Faculty of Electrical Technology and Engineering

DEVELOPMENT OF PORTABLE BIOMASS ENERGY STORAGE WITH IOT MONITORING SYSTEM FOR DOMESTIC USAGE

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Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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DEVELOPMENT OF PORTABLE BIOMASS ENERGY STORAGE WITH IOT MONITORING SYSTEM FOR DOMESTIC USAGE

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I declare that this project report entitled "Development of Portable Biomass Energy Storage With IOT Monitoring 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.

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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 (Industrial Power) with Honours

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DEDICATION

I dedicate this project to the unwavering support and love of my family. Your encouragement has been my pillar of strength throughout this academic journey. To my parents, who have been my constant source of inspiration, and to my siblings, whose laughter has filled my study breaks with joy – thank you for being my rock.

I extend my heartfelt gratitude to my friends, who stood by me during the late-night coding sessions and challenging moments. Your camaraderie has turned the arduous task of completing this project into a memorable and enriching experience.

To my supervisor, your guidance and insights have shaped my understanding of the subject matter. Your patience and encouragement have been instrumental in my growth as a student and as an aspiring professional.

Lastly, I dedicate this work to the countless hours of dedication and perseverance that went into its completion. May this project serve as a testament to the lessons learned, challenges overcome, and the passion that fueled my pursuit of knowledge.

Thank you, everyone, for being a part of this incredible journey.

ABSTRACT

Biomass is a renewable organic material that can be produced from organic sources such as animals and plants. As a method of minimizing carbon dioxide emissions, there has been a shift from the use of fossil fuels to the use of biomass fuels in many industrialized countries. Biomass stores chemical energy derived from the sun. Photosynthesis produces biomass in plants. Various technologies may convert biomass into sustainable liquid and gaseous fuels, or biomass can be burnt directly for heat. The main purpose of this research is to implement the use of biomass energy into a portable power bank that can be used by everyone and to measure the output power produced by different types of biomass fuels. Various methods have been taken in conducting the research by referring to previous articles and research to further deepen the knowledge about this project. The method for this project uses a thermoelectric generator (hot side) supply will type of material biomass used, while the cold side will be chilled water in a metal tray. The TEG output will be stored in the lithium-ion battery. The results for this project are achieved when the green stove prototype can successfully charge electronic devices and can be monitored and controlled through electronic devices such as mobile phones. The different output power should be successfully produced and measured depending on the type of biomass fuels used during the testing. The expected of the result for voltage is 5V until 10V depending on type material of biomass uses. In conclusion, this research project can be learned and used in various industries or daily life as biomass has a lot of uses and benefits.

ABSTRAK

Biojisim ialah bahan organik yang boleh diperbaharui yang boleh dihasilkan daripada sumber organik seperti haiwan dan tumbuhan. Sebagai kaedah meminimumkan pelepasan karbon dioksida, telah berlaku peralihan daripada penggunaan bahan api fosil kepada penggunaan bahan api biojisim di banyak negara perindustrian. Biojisim menyimpan tenaga kimia yang diperoleh daripada matahari. Fotosintesis menghasilkan biojisim dalam tumbuhan. Pelbagai teknologi boleh menukar biojisim kepada bahan api cecair dan gas yang mampan, atau biojisim boleh dibakar terus untuk haba. Tujuan utama penyelidikan ini adalah untuk melaksanakan penggunaan tenaga biojisim ke dalam bank kuasa mudah alih yang boleh digunakan oleh semua orang dan untuk mengukur kuasa keluaran yang dihasilkan oleh pelbagai jenis bahan api biojisim. Pelbagai kaedah telah diambil dalam menjalankan kajian dengan merujuk artikel dan kajian lepas bagi mendalami lagi pengetahuan tentang projek ini. Kaedah untuk projek ini menggunakan bekalan penjana termoelektrik (sisi panas) akan jenis bahan biojisim yang digunakan, manakala bahagian sejuk akan air sejuk dalam dulang logam. Output TEG akan disimpan dalam bateri litium-ion. Keputusan untuk projek ini dicapai apabila prototaip dapur hijau berjaya mengecas peranti elektronik dan boleh dipantau dan dikawal melalui peranti elektronik seperti telefon bimbit. Kuasa keluaran yang berbeza harus berjaya dihasilkan dan diukur bergantung pada jenis bahan api biojisim yang digunakan semasa ujian. Jangkaan keputusan untuk voltan ialah 5V hingga 10V bergantung kepada jenis bahan kegunaan biojisim. Kesimpulannya, projek penyelidikan ini boleh dipelajari dan digunakan dalam pelbagai industri atau kehidupan seharian memandangkan biojisim mempunyai banyak kegunaan dan faedah.

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I am incredible to have loving and supportive parents who have always believed in me and encouraged me to pursue my dreams. Their unconditional love, unwavering support, and sacrifices have been the cornerstone of my academic career. I am also grateful to my extended family for their understanding, encouragement, and prayers. Their unwavering support and belief in my abilities have motivated me to overcome challenges and strive for excellence.

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$\delta\delta$	-	
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LIST OF ABBREVIATIONS

VV	-	Voltage
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CHAPTER 1

INTRODUCTION

1.1 Background

Renewable energy is a natural-type source of energy that can be used many times without worrying about it depleting as it can be replenished. For example, various types of energy such as wind and solar have been used for a long time to generate electricity for a lot of purposes.

Malaysia also has renewable energies that can be used such as wind, solar, and hydro. Solar energy is one of the biggest technologies that is being developed and used in the renewable energy industry in Malaysia. However, other renewable energy such as biomass can also be used as Malaysia is a country that is rich in plants and organisms.

Biomass energy is one of the renewable energies that are not finite and can be replenished. Energy is produced by living or dead organisms such as plants and animals. The process of producing biomass energy started from the energy provided by the Sun for plants through a process called photosynthesis which will be converted to carbon dioxide and water. After that, the energy from these organisms can be burned to produce electrical energy for various uses.

For project specifications, this project uses a cookstove to burn municipal refuse, dry leaves, and woody waste. The primary goal of the project is to use a biomass energy system to create power.

1.2 Addressing Global Warming Through Weather Sensing Project

Biomass technology is a renewable energy source that involves the use of organic materials, such as wood, crops, or agricultural waste, to produce heat and electricity. While biomass technology can provide a sustainable alternative to fossil fuels, it can also have environmental impacts, such as deforestation or the emission of pollutants.

In order to address any potential environmental effects of biomass technology, a weather sensor project would be helpful. Researchers can better understand the effects of this technology on the environment by gathering information on weather patterns and air quality in regions where biomass technology is being implemented.

For example, the study might track how emissions of particulate matter, such as ash or smoke, from biomass power plants, are affecting the air quality in adjacent areas. Policy makers can use this knowledge to better inform their decisions about how to regulate biomass technology to lessen its negative effects on air quality.

The project could also monitor the impact of biomass technology on deforestation rates. By analyzing weather patterns in areas where biomass materials are sourced, researchers can determine whether deforestation rates are increasing and identify areas where sustainable sourcing practices could be implemented.

Overall, a weather sensing project can be a useful tool for addressing the potential environmental impacts of biomass technology by providing critical data on air quality, deforestation rates, and technology efficiency. This information can inform policy decisions and help to ensure that biomass technology is implemented sustainably and with minimal environmental impact.

1.3 History of Renewable Energy on Biomass

Any fuel made recently from plant material can be referred to as biomass, and this includes wood, crops, crop residues, and animal waste. Biomass was also used as a source of energy in the distant past, though. Since the evolution of fire, humanity has been utilizing biomass as its primary source of energy. Since a considerable portion of the world's population utilizes wood, charcoal, straw, or animal dung as a cooking fuel, it still makes up 10% of the main energy supply and is the greatest single renewable energy source in the world (IEA 2012) [28].

Each year sees an increase in the amount of electricity generated from renewable sources. Biomass energy technology made amazing progress in the 21st century. Biogas, biofuels, and bioenergy can be generated through processes like anaerobic digestion, biomass gasification, and pyrolysis. The popularity of wood pellets as a biomass fuel also increased as a result of its high energy content, portability, and clean combustion. Feed-in tariffs, tax credits, and renewable portfolio standards are just a few of the supportive policies and incentives that governments all over the world have implemented to promote the use of biomass [29].

1.4 Problem Statement

Nowadays, power banks are one of the most important products that are needed by a lot of people because of their portability and their functionality to charge electronic and electrical devices. A lot of people love doing outdoor activities such as hiking and camping for days in the jungle or mountain areas. They would bring their own power bank to charge their electronic devices so that they can use them every day without worrying about the battery running out of power.

However, most power banks cannot last for a long time which can be troublesome for outdoor uses, especially for hikers or campers. It is very hard to find a power source to charge the power bank when hikers or campers are in the middle of the jungle. This would also cause many problems, especially during an emergency.

Therefore, developing a power bank that can use natural sources such as biomass energy to recharge the battery will help especially for hikers and campers that are having trouble finding a power source.

To cope with this problem, this project proposes to create a power bank that can use biomass energy to recharge the power bank with IoT and a newly installed automatic night light sensor that can be used as a flashlight during the night.

1.5 Objective of Project

The main objective of this project is to propose an effective and efficient method of estimating the cost of producing a power bank suitable for hiking and camping. Specifically, the objectives are as follows:

a) To develop an environmentally smart power bank using biomass.

b) To monitor the smart power bank using the Blynk App.

c) To analyze each source that can help generate more power and electricity.

1.6 Scope of project

This project's scope is as follows:

a) To develop a smart power bank that can sustain without a power source.

b) This project is specifically for long-term outdoor uses such as hiking and camping in the jungle.

c) The power bank can be monitored through the Blynk Apps.

d) This power bank has a sensor that can detect if it’s nighttime or daytime to light up the lamp automatically.

e) This project is specifically using 7 segment display to show the output ofvoltage.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In today's contemporary civilization, renewable energy is the key to sustaining many types of uses in urban, sub-urban and rural areas because of its massive and unlimited resources. To give an example, biomass is a very adaptable fuel source that may be converted to electrical, gaseous, and liquid fuels. This topic is significant because biomass energy is important for some countries and the usage of biomass is also increasing. For example, Pakistan typically relies on fossil fuels and a little amount of biomass to meet their energy requirements. To meet its current energy demands, Pakistan desperately need advanced conversion technologies such as combustion, gasification, and pyrolysis. These technologies have been successfully implemented in a variety of nations worldwide [1]. Therefore, this project proposes using biomass energy to be converted into electrical energy to supply power for the power bank.

This chapter is focusing on doing more research related to this project from articles, journals and books. The related and relevant theories, models and results based on previous research will be applied to support the effectiveness of this project.

2.2 Understanding [Global/Current Issue] in the Literature

The world's population continues to grow at a high rate, such that today's population is twice that of 1960, and is projected to increase further to 9 billion by 2050. This situation has brought about a situation in which the percentage of global energy used in cities is increasing considerably. Biomass is a resource that is present in a variety of different materials: wood, sawdust, straw, seed waste, manure, paper waste, household waste, wastewater, etc. Biomass resources have traditionally been used, and their use is becoming increasingly important due to their economic potential, as there are significant annual volumes of agricultural production, whose by-products can be used as a source of energy and are even being promoted as so-called energy crops, specifically for this purpose.

2.3 Biomass energy production

Biomass comes from a variety of sources, including municipal solid waste (MSW), agricultural crops, crop leftovers, and forest residues. The distinct features of biomass in both proximal and final analyses enable the production of dependable energy supplies. Biomass is a versatile fuel source that provides biofuel, which may also be used in transportation, and bioenergy, which can be used to create cleaner, more economical power worldwide [2].

A biomass power plant, which may offer heat and electricity energy, is the most common approach to generate electrical energy from biomass. The typical technique of producing electricity has an efficiency of 30-55 percent, whereas the Combined Heat and Power (CHP) approach has an efficiency of 80-90 percent. The second rule of thermodynamics governs the operation of a CHP power plant.

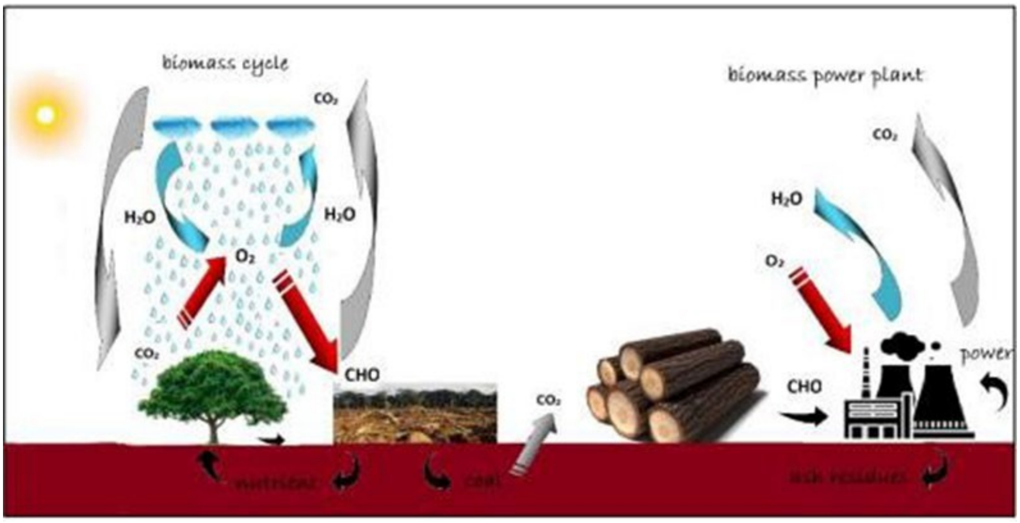

Figure 2-1 Biomass Cycle

First, high-energy heat is converted into electricity and thermal energy is converted into heat at a lower temperature. Biomass power plants use a comparable Basic Parallel Process (BPP) in which the efficiency of the steam turbine generators is about 25%, and fuel conveyance frameworks and the standard BPP is around 20 MW in an estimate, with a couple of dedicated wood-let go plants in the 40– 50 MW estimate range.

First, the flowing cold water feeds the exchanger tubes in the combustion chamber housing the heat exchanger. Burning biomass produces hot combustion gases, which are used to raise the pressure in the feed water. The produced steam is collected in the high- pressure boiler in the next step, with the ultimate objective of feeding the steam turbine to flow the steam pressure at a correct pressure point. Following that, the high-pressure steam is directed onto the steam turbine's blades, which spin the turbine shaft. Power may be generated by connecting an electric power generator at the end of the compressor shaft. The generated electricity is equivalent to 30 million kWh, which may be used for a variety of applications. The combined steam must be returned to the heat trade. However, before delivering the cooled off water to the heat exchanger, the continuing heat might be linked to local warming. Every year, around 50 million KWh of electricity may be saved by taking this option, as a consequence of expelling this heat into the environment via smokestacks, which helps to minimize energy waste. As a result, deploying a Combined Heat and Power (CHP) plant results in energy cost reserve funds to decrease heat waste and CO2 emissions. [3].

