols to describe a process. Each phase in the process is represented by a different symbol and includes a brief explanation of the step. As seen in Figure 3.1, the project flow must began with proper planning of how the project would be performed including literature review, conceptual design, concept evaluation, choose finalize concept, material selection and fabrication process in earlier processes. Therefore, planning is necessary as the initial stage to keep this project on track. Next, do several tests to determine that this concept is viable. After the testing has been confirmed, the process of finishing and report writing research data and materials for this project begins. Lastly, the analysis and result can be done.

![](_page_32_Figure_0.jpeg)

Figure 3.2.1 The project flow chart

The purpose of these flow diagrams is that it provides a visual depiction of a project that makes it simpler to monitor its development and ensure that tasks are produced and allocated, activity and performance are monitored. In addition, this project flow makes it easier to understand the project methods and how to apply them to this project that must be completed by a specific deadline.

#### 3.2.1 Experimental setup

The flowchart in Figure 3.2 serves as the basis for this project's process. The IoTbased monitoring system for power outages includes two scenario. Firstly, the system begins with the detection of the current. If a current is detected by current sensor, the system will keep continue check the status of device and reported to cloud server every seconds.

If the current is not detected, a notification will be sent through the BLYNK application and the status of the device such as power down will be updated in the server. This process will be continuosly looping.

![](_page_33_Figure_4.jpeg)

Figure 3.2.2 Flow Chart

#### 3.2.2 Block diagram

A block diagram is a graphical representation of a system used in software engineering or graphical programming languages. This diagram function helps in understanding the functions and relationships of two or more variables. Also, block diagrams describe complex systems in simple terms.

The process of this project, as shown in block diagram, begins the sunglight energy that has been absorbs by solar panel and then solar panel convert sunlight into electrical energy. Next, a solar charge controller used to regulates and controls the output from the solar PV array to charge the battery. It also protects the battery from being overcharged or overdischarged. Therefore, from battery, it will be used to power up the microcontroller in ESP32 Wi-Fi Module. At the same time, the current sensor SCT-013 will operates and sensing the currents and upload the data to the cloud server. Lastly, loads are used to ensure that the current is present in order to monitor the system's performance.

![](_page_34_Figure_3.jpeg)

Figure 3.2.3 Block Diagram

#### **3.3 Project Implementation**

In this subtopic, we discuss the project that has been proposed to improve effectiveness of implementing the project so that it can function effectively. The research that was conducted in Chapter 2 in order to meet the desired project scope have been used as the basis for this project's concept.

#### **3.4 Hardware Equipment**

Hardware is needed to perform this project properly. It is utilised to be demonstrated to the success of the software. Hardware also refers to performing major functions such as input, output, storage, communication, and processing. Therefore, each component is listed under this subtopic.

Solar technologies use photovoltaic (PV) panels or mirrors to concentrate solar radiation to convert sunlight into electrical energy. This energy can be converted into electricity or stored in batteries or thermal storage.

The photovoltaic effect operates by Sunlight reaches the solar cells, energising and starting electrons in motion. Electrons then flow out of the junction between cell layers, generating an electrical current. Metal plates and wires capture electron flow and generate energy. This project using the solar energy 12 Volt 20 Watt as an alternative to power supply so it can provide energy to turn on the microcontroller in ESP32.

![](_page_36_Figure_1.jpeg)

#### 3.4.2 Solar Charge Controller

A solar charge controller regulates and controls the output from the solar PV array to charge the battery. It also protects the battery from being overcharged or overdischarged. Overcharging the battery causes the electrolyte to produce hydrogen and oxygen gases that might result in an explosion and failure.

During the day, the solar charge controller prevents the solar PV array from overcharging the batteries. A current will flow from the battery to the solar panels throughout the night, when the solar panels are not active and have zero voltage. Therefore, to limit the reverse flow of power from the battery to the array during low solar irradiance or at night, the solar charge controller incorporating a blocking diode or relay. As a result, batteries are not drained during the day and that power is not returned to the solar panels overnight, which

would degrade the batteries. In this work, a solar charge controller is used to protect battery from overcharging.

![](_page_37_Picture_1.jpeg)

#### 3.4.3 Battery 12V 7.2Ah Lead Acid Battery (SLA)

Figure 3.4.3 Battery 12V 7.2Ah

The most common type of general purpose battery is the rechargeable Seal Lead Acid (SLA) battery. SLA benefits include low cost, strong, and low maintenance. However, it is considered hefty weight for some robotic applications. To charge SLA batteries, it can be using any normal Dirent Current power supply as long as it supplies the necessary voltage to the battery. The battery is used in the proposed develop system to power up the microcontroller in ESP32.

## 3.4.4 ESP32 Wi-Fi Module

![](_page_37_Picture_6.jpeg)

Figure 3.4.4 ESP32 Wi-Fi Module

The ESP32 is a flexible System On a Chip (SoC) that can function as a general microcontroller that including WiFi and Bluetooth wireless capabilities. The ESP32 supports two WiFi modes: Moreover, ESP32 functions similarly to a computer that is linked to router. If the router is linked to the Internet, then ESP32 can connect to the Internet as well. In this work, WiFi module is used to transfer data from the develope IoT board to the blynk server.

Function	Description
Wi-Fi	802.11 b/g/n/e/i (802.11n @ 2.4 GHz up to 150 Mbit/s)
Bluetooth	v4.2 BR/EDR and Bluetooth Low Energy (BLE)
Memory	ROM: 448 KB – For booting and core functions SRAM: 520 KB – For data and instruction
Embedded flash	0 MB (ESP32-D0WDQ6, ESP32-D0WD, and ESP32-S0WD chips) 2 MB (ESP32-D2WD chip)
ملاك	4 MB (ESP32-PICO-D4 SiP module)
Security UNIVE	IEEE 802.11 standard security features all supported, including WFA,
	WPA/WPA2 and WAPI, Secure boot and Flash encryption

Table 3.4.1 Function of ESP32 Wi-Fi Module

## 3.4.5 SCT-013 100A

![](_page_38_Picture_4.jpeg)

Figure 3.4.5 SCT-013 100A

This SCT-013 current sensor that slso known as a split core current transformer may be clamped around an electrical load's supply line to measure the current flowing through it. This SCT-013 operating as an inductor and reacting to the magnetic field generated by a current-carrying wire. In this work, this current sensor is used to detect the current that flow into an electronic device.

![](_page_39_Figure_1.jpeg)

![](_page_39_Figure_2.jpeg)

Stripboard features parallel copper track strips on one side. The tracks are sized 0.1"

(2.54mm) apart, with holes every 0.1". (2.54mm). Stripboard is a type of circuit board that is used to create strong soldered circuits. It is ideal for tiny circuits with one or two integrated circuits (chips). A stripboard with a dimension of 2.5cm x 2.5cm is used to solder the circuit.

#### 3.4.7 Jumper Wire

![](_page_40_Picture_1.jpeg)

Figure 3.4.7 Jumper wire

Jumpers are metal connectors that are used to seal or open a circuit component that has two or more connections that control an electrical circuit board. Furthermore, jumpers are used to connect two points in a circuit without using solder. Male-to-male, male-tofemale, and female-to-female jumper wires are the most common.

![](_page_40_Picture_4.jpeg)

Figure 3.4.8 Plug socket

Plugging appliances into electrical sockets allows user to connect them to the electrical grid and provide them with the electricity they require to function. This work uses a 240V supply voltage and a frequency of 50Hz.

#### 3.4.9 Mini Fan

![](_page_41_Picture_1.jpeg)

Figure 3.4.9 Mini Fan

Any component of a circuit that uses power or energy is referred to as an electrical load. The most common examples of electrical loads are light bulbs and appliances. A load on a circuit is defined as any resistor or electric motor in a circuit that transforms electrical energy into light, heat, or useful motion. In additionally, loads are used to indicate a device or a group of devices that consume electrical energy, to demonstrate the power required from a set supply circuit. Lastly, the electrical load represents the amount of current or power flowing through the line or equipment. In this work, a mini fan an the electronic device to test our IoT-Based Monitoring Power Outage develope system.

3.4.10 Resistor 10k ohm

![](_page_41_Picture_5.jpeg)

Figure 3.4.10 Resistor 10k ohm

Resistors are used in electronic circuits to restrict current and supply just the needed biassing to active elements such as transistors and integrated circuits. These 10k ohm resistors work well as current limiters, pull-ups, and pull-downs.

#### 3.4.11 Capacitor

![](_page_42_Picture_2.jpeg)

Figure 3.4.11 Capacitor 10uF

An electrical device known as a capacitor is one that stores and releases electrical energy into a circuit. Instead of putting direct current into the circuit, it actually transmits alternating current. Since it is a necessary component, it may be found in basically in every electrical circuit. This 10uF 50V capacitor is a top-notch electrolytic capacitor with radial polarisation. Power supplies, DC-DC converters, and switched-mode power supply all often employ electrolytic capacitors. Also, this capacitor offers a large working range, a long life, and low leakage current.