2.3.1 Electricity generation from a biomass cookstove

It takes around 4 hours to generate and provide roughly 10 Wh, which is enough to charge electronic devices. In order to satisfy its daily energy requirements of 5 Wh, this will be sufficient. In many cases, 2.5W is the amount of electricity needed to charge a device. It was found to be adequate for field testing when it came to DC charging of low-powered electronics [4].

2.3.2 Coal and biomass for environmental-friendly electricity generation

Gasification is the first step in the CBECCS process, which transforms the solid coal and biomass feedstocks into syngas, a gaseous fuel mostly consisting of H2, CO, and CO2. It is our goal to develop a high temperature (1,300–1,500 °C) entrained-flow gasifier (EF) that can gasify the whole coal and biomass feedstock (more than 99.5 percent). It is more tolerant of feedstock variability because of the gasification process's ability to reduce tar. In addition, gasification reduces air pollution significantly compared to direct combustion of these fuels. While the process partially oxidises the solid-fuel feedstock, it also serves to make up for the energy lost during the gasifier's endothermic operations [5].

2.3.3 Types of Biomass Fuels

Biomass may be derived from natural and organic sources such as animals and plants. It may also be generated by industrial operations, municipal waste, or land clearing activities. Heat, electricity, and fuel may all be produced as end products. The terms "pellets," "wood chips," and "cellulosic ethanol" all refer to forms of biomass energy that are rather widespread [6].

2.3.3.1 Non-woody biomass

Because non-woody biomass contains less lignin than woody biomass, it is often classified as trash. This biomass may be obtained via a wide range of agricultural practises, as well as the waste products of animals and herbaceous plants. Examples of non-woody biomass originating from agricultural processing industries include cotton gin trash (also known as CGT), palm oil waste, animal waste, and sugarcane bagasse. Paddy husks, straw, grass, crop stubble, and rubbish are all common agricultural field wastes. A typical hectare of cotton in Australia generates 1.6 tonnes of lint and 2.5 tonnes of seed each year, making non-woody agricultural waste abundant, accessible, and affordable. Approximately 2 tonnes of straw and 0.4 tonnes of cotton gin waste will be created simultaneously. In addition to the 25 million metric tonnes of wheat and 8 million metric tonnes of barley produced each year, Australia also generates large amounts of non-woody biomass in the form of straw and chaff. Wheat and barley have typical straw to grain ratios of 1:1 and 0.7:1. Solid fuels have a larger carbon content, which results in a higher energy content. Non-woody biomass with higher moisture and ash content, on the other hand, would have lower energy content. However, gasification is not only influenced by carbon. During the gasification process, moisture and oxidants that are rich in hydrogen and oxygen often react to generate hydrogen, methane, and carbon monoxide gas components. Additionally, non-woody biomasses often have low densities, especially those derived from grasses or herbaceous plants. This might create issues during gasification, especially when it comes to controlling the fuel flow rate [7].

2.3.3.2 Thermochemical conversion

For woody biomass conversion, there are a variety of methods available, most of which may be divided into thermochemical and biochemical processes. Thermochemical processes include combustion, pyrolysis, gasification, and thermal liquefaction, whereas biochemical processes include digestion and fermentation. This study will highlight current research and development developments in thermochemical conversion systems for the generation of energy, fuels, and chemicals from wood biomass. The combustion process generates heat from the biomass through oxidation combustion reactions. Aside from pyrolysis and gasification (which have been commercialised), this research will focus on thermal liquefaction and liquefied natural gas (LNG). Most biomass comes from plant stems, and their shapes and contents are rather predictable. Structurally supporting the plant, the stems also serve as conduits for nutrients (sugars and derivatives) needed for stem development and water and minerals from the ground to the leaves for photosynthesis, as well as for stem growth. Throughout millions of years of evolution, plant stems have perfected their physical shapes and chemical compositions to do both of these roles [8].

2.3.3.3 Biomass Fast Pyrolysis

As a consequence of the thermochemical breakdown process of biomass pyrolysis, which happens in the absence of oxygen, liquid, solid, and gas are all formed. Depending on the kind of biomass utilised, as well as operating temperature, heating rate, and residence time, the percentages of these products will change. Temperatures between 400°C to 650°C are required for the liquid target product, which necessitates swift heating and rapid cooling. Biomass pyrolysis has been the subject of several reviews; this one will focus on the end product of bio-oil and new developments to raise the quality of bio-oil [9].

2.3.3.4 Catalytic Pyrolysis

The potential for catalytic pyrolysis to increase the quality of bio-oil has also attracted great interest. It is possible to improve pyrolysis vapours in-situ or ex-situ using catalytic pyrolysis, which eliminates the need for hydrogen [10].

2.3.3.5 Thermal Liquefaction

Rapid pyrolysis and liquidification of biomass both aim to produce liquid as a byproduct of the process. But in most cases, biomass liquefaction happens in a liquid medium and at high pressures. Liquidification and pyrolysis are two different processes that can process biomass with high moisture content, but only pyrolysis can produce bio-oil that has less than 10% water. It is possible to liquefy biomass via hydrothermal liquefaction, solvent-based liquefaction, or a combination of both. The liquefied liquid product has a lower oxygen and water content, making it easier to process. Because it requires high pressures and the use of solvents and catalysts, liquefaction is a more complex process [11].

2.3.3.6 Hydrothermal Liquefaction

Between 200 and 400 degrees Celsius, the hydrothermal liquefaction (HTL) process takes place, with pressures ranging from 5 to 25 megapascals (MPa) [12]. In the HTL process, water is often used as a working medium to enhance heat transfer and biomass degradation. The HTL process may be carried out at either a subcritical (250 degrees Celsius and 5 MPa) or a supercritical temperature and pressure since water has a critical temperature and pressure of 373 degrees Celsius and 22.1 MPa, respectively (400 degrees Celsius and 25 MPa).

2.3.3.7 Gasification for Woody Biomass

It is also possible to make producer gas or product gas via the thermochemical conversion of biomass, which primarily yields CO, H_2, CO_2, and CH_4 as well as other hydrocarbon species. Temperatures in the 700–1200-degree Celsius range are required for gasification. Gasification agents such as O_2, air, steam, and CO_2 or their mixtures are used in the biomass gasification process. It is possible to generate heat for later endothermic processes by using oxygen or air as a gasifier. It's necessary to supply heat to the gasification reactor when steam is used as the gasification agent. In addition to fixed bed gasifiers (updraft and downdraft), there are fluidized bed gasifiers (bubbling and circulation) and entrained flow gasifiers. There have been recent developments in biomass gasification that aim to reduce the quantity of tar in the producer gas, boost its hydrogen content, and enhance its energy efficiency [13].

2.3.3.8 Municipal Solid Waste (MSW)

Garbage to fuel facilities produce fuels from the energy-dense elements present in home and industrial waste. It's a word used to describe a collection of municipal and industrial wastes that are produced mostly from suburban, commercial, and industrial sources. Solid waste, food waste, shrubs and paper products, plastics, latex, textiles and firewood are all part of the rubbish collection. The proportion of such components will vary across sites and within a single location. There are many factors that contribute to the development of the waste stream, such as changes in lifestyles and laws, periodic causes, preparation and reprocessing activities, and rubbish composition varies by district in various areas of the world. In impoverished countries, leftovers often include a greater proportion of decomposable material than plastics. However, countries such as Germany have well- developed plans for reprocessing and repurposing trash that are constituted of non- biodegradable compounds and have a more consistent and reliable categorization. There are several ways for managing solid waste in a helpful and environmentally sustainable manner, including hydrothermal liquefaction, pyrolysis, and gasification. Over the last two decades, reusing has been the dominant strategy for recovering resources and minimising garbage, although further study is required in this area. The primary objective is to directly generate heat and power via a range of biological or thermal progressions. Fuel created from waste may have a lower carbon impact than fossil fuels [14].

2.4 Power Banks

Electronics are used to control the amount of electricity going and coming out of a power bank. To charge battery-powered devices like mobile phones and other gadgets, these devices may be recharged using a USB charger.

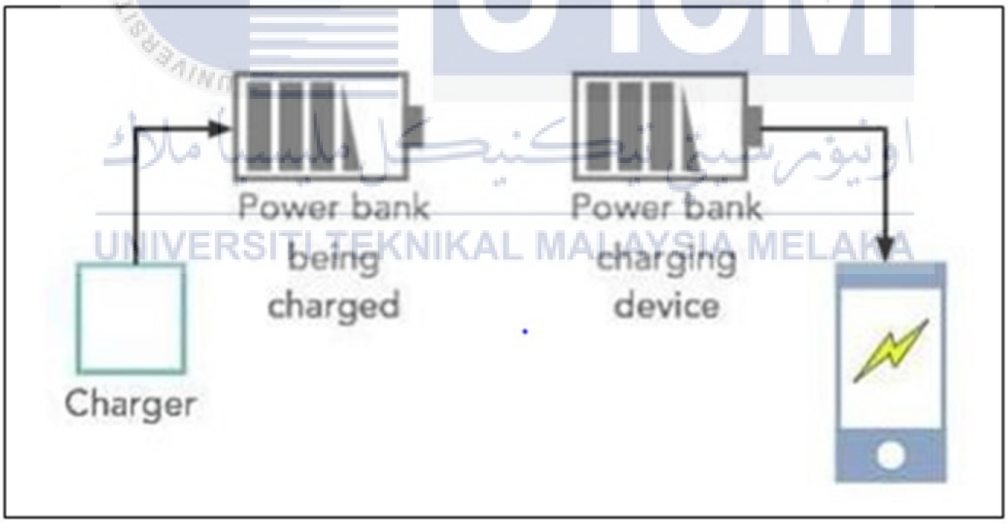

Figure 2-2 Power Bank Operation

"Power bank" is a word used to describe a financial institution that allows customers to deposit, store, and take money as needed. Even while these devices may power things like mobile phones without the need for a mains connection, they still need charging, which is normally done via a mains charger.

2.4.1 Batteries

One or more cells make up a battery, and their chemical reactions generate an electric current in a circuit. When it comes to batteries, there are three main components: the electrolyte, a cathode (the '+' side), and an anode (the '-' side) (a substance that chemically reacts with the anode and cathode).

Figure 2-3 Different types and shapes of batteries

Anode and electrolyte reactions occur when a battery's anode and cathode are connected in series. The movement of electrons through the circuit and back into the cathode is the outcome of this chemical process, which causes another chemical reaction. It is no longer possible for a battery to produce electricity if the cathode or anode material has been depleted or is no longer functional. The battery is deemed "dead" at this point.

2.4.2 Types of batteries

When a primary battery is used, it may be thrown away. Batteries that may be recharged several times are known as secondary batteries.

2.4.2.1 Primary batteries

It is not possible to replenish primary batteries. Most people use the dry cell as their primary battery. Zinc and carbon make up the dry cell, a lithium-ion battery. Zinc may be used as both a container and a negative electrode in the same device. An ammonium chloride, manganese (IV) oxide, zinc chloride, carbon powder, and a minuscule amount of water make up the paste that coats the positive electrode.

2.4.2.2 Secondary batteries

Secondary batteries are supplies that may be recharged. In smartphones and electronic tablets, these batteries are often found. One of the three electrodes in a NiCd battery is potassium hydroxide; the other two electrodes are nickel-plated cathodes. The positive and negative plates are rolled together and put in the case, with the separator preventing shorting. The “Jelly roll" arrangement allows the NiCd cell to deliver significantly more current than an alkaline battery of the same capacity.

2.4.2.3 Difference between primary and secondary batteries

Primary cells cannot be used multiple times, but secondary cells must be replenished when the charge runs out. Both forms of batteries are widely employed in a variety of gadgets, and these cells vary in size and material composition.

Table 2-1-1 Different between primary and secondary batteries

Primary cell	Secondary cell
They have a high density of energy.	They have a reduced energy density.
Its design is more compact and lightweight.	Its design is more intricate and substantial.

It has small initial cost.	Its initial investment is substantial.
They are referred as dry cells because the cells contain no fluid.	Molten salt cells, flooded cells, and liquid cells are all varieties of wet cells (liquid cells with different composition)
Its internal resistance is rather substantial.	It has a low coefficient of internal resistance.
It is a chemical compound that undergoes an irreversible chemical reaction.	It undergoes a chemical process that is reversible.

2.4.2.4 Lithium Ion

Sony commercialised the Li-ion battery in the early 1990s. Li-ions are added and removed from the negative and positive electrodes, respectively, during charging. Additionally, when charging, Li + is deintercalated from the cathode oxide complex and incorporated into the anode's lattice. Cathodes have a high potential but a low Li state, while anodes have a low potential but a high Li state. During discharge, the procedure is reversed. In comparison to other kinds of batteries, Li-ion batteries have a high energy density (due to the high output voltage), great efficiency, a long cycle life, and are environmentally friendly. These desirable characteristics have resulted in Li-ion batteries being prevalent in portable gadgets such as smartphones and power banks [15].

Figure 2-4 Example of a lithiumion battery

2.4.2.5 Lithium-Ion Polymer

Lithium-ion polymer batteries do not use a liquid electrolyte, but rather a semisolid polymer electrolyte with excellent conductivity (gel). The electrode materials' chemical composition determines the battery cell's voltage. Lithium–metal–oxide ($LiCoO_2$) cells have a completely discharged voltage of 2.5–2.8 V and a fully charged voltage of 4.2 V, while lithium–iron–phosphate ($LiFePO_4$) cells have a fully drained voltage of 1.8–2.0 V and a fully charged voltage of 3.6–3.8 V. Lithium polymer batteries have a greater specific energy than lithium-ion batteries. The polymer electrolyte provides a more stable performance for the lithium polymer battery when subjected to vibration. These two characteristics have aided in the development of lithium polymer batteries for use in electric vehicle applications [16].

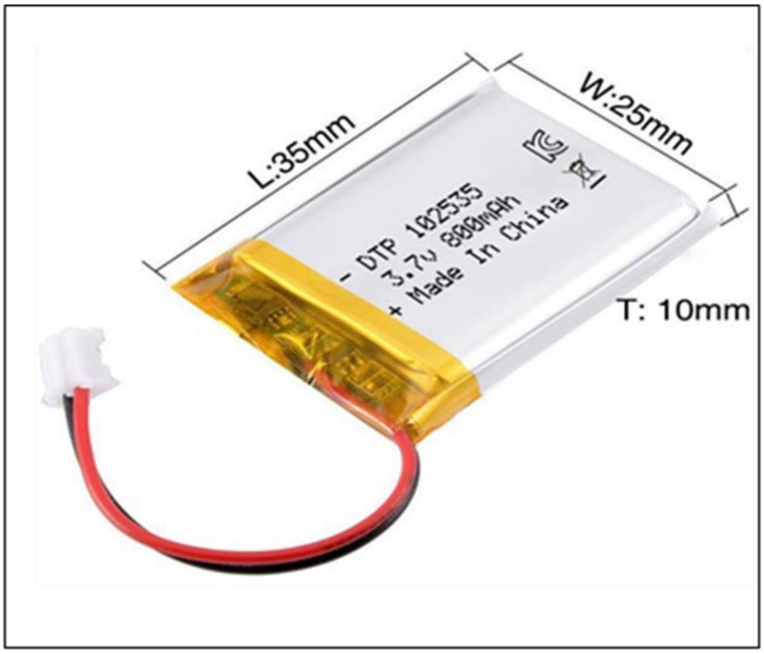

Figure 2-5 Lithium-Ion Polymer

2.4.2.6 Nickel-Cadmium

The nickel–cadmium battery was invented in Sweden in 1899 by Waldemar Jungner. Neumann invented the first sealed version in 1947, paving the way for current nickel– cadmium batteries. High cycle life, increased energy density, low internal resistance, high power density, outstanding performance at low temperatures, extended shelf life, and quick recharging are all advantages of nickel–cadmium batteries. In contrast, the energy density of nickel–cadmium batteries is lower than that of nickel–metal hydride batteries and lithium– ion batteries. Known as the "memory effect," nickel–cadmium batteries need repeated full discharges because of this. Because of the toxicity of cadmium, nickel–cadmium batteries are seen as both environmentally harmful and problematic. The use of nickel–cadmium batteries has so been restricted in EU member states lately. Aside from its high self-discharge rate, nickel–cadmium batteries have a poor performance at high temperatures, and a difficult charging procedure [17].

Figure 2-6 Nickel-Cadmium Battery

2.5 Thermoelectric Generator (TEG)

Increasing attention has been paid to thermoelectric generator (TEG) systems in the waste heat recovery industry because of their unmatched advantages: TEGs enable the generation of electricity from heat energy without the use of moving parts such as turbines, which eliminates additional maintenance and replacement expenses. TEGs have no economy-of-scale impact and may be utilized to produce microwatts in confined spaces or kilowatts. TEGs' quiet functioning makes them environmentally favorable as well. However, the energy conversion efficiency of TEGs is subpar, and they need a constant heat source. TEGs may be used for a variety of purposes, including the recovery of waste heat and the creation of solar energy. Kraemer et al. describe experimental observations of solar thermoelectric generators with a peak efficiency of 9.6% and a system efficiency of 7.4% [18].

2.5.1 How thermoeletric generator works

TEGs are based on the idea of seamless conversion of electric potential and heat. According to the Seebeck effect, if two junctions are made of dissimilar metals, an electric potential may be created between them. An electric potential is applied between two distinct metals in order to alter the temperature between their junctions, and this is known as the Peltier effect, which is the inverse of the Seebeck effect. In power generating mode, TEGs use the Seebeck effect, whereas in thermal management mode, they utilize the Peltier effect. TEGs' flexibility to be tailored for specific purposes, such as temperature control, makes them a popular choice. In a TEG, there are several thermocouples constructed of n- and p- type semiconductor materials that are electrically and thermally linked in series and in parallel. There are normally heat sinks on both sides of a thermoelectric module (TEM), as well as an interface and insulating layers to prevent heat transmission from the hot side of the module to the cool one [19].

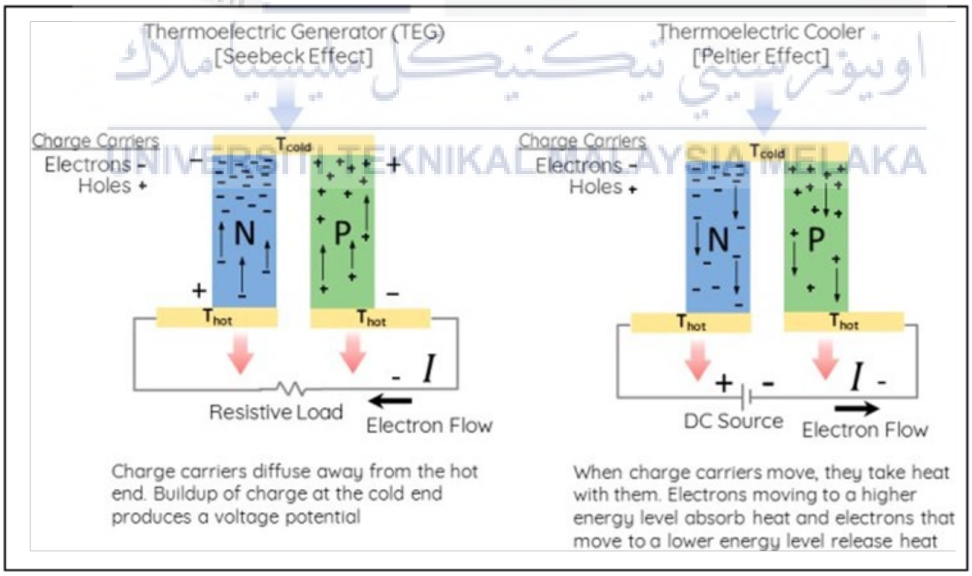

Figure 2-7 Working Principle of TEG and TEC

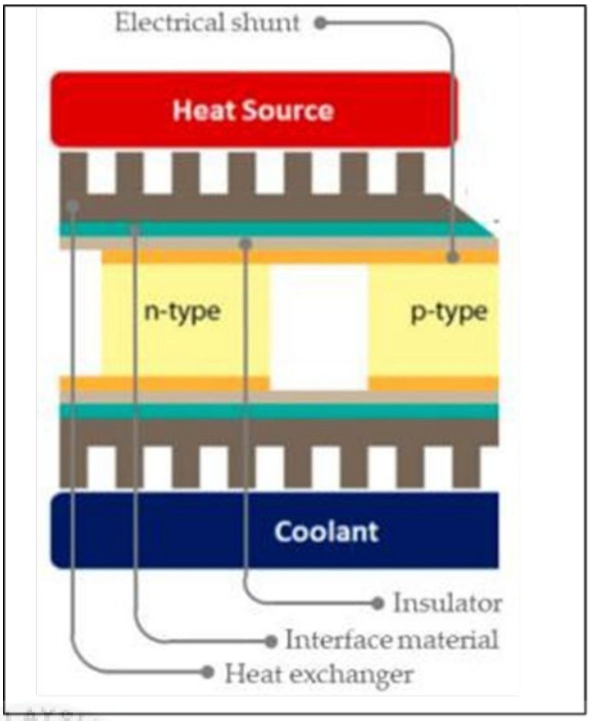

Figure 2-8 Component of thermoeletric generator

2.6 Charge controller

Charge controllers are essential in BIPV systems because they manage the current flow from and to the batteries, protecting the batteries from overcharging and over-discharging. In BIPV systems, they may also protect the appliances that are connected to the batteries. Using controllers in BIPV systems may improve the battery's life greatly due to the inability of most batteries to recover from overcharging or over discharging.

2.6.1 Types of charge controllers

In terms of setup, charge controllers may be divided into three types: Shunt, Single-Stage, and Multi-Stage.

2.6.1.1 Shunt controllers

Shunt controllers monitor the maximum point of battery charge. Once the batteries are completely charged, they are separated from the PV arrays by the shunt controller, and the extra power is transformed into heat, and then the heat is dissipated via the heat sinks of the shunt controllers. Through these laws, overcharging may be avoided for batteries. For shunt controllers, enough ventilation is important for heat dissipation.

2.6.1.2 Single-stage controllers

Once the batteries are completely charged in BIPV systems controlled by single- stage controllers, the charging circle is turned off to preserve the batteries. The charge termination point in the control strategy is decided to be the battery's full state of charge, whereas the charge beginning point is predetermined to be the battery's minimal state of charge. When the battery is completely discharged, the single-stage controller reconnects the charging circle to permit charging. In BIPV systems managed by this sort of controller, minimal power is converted to heat, which eliminates the need for ventilation.

2.6.1.3 Multistage controllers

When the batteries are in a low power condition, current flow for battery charging is allowed in BIPV systems with multistage controllers. When batteries are near full charge, excess electricity generated by photovoltaic panels may be dissipated. Similar to shunt controllers, multistage controllers may also extend the life of batteries. Additionally, this control system needs enough ventilation since heat is generated during power dissipation.

2.6.1.4 Pulse-width Modulation (PWM)

Charge controllers that operate in the on/off mode directly use the charge current generated by the energy source. Several experiments are being conducted, again on lead– acid batteries, on various methods for modulating the current by modifying its period. This technique, dubbed pulse-width modulation (PWM), seems to reduce gas and water usage while increasing charging efficiency. Studies are being conducted to optimize the settings of this technology and to better understand the physicochemical processes that result in an increase in battery life when PWM management is used.

2.6.1.5 Maximum Power Point Tracking (MPPT)

MPPT controllers have been critical in tracing the PPP and increasing the efficiency of photovoltaic installations. In 1968, the first photovoltaic system incorporating MPPT was developed for use in a space system. Following then, MPPT controllers improved significantly in terms of reliability, precision, tracking speed, efficiency, and simplicity. The ideal MPPT algorithm is often quick, has little oscillation around the PPP, and can keep up with rapid changes in output power. There are several MPPT control strategies that have been implemented to date. These controllers are used to monitor the maximum power point under uniform irradiation for a single MPP or to track a photovoltaic system with numerous maximum power points (MMPP). The environment has a considerable effect on the output of the photovoltaic system. As a result, the production yield varies dynamically. Solar panels cannot provide their full power output without the usage of an MPPT controller. Nowadays, every photovoltaic system installed has an MPPT controller. The primary objective of MPP trackers is to ensure that the MPP is located quickly, with little convergence time, minimal oscillation, and high precision, in order to improve energy production [20].

Figure 2-9 Example of an MPPT

2.7 Internet of Things

Because of the rapid spread of smart devices and high-speed networks in recent years, the Internet of Things (IoT) has become widely acknowledged and popular as the leading standard for low-power lossy networks (LLNs) with limited resources. Networks in which "things" or embedded devices with sensors are connected to each other through private or public networks are examples of this kind of network. It is possible to remotely control Internet of Things (IoT) devices in order to get the desired outcome. The information exchange among the devices is then accomplished via the network, which makes use of the industry-standard communication protocols to do this. The smart linked gadgets, often known as "things," vary from modest wearable items to massive equipment, and each is equipped with sensor chips to communicate with one another. Lenovo's smart shoes, for example, have chips that enable real-time data collecting and processing. Additionally, appliances like washing machines and refrigerators may be remotely controlled through the Internet of Things. The internet allows anybody in the world to see the surveillance cameras that have been set up to keep an eye on a certain location [21].

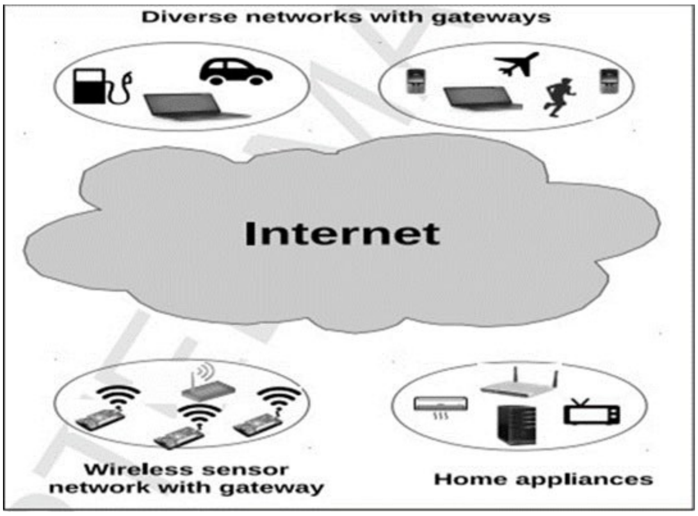

Figure 2-10 Diagram of IoT elements

2.7.1 Blynk Application

Blynk is a platform for the internet of things that enables remote control of electrical equipment through its iOS and Android mobile applications. It has a dashboard via which the user may design a graphical user interface by using various widgets. Additionally, Blynk is capable of storing and visualising sensor data. Blynk includes libraries for the majority of popular hardware platforms, including Arduino, ESP8266, Raspberry Pi, and SparkFun, among others. The three most critical components of Blynk are the App, the Server, and the libraries. Apps may assist in the interface design process. The server oversees all communication between the app and the hardware. Additionally, libraries allow hardware to communicate with the server through commands [22].

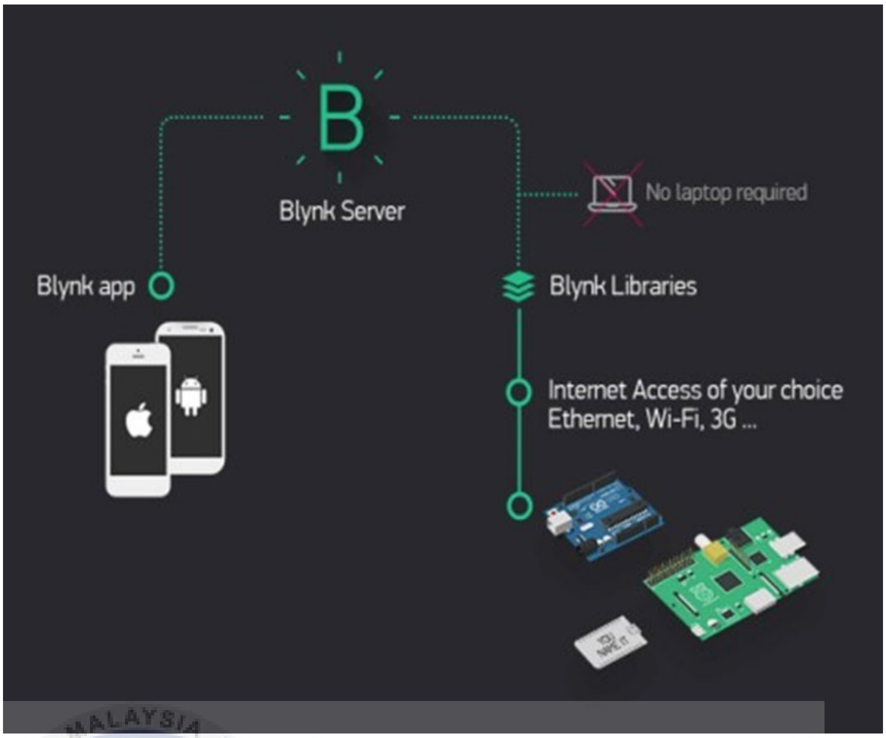

Figure 2-11 Blynk App working diagram

2.7.1.1 Smart Automated Home Application using IoT with Blynk App

The Node MCU ESP8266 controller chip is used to link the relay module system to the home appliances to be controlled and to each other through Wi-Fi. The Blynk app for iOS was customised with a new layout and buttons to make it easier to monitor and manage many paired devices.