![](_page_43_Figure_1.jpeg)

Figure 3.4.12 Blynk Application

The Blynk platform is a mobile phone applications which enables user to develop interfaces for projects using a variety of widgets. For this purpose, all communications between the smartphone and hardware are handled by the Blynk Server. Users can use Blynk server locally or utilise Blynk Cloud. This application is open-source able to manage thousands of devices. All of the primary hardware platforms' Blynk Libraries are able to communicate with the server and handle all incoming and outgoing commands. In this work, Blynk server is used to store the monitor current value from current sensor that is attached to the electronic device.

#### 3.5 Limitation of proposed methodology

The limitation of this project is the weather conditions which will affecting the result and the power back up to the system since it is use Renewable Energy to power up the

system. Moreover, the limitation is this project are only focus on indoor building for smart agriculture.

# 3.6 Summary

This chapter shown the equipment and devices used to develop the proposed IoT-Based Power Outage Monitoring System with Renewable Energy Integration for Smart Agriculture to achieve the objectives. An easy-to-follow flowchart decribes the project's workflow, making it easy to follow along.

![](_page_44_Picture_3.jpeg)

### **CHAPTER 4**

#### **RESULTS AND DISCUSSIONS**

#### 4.1 Introduction

The result and analyses of the development of IoT-based Power Outage Monitoring System with Renewable Energy for Smart Agriculture are represented in this chapter. Several studies and testing have been conducted to demonstrate the proposed system technique. The circuit, result and analysis are shown in this chapter.

#### 4.2 Design of Project Circuit

AALAYSIA

Figure below shows the order of components in the circuit. It includes all the components that have been described in Chapter 3.

![](_page_45_Figure_6.jpeg)

Figure 4.2.1 Schematic Diagram

#### 4.2.1 Prototype

This subtopic displays the hardware prototype and the devices discussed in previous chapter. It demonstrates how the hardware and devices are connected altogether, how they are arranged, and how they combine to produce the finished product. This prototype consists three part which is the renewable energy solar power, the soldered circuit and the extension.

![](_page_46_Figure_2.jpeg)

Figure 4.2.3 Renewable Energy Solar Power

This section is called as renewable energy, which is used solar panel, solar charge controller and 12V 7.2h battery. This section's major purpose is to turn on the ESP32 Wi-Fi Module's microcontroller so that it may function to transfer data to a cloud server.

# 4.2.3 Soldered Circuit

![](_page_47_Picture_1.jpeg)

Figure 4.2.4 Soldered Circuit

The connection of diagram is straightforward. The micro usb cable is supply 5V to power on the ESP32 from solar charge controller. The ESP32's GND is wired to the capacitor's GND pin. The SCT-013 Current Sensor's output analogue pin is then attached to ESP32's GPIO18. A 10uF Capacitor and two 10K resistors must be connected in this circuit.

4.2.4 Extension

![](_page_47_Picture_5.jpeg)

Figure 4.2.5 Extension

In addition to the circuit, the SCT-013 current sensor is attached to the AC cables where the current and voltage should be detected. As seen in the diagram above, the current sensor clip is unconnected, and a single live wire is placed inside the clip part to determine the load's current.

![](_page_48_Figure_1.jpeg)

## 4.3 Result and Analysis

4.3.1 Testing in terms of realibility

![](_page_48_Figure_4.jpeg)

Figure 4.3.2 Current values every 2 minutes in 1 hour duration

![](_page_49_Figure_0.jpeg)

![](_page_49_Figure_1.jpeg)

![](_page_49_Figure_2.jpeg)

Figure 4.3.4 Current values every 6 minutes in 1 hour duration

The result in Figure 4.3.2, 4.3.3 and 4.3.4 shows the performance of the developed IoT-based Power Outage Monitoring system with Renewable Energy Integration, has been evaluated in terms of its reliability through several experiments. The results show that the

developed system has 100% reliability in detecting and updating the monitored current data in the Blynk server from time to time when there is no power outage event occurs. Figure 4.3.2 shows the value of the monitored current value every 2 minutes. Figure 4.3.3 shows the value of the monitored current value every 2 minutes and Figure 4.3.4 shows the value of the monitored current value every 6 minutes.

#### 4.4 Summary

This chapter demonstrates the applicability of the proposed IoT-based Power Outage monitoring system with renewable energy for smart agriculture using a solar to power up the system, ESP32 as microcontroller and current sensor to evaluate the performance of the developed system in terms of its reliability.