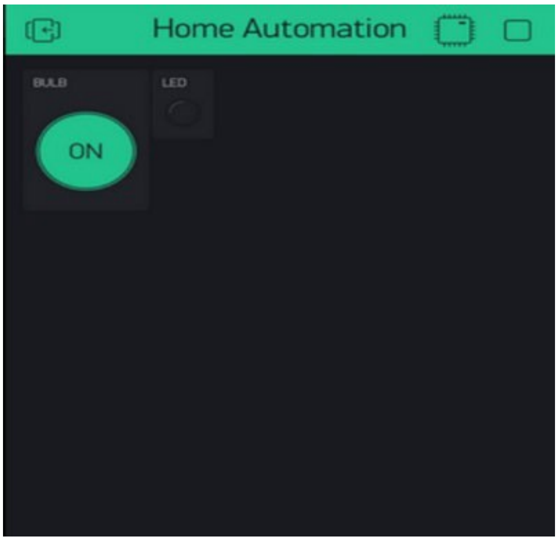

Figure 2-12 Appliance switch on Blynk App

Smart phones may be used to control home appliances from afar. A big advantage of this program is that it may be used by all members of a single household. All members of a shared app may see when an appliance is turned on or off by a single user. Aside from GPS location and distance measurements, the app may also be used to gather real-time and historical data on variables such as temperature, relative humidity, and GPS position. As an added bonus, this system may be used in a wide range of settings, including financial institutions, health care facilities, research facilities, traffic control stations, dwellings for people to live in, public roadways, poultry farms, and even greenhouses. To sum it up, this technique may be used to a wide range of industries and areas in order to improve efficiency [23].

2.7.2 Thingspeak

By sharing data, an IoT system enables the simple yet powerful capacity of working with a variety of devices and applications. IoT services are in charge of disseminating messages to the platform's customers. ThingSpeak is an Internet of Things (IoT) platform for collecting and storing sensor data in the cloud, as well as developing IoT applications. The ThingSpeak IoT platform includes programmes that enable you to analyse and display data in MATLAB and then take action on it. Sensor data may be transferred to ThingSpeak through the ESP8266 Wi-Fi module on the NodeMCU [24].

2.7.3 Arduino Uno

The ATMega 328 microcontroller powers Arduino Uno, a single-board computer. All of this microcontroller's digital I/O (six of which may be used for PWM output), six analogue inputs, a crystal oscillator, a USB connection, a power connector, an ICSP header, and a reset button are included in one single board. Using a USB-to-serial adapter, this microcontroller is able to communicate with a computer through the USB port [25].

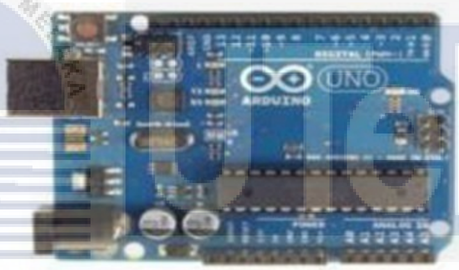

Figure 2-13 Arduino Uno

2.7.4 Arduino Mega

Modular hardware and software combine to build Arduino's open-source electronics prototyping platform. It's intended towards designers, artists, hobbyists, and anybody else interested in creating interactive objects or environments. Atmel's ATmega2560 SMD chip powers the Arduino Mega 2560 R3, a successor to the original Arduino Mega. SDA and SCL pins are also included on the Mega 2560 R3, which are located adjacent to the AREF pin. Near the RESET pin, two more pins have been added. In particular, the IOREF allows shields to adapt to the voltage provided by the motherboard. An irrelevant item has been put away for future reference. All existing shields can be used with Mega 2560 R3, however new shields that need more pins may be accommodated [26].

Figure 2-14 Arduino Mega

2.7.5 Raspberry Pi

Credit card sized single board computer (SBC), the Raspberry Pi is both powerful and inexpensive. At about USD35, the Raspberry Pi 3B + includes a quad-core processor that runs at 1.4 GHz (CPU). With the availability of additional SBCs, they are emerging as a disruptive technology with increasing relevance for a variety of applications, particularly in the Internet of Things. SBCs can be programmed using free, open-source software, and the 40-pin GPIO interface can be used to interact with other devices. The small, flexible, low- cost, and mobile nature of SBC-based systems makes them ideal for use in point-of-care and point-of-need applications. A Raspberry Pi-based instrument was used to electrochemically quantify C-reactive protein with a limit of detection (LOD) of 58%, while the same instrument was used by Lin et al. to detect Salmonella with a LOD of 14 CFU/mL 1 using colorimetric analysis with a microfluidic biosensor and a Raspberry Pi [27].

2.7.6 Light Sensor

Using a basic electrical circuit, such as a light sensor, you may automate the control of many types of electrical load appliances. By using this light sensor circuit, we can prevent the need to manually switch the loads, as the quantity of sunlight can be regulated automatically. Thus, it may be regarded as an automatic light detector.

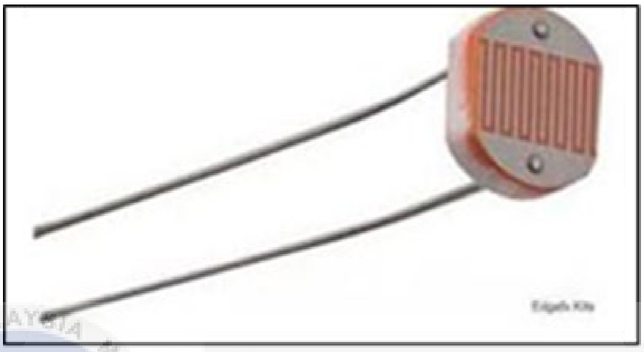

Figure 2-15 Example of a Light Sensor

2.7.6.1 Design of Automatic Intersity Varying Smart Street Lighting System

A Light Sensor (LDR) was used to control the streetlight's automated ON and OFF. Its resistance varies according on the strength of the light striking it. The light dimmer has been programmed for the LDR ranges. As night falls, the LDR values begin to fall within the range, and the streetlight turns ON based on the intensity of the light shining on the LDR. Current is measured using the current sensor. The LDR transmits the appropriate value to the microcontroller when the sun sets. The microprocessor delivers it to the dimmer, which changes the intensity of the LED based on the signal received. The luminaire utilised is 100W and has a lumens per watt efficiency of 100. When the luminary is completely black and glowing at its maximum intensity, its effectiveness is 100 lumens per watt. At dawn, the efficiency drops to 80 lumens per watt. The automated intensity changing streetlight prototype has been successfully developed. Different levels offer varying degrees of illumination to the streetlight, so conserving energy. The data acquired from the current sensor enables us to determine the energy saved as a result of the light's fluctuating intensity. This also minimises the need for human involvement [28].

2.8 Summary

In summary, this chapter demonstrates an in-depth comprehension of the variables involved in the current study. The concept of biomass as a renewable energy source and how it can be integrated into this project has been elaborated based on the articles and the previous research that has been made. The previous journals, articles and research were also presented in this chapter in the expectation that it will provide sufficient information regarding this project.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter is important because it explains the workflow to this project. The methodology will serve as a guide, identifying each stage and flow according to the flow chart planning, including data analysis, to support the project's objectives while achieving the anticipated results and validating that the project has been completed effectively and realistically.

This endeavor is divided into four phases. During the first phase, technical examination is conducted with guidance from a variety of sources, including journals, project research papers, and previous research. The second phase is the execution of the first phase, which included the analysis of data and concept development. Phase three is the implementation of phase two. This location is responsible for designing hardware and assembly. The fourth phase will focus on the interface of each project component as well as the troubleshooting of any current difficulties.

3.2 Flow Chart

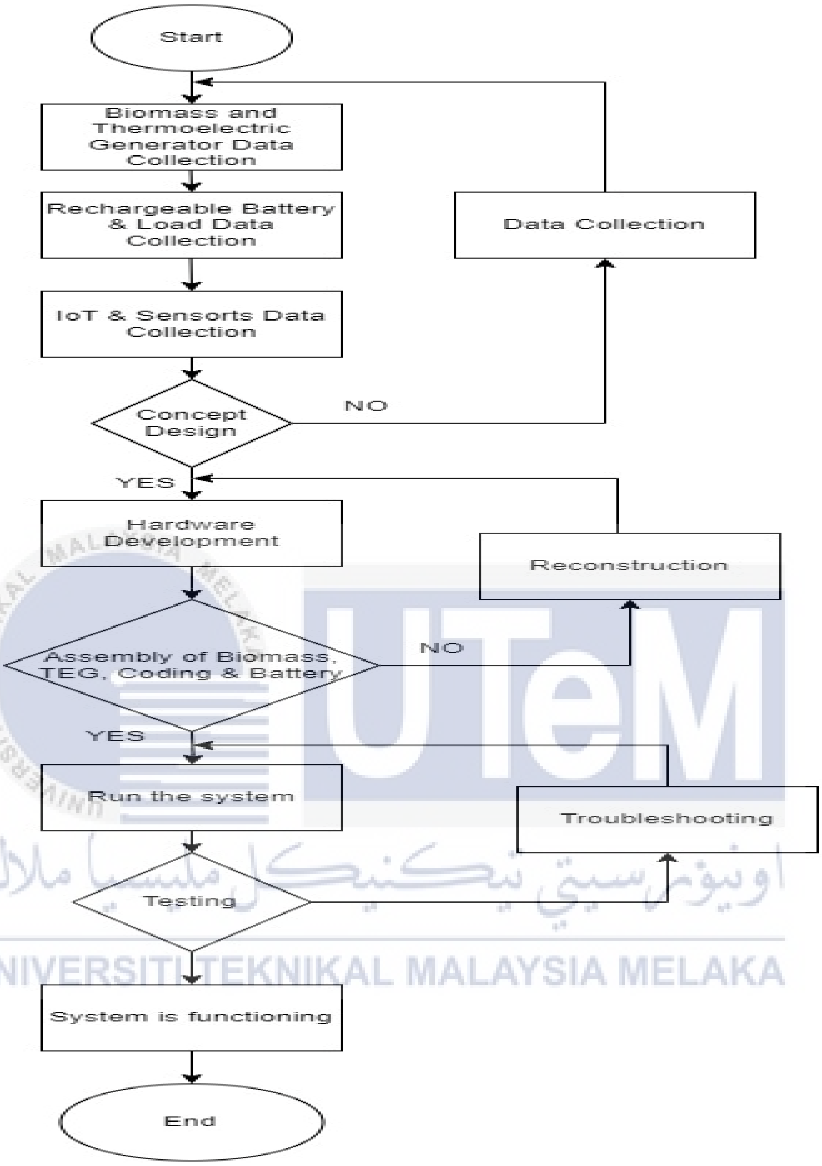

Figure 3-1 Complete flowchart of this project

The flowchart above was constructed using a web-based flowchart maker. The flowchart also shows the overall steps and procedures in developing the prototype of the project.

This project's initial stage is to do thorough research into relevant sources such as prior publications, journals, and previous studies. The project's problem statement is subsequently identified.

The next step is to collect data from all of the main components, including biomass, thermoelectric generator, rechargeable battery, sensors, and load. The rechargeable battery is powered by a thermoelectric generator module and biomass. In order to get past this step, the two preliminary designs must be compatible.

After finalizing the system, the next phase is to plan and construct the hardware. To conclude the project, the project body must be developed and implemented. If necessary, a number of examinations and reconstructions should be carried out in order to reach the desired outcome.

Lastly, the system must be tested multiple times to make sure it is functioning properly. Troubleshooting is also required if the system encounters any problem and does not give the desired result.

3.3 System Structure for Block Diagram

The goal of this endeavour is to develop a thermoelectric generator-powered biomass stove burner that could be used, for example, while camping or hiking in the forests. The biomass combustion chamber, the thermoelectric module, the Internet of Things, and the rechargeable battery make up this system's four major components. The biomass chamber in this system burns wood to provide the electricity needed by the system. All electronic devices will be charged using the electricity.

Concurrently, the excess energy will simultaneously be stored in the battery. The presence of these battery provides reliability for this system, as users will no longer require firewood to charge their electronic devices. This technology will make it possible for electrical gadgets to be used everywhere and at any time without worrying about running out of power.

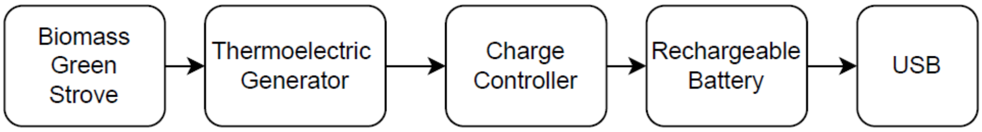

Figure 3-2 The Process of Portable Biomass Energy Storage

The graphic above depicts the project's system block diagram. The system will be fueled by a variety of biomass fuels. The difference between the sources will be the primary controller of this system since it will determine the output voltage. The output power will be sent to a rechargeable battery to assist in its recharging. Then, two Universal Serial Bus (USB) connections will be made to the battery, allowing electrical devices to be charged.

3.4 Equipment and Materials

Biomass fuels, a thermoelectric generator module, a charge controller, a rechargeable battery, a light sensor, an Arduino Uno, and a USB port will be used in this project.

3.4.1 Biomass

According to recent reports, biomass is the most common modern renewable energy source. Many different forms of energy may be generated from organic material derived from animals and plants. This project will make use of combustion as the method. Due to the project's intended audience of hikers and campers, this approach was chosen. Fire is regarded as matter because it consists of both space and substance. The mass of fire is dependent on the mixing between its gases. Therefore, the flame's heat and light exposure create energy.

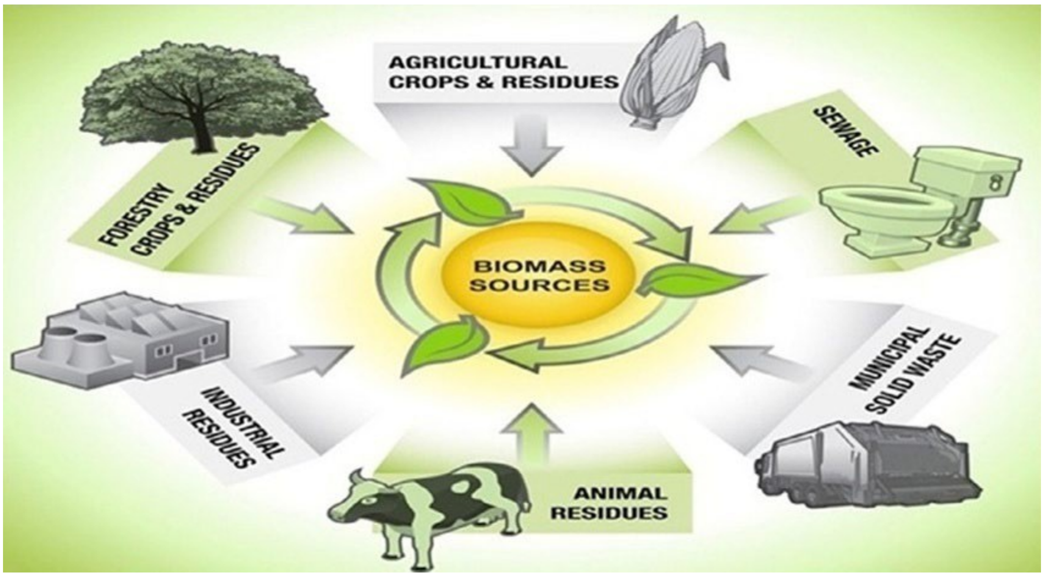

Figure 3-3 Example for sources of biomass

3.4.2 Thermoelectric Generator Module

Regarding this project, a 40mm x 40mm TEG was used. This little component is very dependable and requires no maintenance. Again, a modest TEG is utilised due to the project's constraints. The following is accomplished so that users are able to carry the stove in their baggage, as it is extremely light.

Figure 3-4 Module of Thermoelectric Generator

Biomass will be burned on the generator's hot side, and heat will be discharged via a heat sink on the cold side. Heat sink will be 40mm x 40mm and cover all ceramic surfaces of generator, therefore it'll be a perfect fit. So, more heat may be released to generate higher temperature differences.

3.4.3 Charge Controller

The charge controller of this project have a two-phase design that uses transistors to set the upper and lower output limits. Due of this circuit's simple calibration and components, it was chosen.

3.4.3.1 Relay

In this project, the application is switched between two circuits using a high-power relay. It has five terminals, two coils, a generally open terminal, a normally closed terminal, and a common terminal. Depending on which terminal the voltage is supplied, only one may be triggered at once.

Figure 3-5 Relay SLA-VDC-SL-A

3.4.3.2 Seven-Segment Display

Decimal numbers may be shown using a seven-segment indication. Electrical devices and digital clocks often use this component. Segment displays often make use of LCDs and LEDs as their primary display technologies.

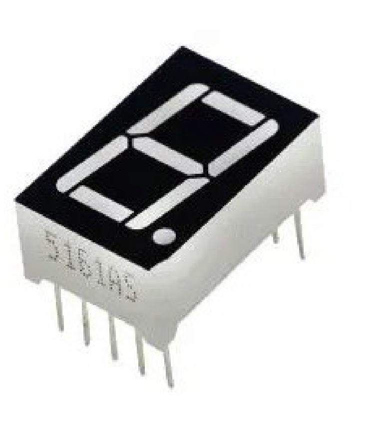

Figure 3-6 Example of a 7-segment Display

3.4.3.3 Capacitors

A capacitor is the name given to this kind of two-terminal passive component. It's used to store electrical energy in a magnetic field for later use. In electrical terms, the effect of this component is known as its capacitance. The Farad is the standard unit of measurement (F).

Figure 3-7 Example of Capacitors

3.4.4 Lithium-Ion Battery

Due to the project's emphasis on travel, size, form, and capacity play a significant influence in determining the sort of battery will be used. Most of all other requirements, a lithium-ion secondary battery has been used for this project (Li-ion). Battery made from lithium-ion are more dependable than previous battery types such as nickel-cadmium (NiCad).

In addition, lithium-ion batteries are not influenced by the so-called "memory effect," in which they must be entirely depleted before being charged again. The size and form of lithium-ion batteries is also a major factor in their selection over other kinds of batteries. The lithium-ion battery has a lower size and more capacity than previous batteries due to its packing.

Figure 3-8 Batteryof Lithium-Ion

3.4.5 Universal Serial Bus (USB)

Because it is the most commonly used and recognized USB connector, the type of USB connector was chosen for this project. All USB generations, including USB 3.0, USB 2.0, and USB 1.1, are compatible with this connection. On top of that, it's a great fit for this project since it's widely compatible with most electrical devices. In addition, the cable needed for this kind of connection is widely accessible.

Figure 3-9 Example of USB 3.0 Type A

3.4.6 Light Sensor

A Light Sensor creates an output signal representing the intensity of light by measuring the radiant energy that occurs in a very restricted band of frequencies termed "light," which runs from "Infra-red" to "Visible" to "Ultraviolet" light spectrum. The light sensor is a passive device that converts visible or infra-red "light energy" into an electrical signal. Light sensors are more generally referred to as "Photoelectric Devices" or "Photo Sensors" due to the fact that they transform light energy (photons) into electricity (electrons).

Figure 3-10 Light Sensor

3.4.7 Arduino Uno

The ATmega328P microprocessor is used in Arduino Uno, an open-source microcontroller board. Various expansion boards (shields) and circuitry may be connected to the board's digital and analogue input/output (I/O) ports. Arduino IDE is used to program the board, which has 14 digital I/O pins (six of which may be used for PWM output), six analogue I/O pins, and a USB connection (Integrated Development Environment). It can be plugged into a USB port or an external 9-volt battery, although it can accept voltages between 7 and 20 volts. Comparable to the Arduino Nano and Leonardo. The Arduino UNO microcontroller board may be used in a variety of electrical applications since it is low-cost, versatile, and user-friendly.

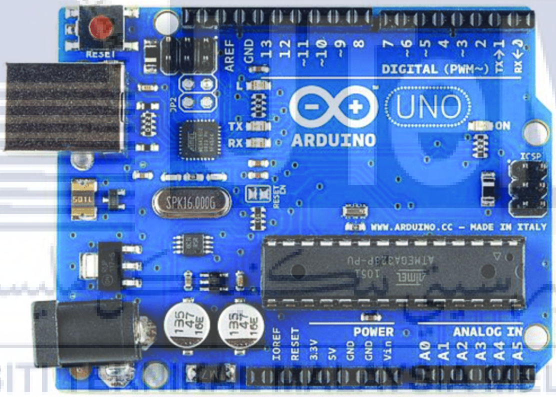

Figure 3-11 Arduino Uno

3.5 Software

The software that will be used in developing this project is Blynk for monitoring and controlling purposes and AUTOCAD to demonstrate the model of the green stove prototype.

3.5.1 Blynk

Because of its ability to compile and provide the right widget address, Blynk App was selected to be utilized in the creation of this project's graphical user interface (GUI). It can remotely control gear, display sensor data, preserve data, and present it in a user-friendly format. Blynk can be used in several platforms such as IOS and Android which is suitable for this project as users can remotely control and monitor the prototype from their mobile phones.

Figure 3-12 Blynk App

3.6 Circuit Diagram

The figure below shows the circuit diagram for “Portable Biomass Energy Storage” using software proteus.

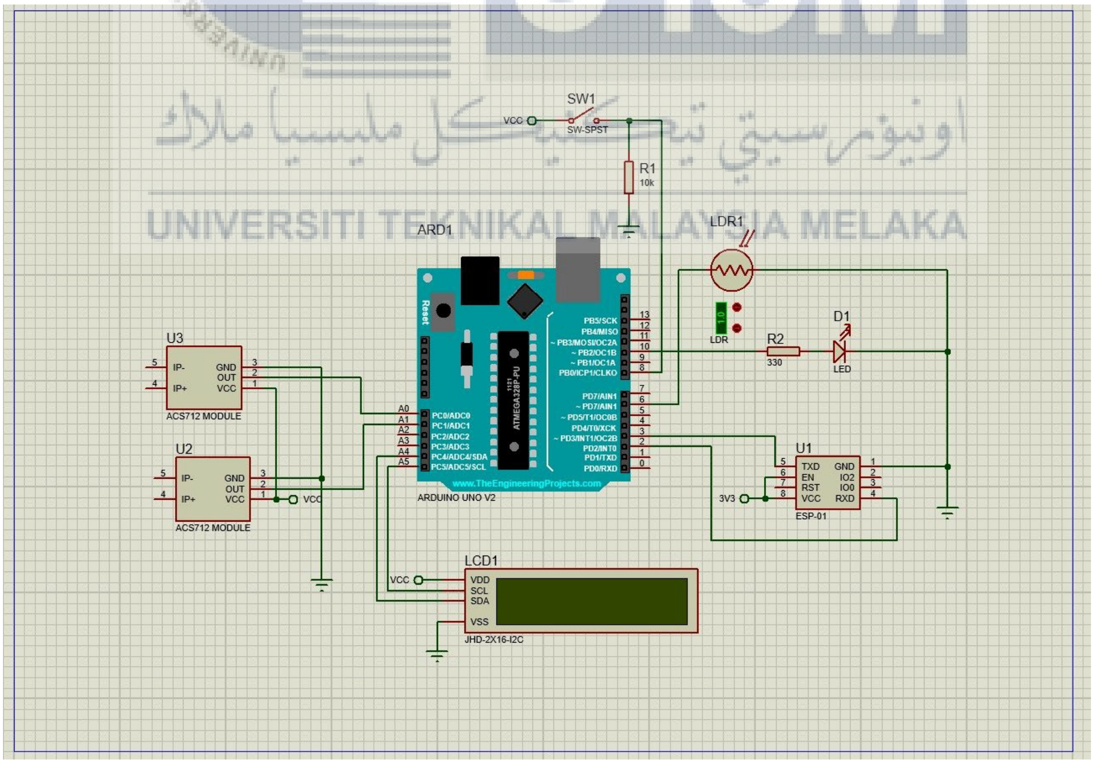

Figure 3-13 Circuit Diagram for Portable Biomass Energy Storage

The supply of the circuit use battery 9V to on the Arduino Uno which is for Iot Monitoring System. Then, the main of the supply which is woody, leaves and municipal waste. The system will uses thermoelectric generetor to convert the energy supply. The thermoelectric generator is divided into two sections which is the cold side and the hot side. The output of the termoelectric generator has been stored in the lithium-ion battery. This system will generate enough electrical energy to charge equipment such as smartphones, portable fan, and other equipment will be uses at camping or trekking in the forest.

The light sensor for this circuit is to uses for LED system which is prototype for users to uses at the night. The function of the LED like a flashlight, the system of flashlight will be automatic on at the night.

3.6.1 Model Design

The figure below shows the example of model design for portable biomass energy storage using green stove system.

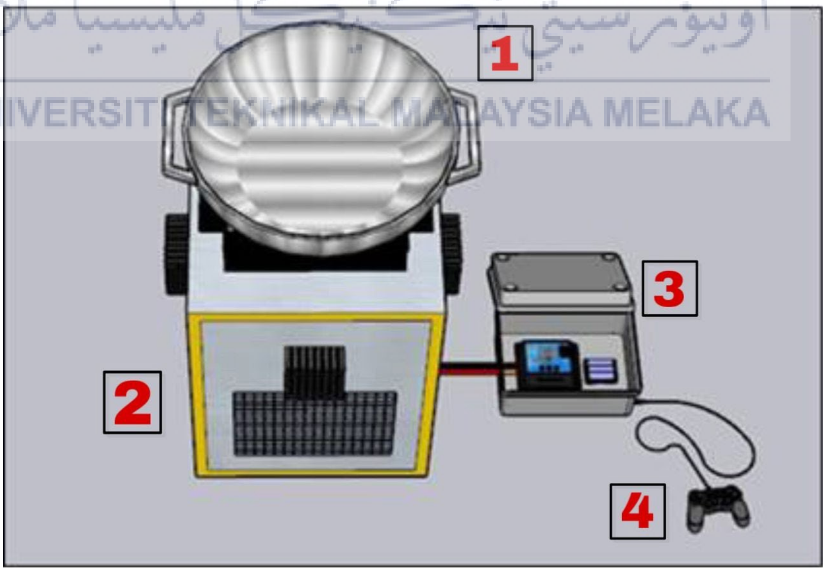

Figure 3-14 Design for Portable Biomass

The design of this project is to burning the woody, leaves and municipal waste for outdoor uses, especially for hikers or campers. It is very hard to find a power source to charge the power bank when hikers or campers are in the middle of the jungle. This would also cause many problems, especially during an emergency. Then, the design uses metal tray (1) on the top with peltier modules underneath it, which will be filled with cool water as a cooling solution for the Peltier modules. The design for burned the biomass cook strove (2) use metal bracket.

The design of this project use junction box (3) has three components: a charge controller module for charging devices and lithium-ion batteries, a battery holder for three lithium-ion batteries, and a USB Port (4) for connecting devices. Besides that, the design of this project uses IoT system compenents such as LCD display, Arduino UNO, LDR sensor, voltage sensor and a 9V battery.

3.7 Limitations

There are several limitations and constraints in developing this project. The result for this project cannot be guaranteed to be completely perfect based on the objectives and the scope of the project as this project is more focused on the real prototype and hands-on work rather than doing simulations. So, the result cannot therefore be guaranteed to be precise. Not only that, but the total cost for the whole project is also expected to be quite high. It is also lengthy and time-consuming to complete this project.

3.8 Summary

As a summary of the whole chapter, the process of generating this project's design and the materials used have been outlined. Due to the appropriateness of the circuits, the values of certain components may vary. In the future or during the period of the project's development, modifications will be made to improve its efficiency.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter will examine the voltage generated by each biomass source collected from this portable biomass energy storage with iot monitoring system for domestic usage in order to have a better knowledge of biomass. Results and general hardware performance will be explored in depth.

4.2 System Overview

Biomass is a well-known renewable energy resource since it has an infinite supply and is constantly accessible. However, an excessive amount of biomass residue might pollute the environment. Many initiatives were done to reduce pollution. Burning has long been a popular way of reusing garbage since the heat generated may be utilised for interior uses such as cooking, heating, and so on.

In that regard, the design on the previous prototype has been built to benefit the environment by reducing biomass residue via burning technique while supporting the primary objective, which is to enable campers and travelers to produce electric power in the woods. The thermoelectric generator's (hot side) supply will be wood combustion, while the cold side will be chilled water in a metal tray. The output value of the TEG will be determined by the temperature differences. Variations in temperature will be proportional to the generated voltage.

The lithium-ion battery will store the TEG output. If a battery is present, the system will be considered reliable. People who will be camping or hiking in the forest will be able to charge their mobile phones, cameras, and other electronic devices with electricity generated by this system.

4.3 Thermoelectric Generator

From this point on, the hardware analysis and data outcomes will be discussed. Five TEG modules were put through their tests to determine the output value. The values of the voltage and current were determined with the assistance of a multimeter.