![](_page_50_Picture_3.jpeg)

#### **CHAPTER 5**

#### CONCLUSION AND RECOMMENDATIONS

#### 5.1 Conclusion

The developed IoT based Power Outage Monitoring System with Renewable Energy Integration System has been developed using the ESP32 as the microcontroller. A solar panel is used in this work to power up the microcontroller. Meanwhile, a current sensor is used in the system to detect and read the value of current supplied to the electronic devices. The system is integrated with the Blynk application where all the monitored data which is current values will be updated from time to time. The result shows that, the developed system can detect the presence of the current and updated the value of the current in the Blynk server from time to time with 100% reliability.

## 5.2 Future Works

The future work for this work is presented as follows: AYSIA MELAKA

- i. The future work will consider the optimization of other parameters such as cost and stability in system.
- Build a large-scale power outage monitoring system in indoor Smart Agriculture.
- iii. The future work will design a new method for Power Outage monitoring systems.

# 5.3 **Project Potential**

This system potential is made for industrial sector, agriculture sector and manufacturing sectors that used electronic devices and machines to run their business. This system can help them to monitor the power outage event to avoid lost revenue.

![](_page_52_Picture_2.jpeg)

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# APPENDICES

# **APPENDIX A CODING**

MALAYSIA
#define BLYNK_PRINT Serial
#include <wifi.h></wifi.h>
<pre>#include <wificlient.h></wificlient.h></pre>
#include <blynksimpleesp32.h></blynksimpleesp32.h>
اونيوبرسيتي تيڪنيڪل مليسيا ملاك
#include <wire.h>IVERSITI TEKNIKAL MALAYSIA MELAKA</wire.h>
#include "EmonLib.h"

EnergyMonitor emon1;
char auth[] = "8d7kBkheGbvhG9KakQP11fJLLtVv9oi-";//Enter your Auth token
char ssid[] = "";//Enter your WIFI name
ST TO THE REPORT OF THE REPORT
char pass[] = "";//Enter your WIFI password
BlynkTimer timer;
void setup() {
Serial.begin(9600);
emon1.current(35, 56.1); // input pin, calibration sensor.
Blynk.begin(auth, ssid, pass, "blynk.cloud", 80); KAL MALAYSIA MELAKA
timer.setInterval(100L,Sensor);

![](_page_58_Figure_0.jpeg)

# APPENDIX B Gant Chart

No.	PSM 1 Project Activity	Expected	Weeks														
		Actual	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Registration for PSM	Expected															
		Actual															
2	2 Final year project briefing	Expected															
		Actual															
3	Title discussion and decision with supervisor	Expected	4														
		Actual	A						-								
4	Study Related Research	Expected															
		Actual									T						
5	Complete Chapter 1: Introduction	Expected							_								
		Actual							E								
6	Progress Update to supervisor	Expected															
		Actual															
7	Complete Chapter 2: Literature Review	Expected		1		1											
		Actual	14	_	5.1	6	-		1		. *.	1.1.10					
8	Complete Chapter 3: Methodology	Expected			10000			1	5.	- 4	72	2					
		Actual															
9	Submit report NIVER	Expected															
		Actual	:Kr	IK	AL	M		$\mathbf{X}$	<u>sia</u>	Mt	EL/	(K/					
10	Preparation for presentation	Expected															
		Actual															
11	Submit presentation video	Expected															
		Actual															
12	PSM 1 presentation	Expected															
		Actual															1

No.	D. PSM 2 Project Activity	Expected	Week														
		Actual	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Draft Material List	Expected															
		Actual															
2	2 Purchase Hardware	Expected															
		Actual															
3	Design Schematic and hardware coding	Expected															
	~	Actual	100														
4	Set up Hardware Circuit	Expected	N.														
		Actual	N.														
5	Analyse Result	Expected	Ą														
		Actual															
6	Complete Chapter 4:Result and	Expected															
	Discussion	Actual															
7	Complete Chapter 5:Conclusion	Expected							1								
		Actual															
8	Submit draft report	Expected															
		Actual		1			1										
9	Prepare Project Poster	Expected	0	4		. 6		2.5		a ch		ero.	0				
		Actual	0						5		1-	1	2				
10	Proparation for procentation	Expected							-								
	Preparation for presentation	Actual		( ). I I	100				101			A 1.4					
11	Presentation	Expected	E	IN	N.F		MA	LA	121		EL	AK	A				
		Actual															
12	Submit Final Report	Expected															
		Actual															