4.3.1 Hardware Design

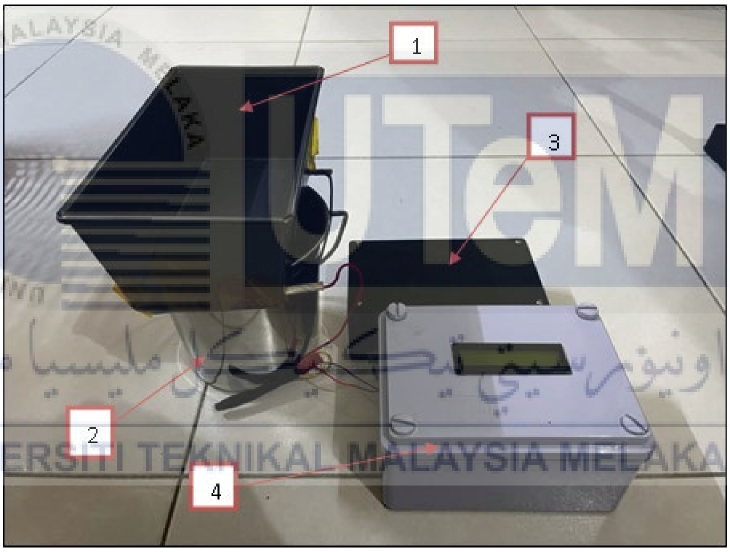

Figure 4-1 Prototype of Portable Biomass Energy Storage with IoT Monitoring System for Domestic Usage

The completed design of the project is seen in the figure positioned above. The entire system is made up of four different components, one of which is a metal tray (1) that has five Peltier modules attached below it. This tray will be filled with cold water to provide a cooling solution for the Peltier modules.

From that point on, the metal basket (2) will be utilized as a chamber for the purpose of burning the fuels. Aluminum was chosen as the material for this project because it ensures that the heat produced by the fuels will remain for a longer period of time and will not cause the basket to catch fire.

A charge controller module that can be used to charge devices and lithium-ion batteries, a battery holder that can hold three lithium-ion batteries, and a USB port that can be used to connect devices are the three components that are included within the black junction box of the (3).

The 4th and final component of the Internet of Things system is the blue junction box, which is used to store components such as an LCD display, an Arduino UNO, an LDR sensor, a voltage sensor, and a 9V battery.

4.3.2 IoT System

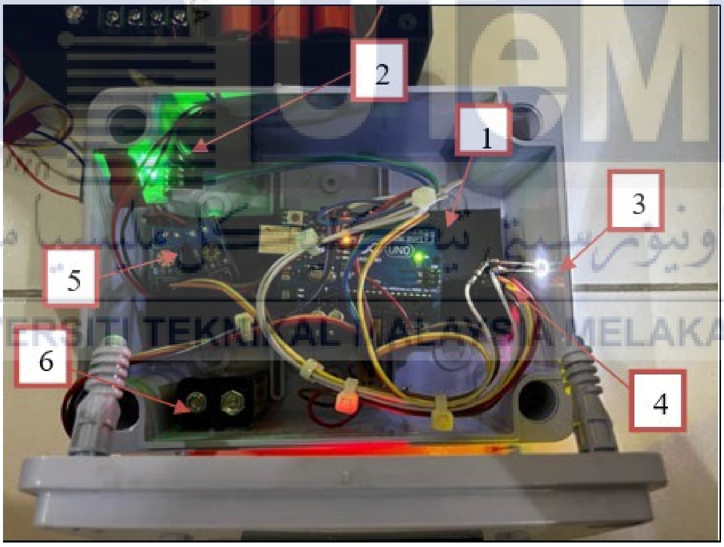

Figure 4-2 Inside of IoT System Junction Box

For monitoring the voltage generated by the battery, Peltier modules, and the overall battery percentage of the system, an Arduino UNO (1) is utilized in conjunction with an ESP8266 (4) to establish a connection with the Blynk App on the smartphone. The LED (3) is used in conjunction with the LDR sensor (2) to create a torchlight that may be utilized by hikers and campers during the late hours of the day. If the light that is being detected by the LDR sensor is light, such as sunshine, it will detect it. The light-dependent resistor (LDR) will detect the absence of light and send a signal to the LED, which will cause the LED to light up on its own will. (5) The voltage sensor is utilized in order to determine the voltage generated by the battery as well as the Peltier. The signal will then be transferred from the voltage sensor to the Arduino UNO, which can then be monitored using either the LCD display or the Blynk phone app. Lastly, in order to power the Arduino UNO and ensure that the entire system is operational, a 9V battery (6) is utilized.

4.3.3 Blynk App Monitoring System

Figure 4-3 Blynk App for Monitoring System

The battery voltage displayed on the Blynk App is used to monitor the charging status of the lithium-ion battery in the system. In the next step, the Peltier voltage is shown when establishing a connection between the Thermoelectric generator and the Arduino, which is utilized for the Blynk App system. The Blynk app is used to monitor both the battery voltage and the Peltier voltage generated by the fuels. The LED light may also be controlled via the ON/OFF button, which allows it to be turned off so that it doesn't light up for the whole of the night.

4.4 Thermoelectric Generator

The thermoelectric generator is divided into two parts which is for the hot side and the cold side. As a result, the first is to establish which side is hot and which side is cool. The cold side has the TEG's code in numbers and letters, whereas the hot side is blank.

4.4.1 The Hot Side and Cold Side

A multimeter may be used to identify the hot side. The surface of a hot and cold side may also be assessed using a simple test.

Connect the red and black wires of the TEG to the multimeter to commence. Positive current flows through the red wire, whereas negative current flows through the black wire. Then, apply heat to both surfaces and verify the reading on the multimeter. When heat is applied to a heated surface, it produces a greater reading.

4.5 Result

The project will be tested with TEG modules stuck under the metal tray. The output of the TEGs is measured using a multimeter and Blynk App based on the time the TEG is exposed to heat. An open fire may achieve temperatures of up to 1100 degrees Celsius. However, since aluminum is utilized in this project, the project can withstand temperatures of up to 660 degrees Celsius before melting. The cold side of the TEGs will be cooled using cool water in a metal tray, which may assist provide a larger temperature differential and hence a higher output value.

The output of the TEG modules will be measured using three sources: woody waste, municipal trash, and food crops since these sources are obtainable during camping and hiking.

4.5.1 Experimental Result using Wood

One of the sources that may be found everywhere in the forest is wood. The test is divided into two conditions: dry and wet. A multimeter is used to measure the findings.

In general, the output from wood is not excessive since the heat generated by burning the wood is not excessive when compared to leaves and municipal garbage. Although the output from wood is not very great, the voltage and current rose consistently because the fire took a long time to extinguish from the wood.

4.5.1.1 Dry Wood Experimental Result

Table 4-1 TEG output produced using Dry Wood

Duration of fuel burning (seconds)	Voltage produced (V)	Current produced (A)	Power (P)
20	1.87	0.12	0.22
40	2.14	0.14	0.30
60	2.25	0.18	0.41
80	2.32	0.20	0.46
100	2.44	0.22	0.54

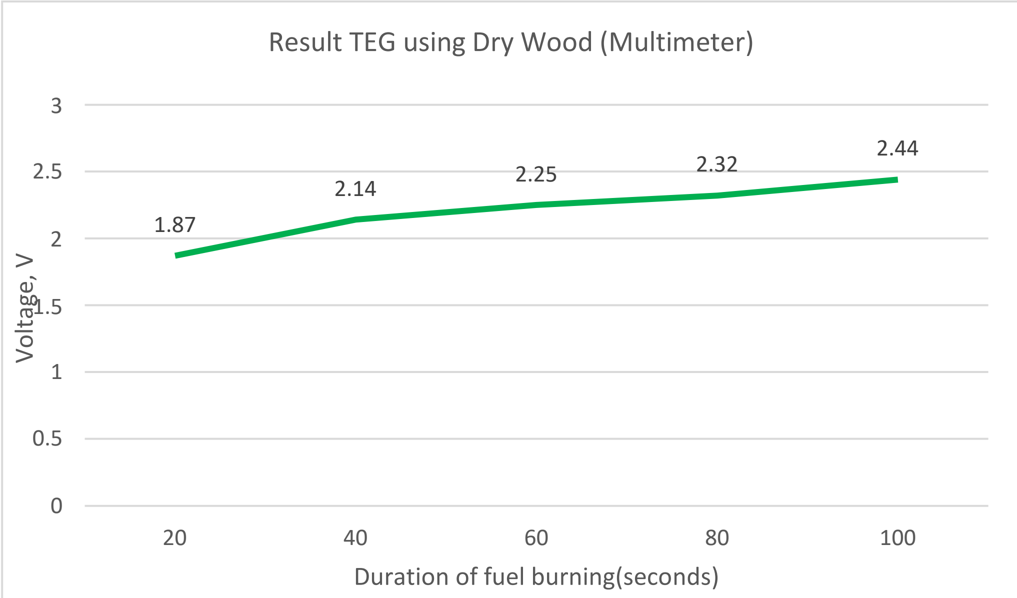

Figure 4-4 TEG Voltage Output using Dry Wood

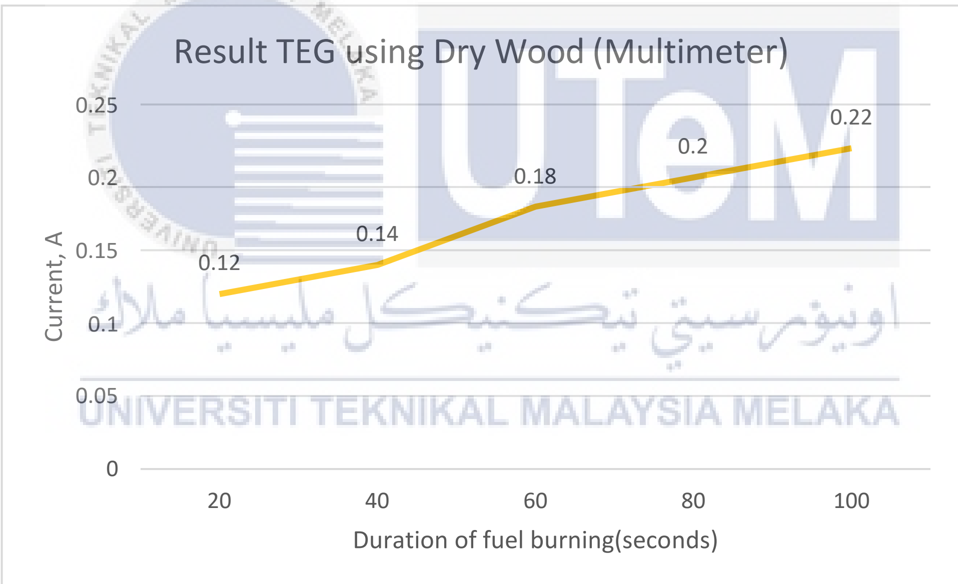

Figure 4-5 TEG Current Output using Dry Wood

4.5.1.2 Wet Wood Experimental Result

Table 4-2 TEG output produced using Wet Wood

Duration of fuel burning (seconds)	Voltage produced (V)	Current produced (A)	Power (P)
20	1.75	0.10	0.18
40	1.97	0.11	0.22
60	2.14	0.13	0.28
80	2.23	0.17	0.38
100	2.34	0.19	0.44

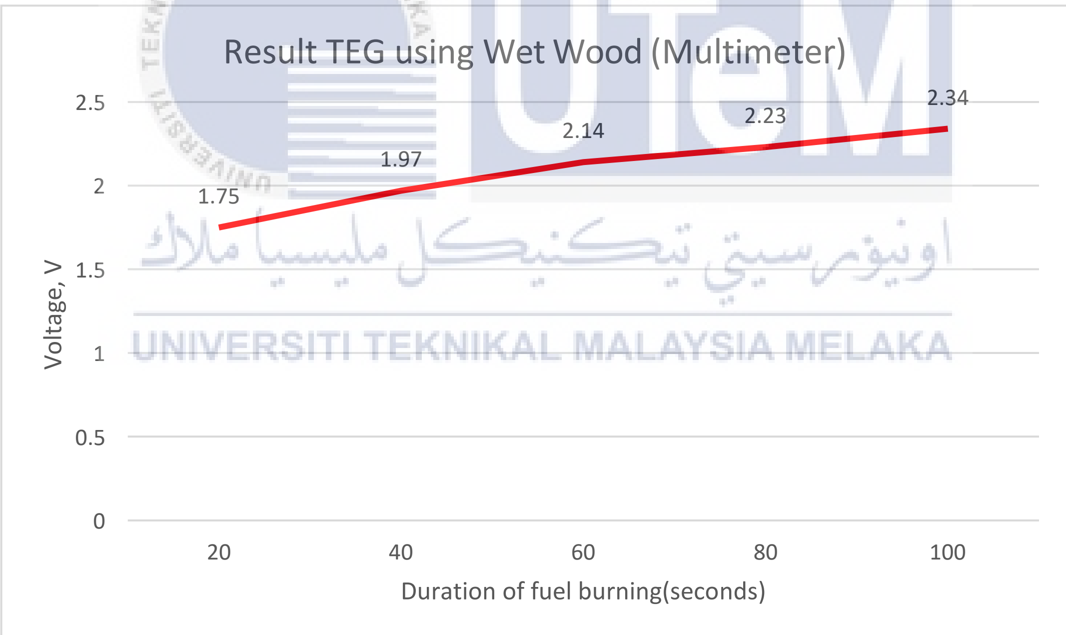

Figure 4-6 TEG Voltage Output using Wet Wood

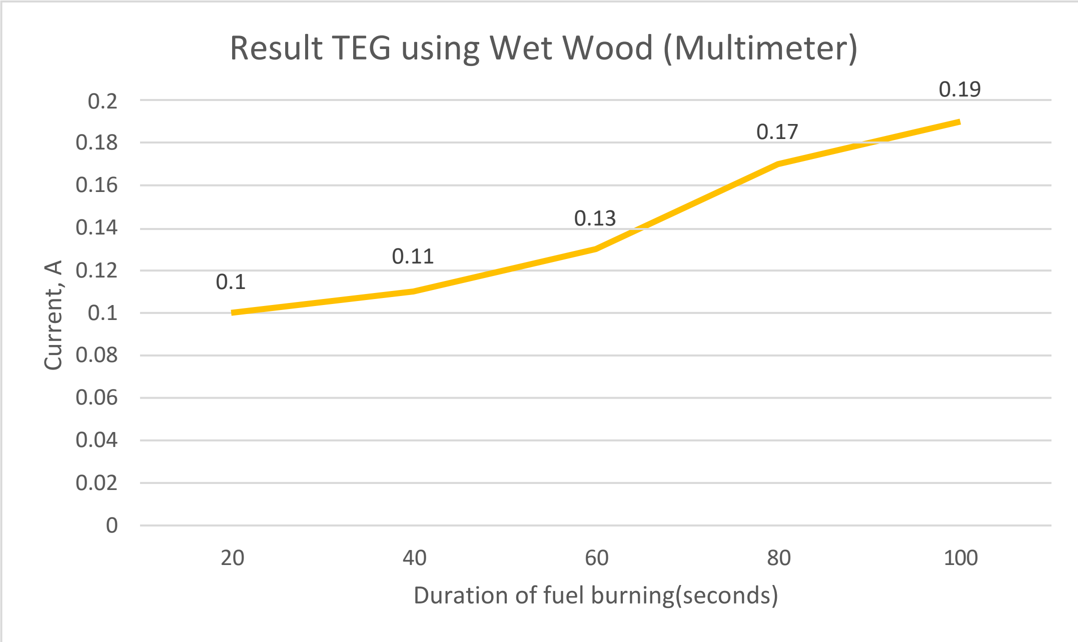

Figure 4-7 TEG Current Output using Wet Wood

4.5.1.3 Comparison between Voltage and Current for Dry Wood and Wet Wood

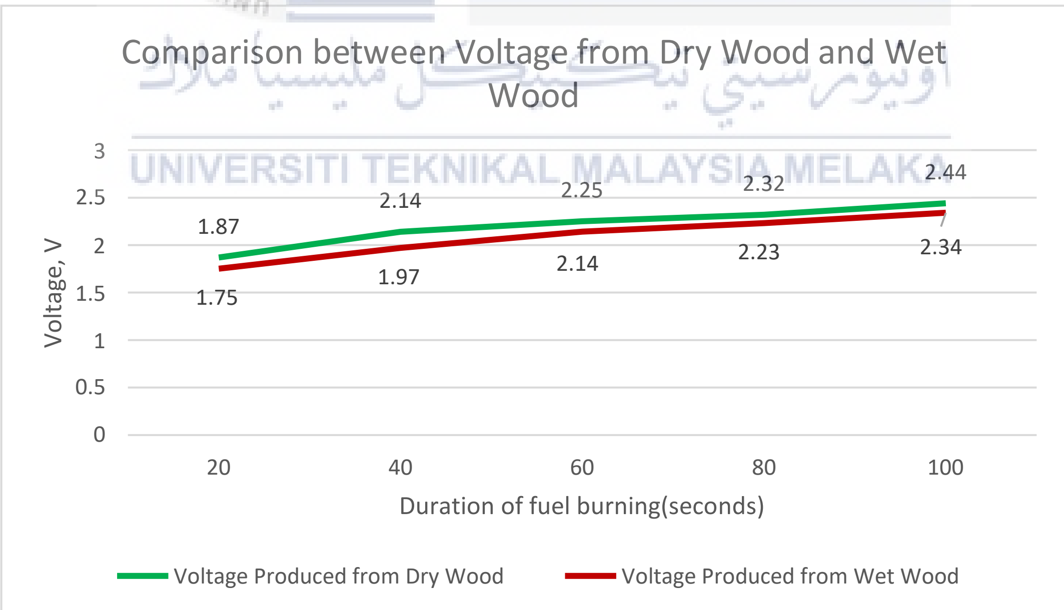

Figure 4-8 Comparison TEG Voltage Output from Dry Wood and Wet Wood

The differences in thermoelectric voltage output produced between dry wood and wet wood in the specified material are depicted in Figure 4-8. After doing the analysis, it was discovered that the voltage production is greater when dry wood is burned as opposed to wet wood. This mismatch can be defined to the inefficiency of heat transmission to the thermoelectric generator system while burning wet wood. This is because the moisture content in the wood makes it difficult for the wood to effectively burn and generate heat.

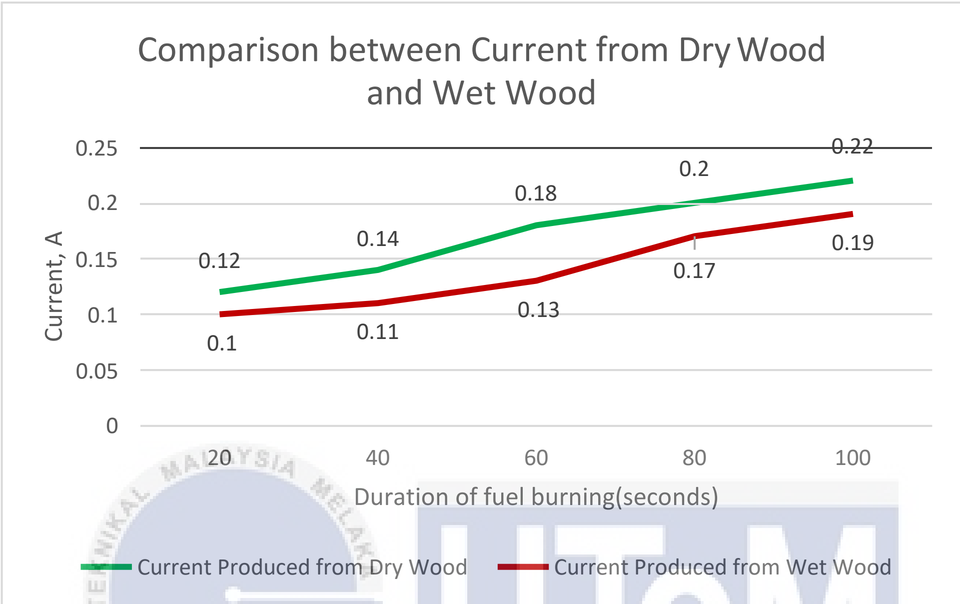

Figure 4-9 Comparison TEG Current Output from Dry Wood and Wet Wood

An illustration of the difference in thermoelectric current output between dry wood and wet wood in the material that was specified may be found in Figure 4-8. According to the data, the amount of current produced by burning dry wood is more than the amount produced by burning wet wood. This mismatch emerges due to the fact that when wet wood is utilised, the combustion of leaves and the fire are unable to transmit heat to the thermoelectric generating system in an efficient manner.

4.5.2 Experimental using Leaves

Given their commonly available presence, leaves might be considered a common biomass resource. Furthermore, the testing process is separated into dry and wet conditions. A multimeter is used to evaluate the parameters.

Because leaves burn easily and quickly raise the temperature, they produce a lot of energy. Although the output is considerable, the voltage and current decreased dramatically due to the ease with which the fire was doused by the leaves.

4.5.2.1 Dry Leaves Experimental Result

Table 4-3 TEG output produced using Dry Leaves

Duration of fuel burning (seconds)	Voltage produced (V)	Current produced (A)	Power (P)
20	4.96	0.18	0.89
40	6.85	0.21	1.44
60	7.88	0.24	1.89
80	6.73	0.19	1.27
100	5.54	0.16	0.89

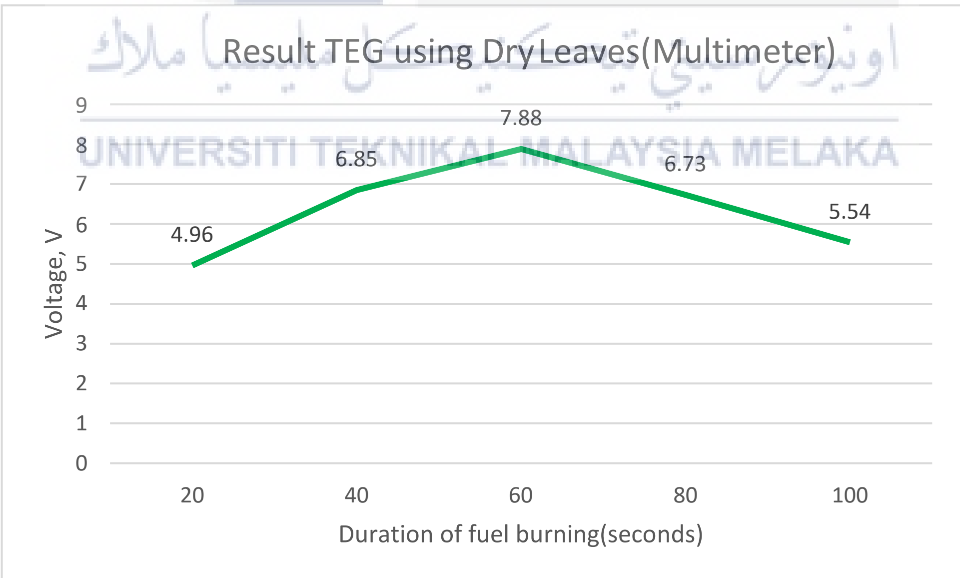

Figure 4-10 TEG Voltage Output using Dry Leaves

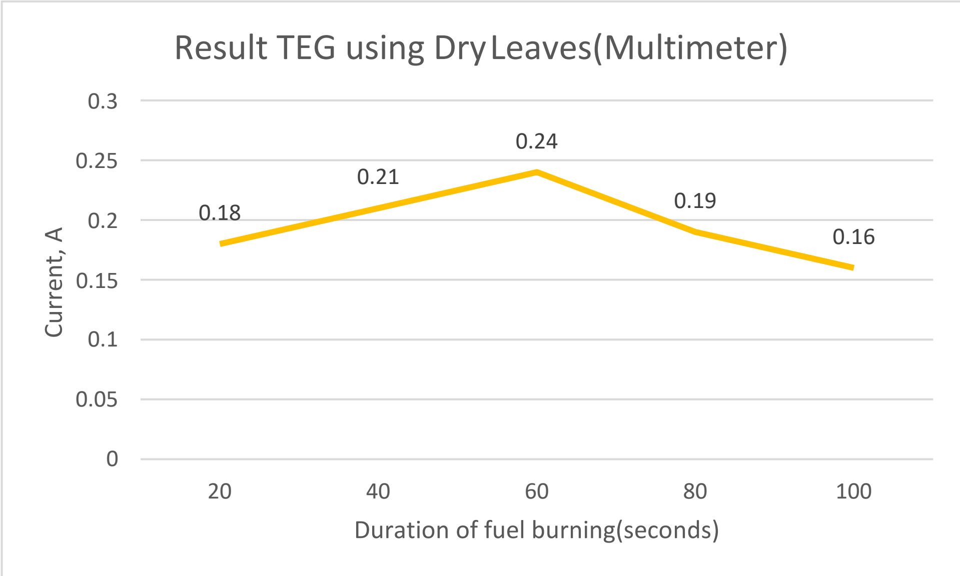

Figure 4-11 TEG Current Output using Dry Leaves

4.5.2.2 Wet Leaves Experimental Result

Table 4-4 TEG output produced using Wet Leaves

Duration of fuel burning (seconds)	Voltage produced (V)	Current produced (A)	Power (P)
20	4.23	0.14	0.59
40	5.98	0.18	1.08
60	7.09	0.19	1.35
80	5.65	0.16	0.90
100	4.83	0.14	0.68

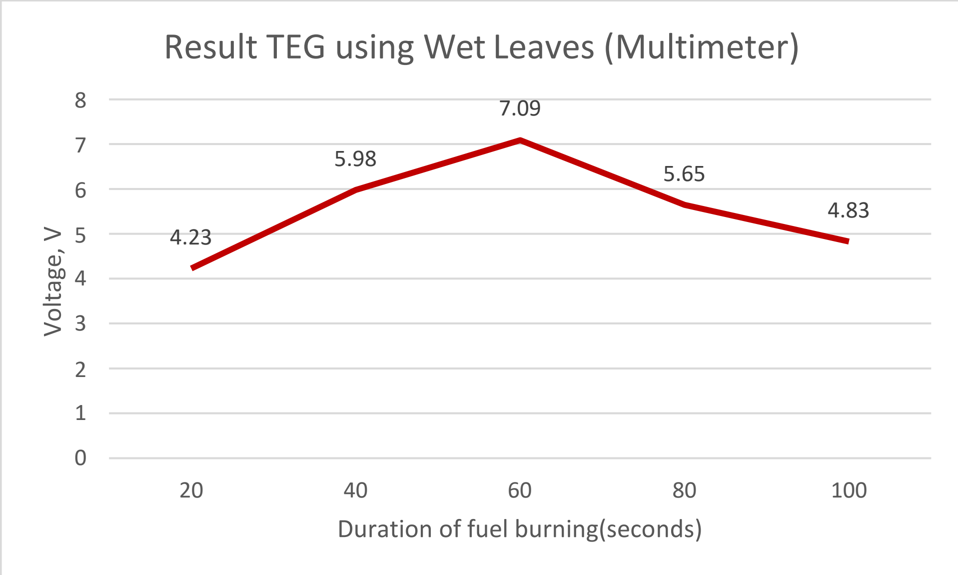

Figure 4-12 TEG Voltage Output using Wet Leaves

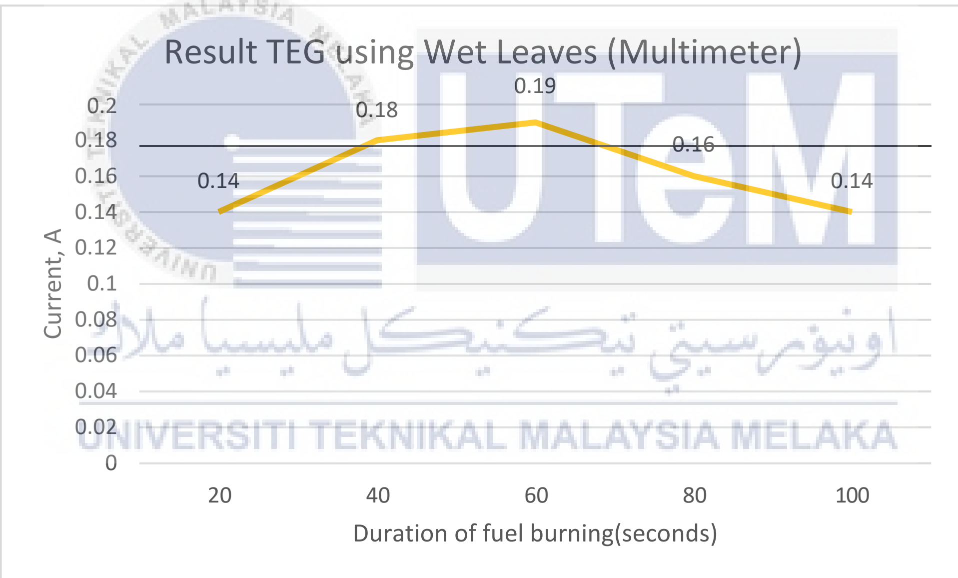

Figure 4-13 TEG Current Output using Wet Leaves

4.5.2.3 Comparison between Voltage and Current for Dry Leaves and Wet Leaves

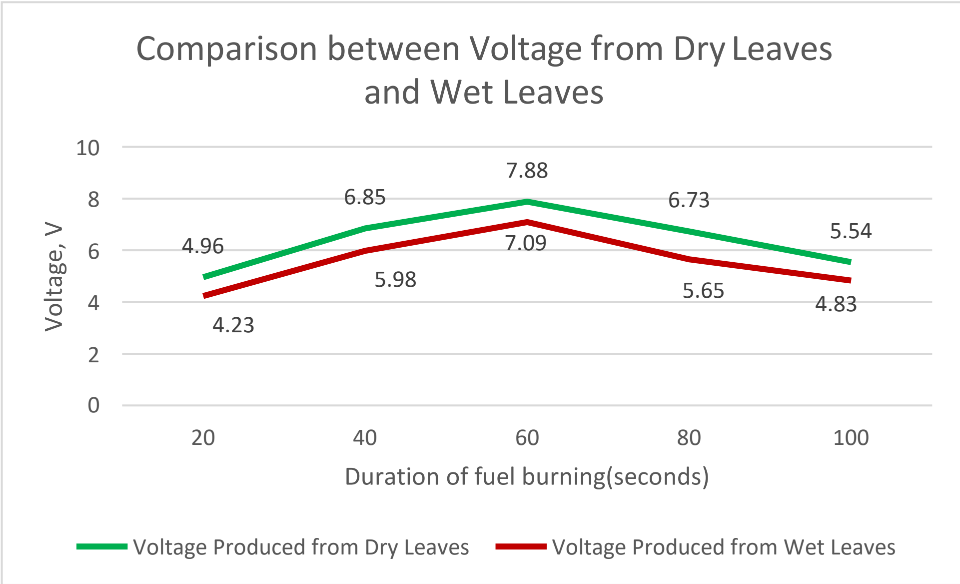

Figure 4-14 Comparison TEG Voltage Output for Dry Leaves and Wet Leaves

Figure 4-14 illustrates a comparison of the thermoelectric voltage output of dry leaves and wet leaves for the material that is being looked at. According to the findings, the voltage output is greater when dry leaves are burned as opposed to wet leaves if the leaves are burned. When wet leaves are burned, the heat transmission to the thermoelectric generator system is inefficient because the moisture content slows down the combustion process. The reason for this difference can be related to the fact that the wetness content prevents proper combustion. As an additional point of interest, leaves have a tendency to convert into ash more rapidly than wood does.

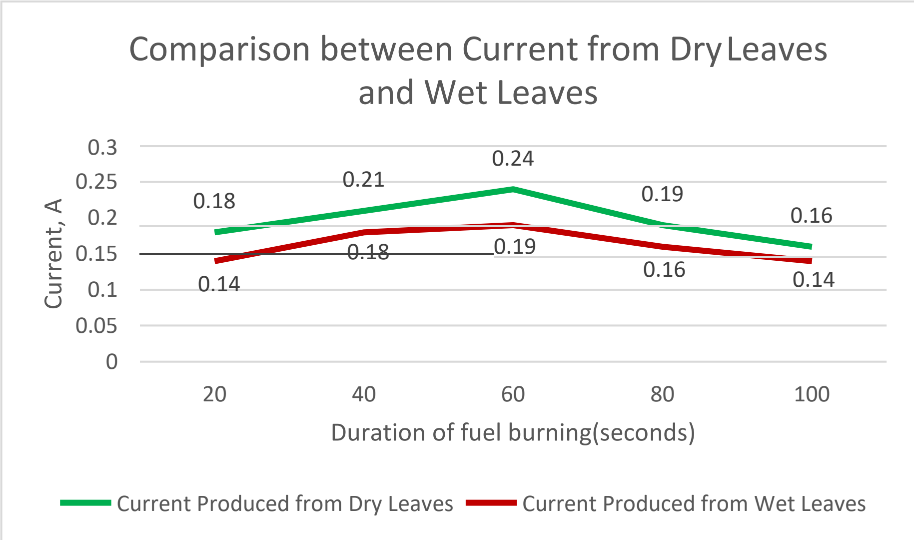

Figure 4-15 Comparison TEG Current Output for Dry Leaves and Wet Leaves

Figure 4-15 shows the difference in thermoelectric current output that occurs between dry leaves and wet leaves for the material that is being explored. According to the data, the amount of current produced is greater when dry leaves are burned as opposed to wet leaves after being burned. The poor performance of heat transmission to the thermoelectric generator system that occurs when wet leaves are burned is the cause of this gap. This is because the wetness of the leaves prevents them from burning effectively. As an additional point of attraction, leaves have a tendency to convert into ash more quickly than wood does.

4.6 Wood using Blynk App

The test was repeated to check whether there was a change if the output was routed via the Blynk system, which was established for monitoring reasons. The test was likewise separated into two conditions: dry and wet. The result is then compared to the multimeter reading.

4.6.1 Dry Wood Blynk Experimental Result

Table 4-5 Comparison between Blynk and Multimeter for Dry Wood

Duration of fuel burning (seconds)	Voltage produced from Blynk (V)	Voltage produced multimeter (V)
20	1.82	1.87
40	2.07	2.14
60	2.19	2.25
80	2.28	2.32
100	2.40	2.44

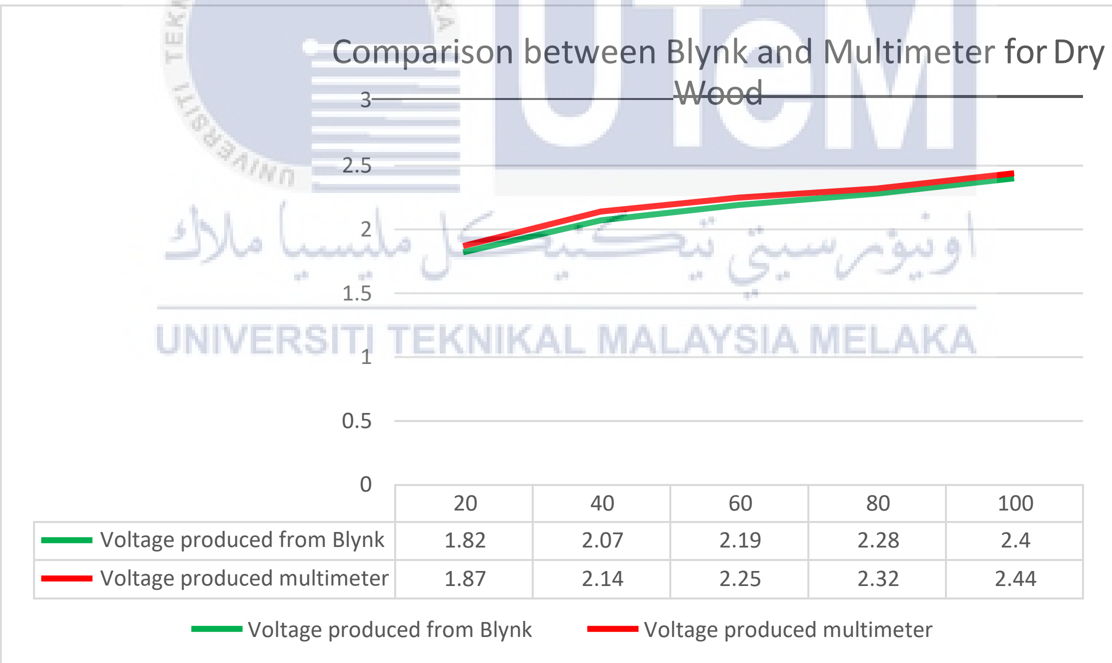

Figure 4-16 Comparison between Blynk and Multimeter for Dry Wood

The fundamental distinction in voltage measurement between a multimeter and Blynk lies in the tools employed and the methodology of data collection. A multimeter is a tangible, portable device equipped with probes, enabling the direct measurement of voltage by connecting to the specific circuit or component under consideration. Conversely, Blynk functions as a software platform or application commonly used for electronic device control and remote monitoring, potentially incorporating voltage measurement capabilities.

In the Blynk scenario, voltage measurement can be conducted using a sensor connected to a microcontroller or similar hardware. Following this, the data is transmitted to the Blynk platform for display or further processing. This introduces a layer of digital communication and the potential for wireless connectivity, distinguishing it from the hands-on approach of a multimeter.

Regarding specific readings, a multimeter indicates a voltage of 1.87V, while the Blynk reading is slightly lower at 1.82V. This results in a difference of 0.05V between the two measurements. The direct, manual nature of the multimeter contrasts with the digital and potentially remote aspects of voltage measurement through Blynk, emphasizing the varied approaches these tools employ in capturing and presenting voltage data.

4.6.2 Wet Wood Blynk Experimental Result

Table 4-6 Comparison between Blynk and Multimeter for Wet Wood

Duration of fuel burning (seconds)	Voltage produced from Blynk (V)	Voltage produced multimeter (V)
20	1.63	1.75
40	1.82	1.97
60	1.95	2.14
80	2.12	2.23
100	2.25	2.34

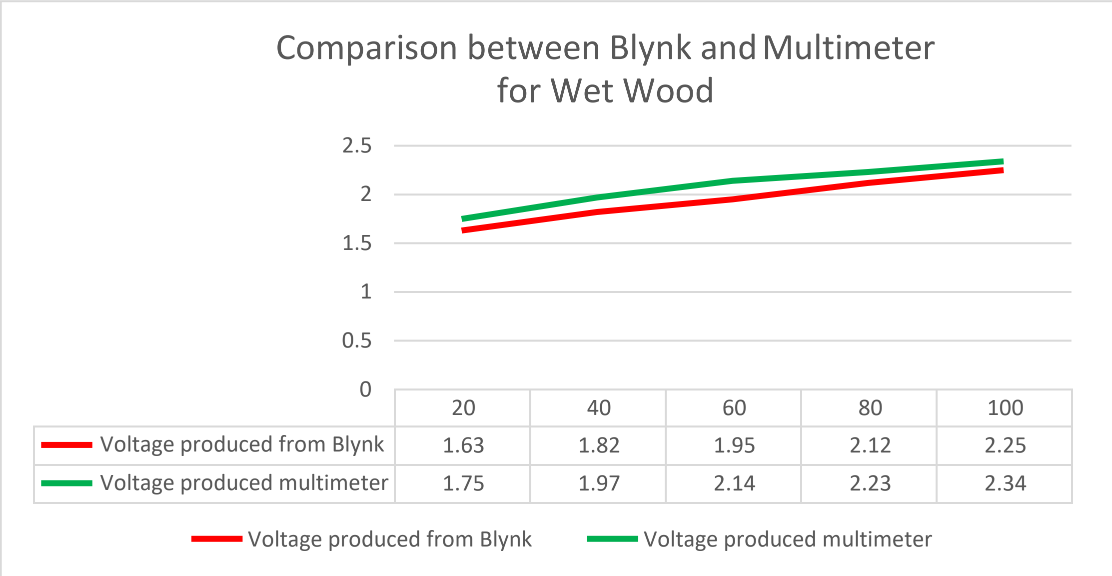

Figure 4-17 Comparison between Blynk and Multimeter for Wet Wood

The core distinction in voltage measurement between a multimeter and Blynk lies in the utilized instruments and the methodology of data collection. A multimeter, a tangible and portable device equipped with probes, facilitates direct voltage measurement by establishing a connection with the specific circuit or component under examination. In contrast, Blynk serves as a software platform or application commonly employed for electronic device control and remote monitoring, potentially encompassing voltage measurement capabilities.

In the context of Blynk, voltage measurement can be executed using a sensor connected to a microcontroller or analogous hardware. Subsequently, the data is transmitted to the Blynk platform for display or further processing. This introduces a layer of digital communication and the potential for wireless connectivity, distinguishing it from the hands-on methodology of a multimeter.

Regarding specific readings, a multimeter indicates a voltage of 1.75V, while the Blynk reading is marginally lower at 1.63V. This yields a difference of 0.12V between the two measurements. The manual, direct nature of the multimeter stands in contrast to the digital and potentially remote aspects of voltage measurement through Blynk, highlighting the diverse approaches these tools employ in capturing and presenting voltage data.

4.7 Leaves using Blynk App

The test was performed to see if there was a difference when the output was routed via the Blynk monitoring system. Similarly, the test was divided into two conditions: dry and wet. The result is then compared to the reading from the multimeter.

4.7.1 Dry Leaves Blynk Result

Table 4-7 Comparison between Blynk and Multimeter for Dry Leaves

Duration of fuel burning (seconds)	Voltage produced from multimeter (V)	Voltage produced from Blynk (V)
20	4.96	4.60
40	6.85	6.25
60	7.88	7.68
80	6.73	6.23
100	5.54	5.31

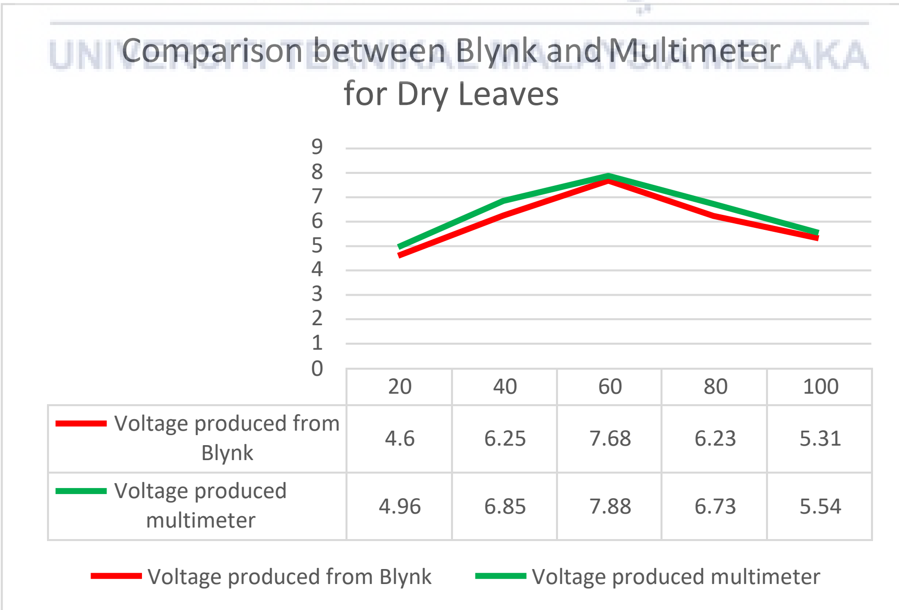

Figure 4-18 Comparison between Blynk and Multimeter for Dry Leaves

The primary distinction in voltage measurement between a multimeter and Blynk lies in the tools used for measurement and the method of data collection. A multimeter is a physical, portable device equipped with probes, enabling direct voltage measurement by establishing a connection with the specific circuit or component under consideration. On the other hand, Blynk is a software platform or application commonly utilized for electronic device control and remote monitoring, potentially incorporating voltage measurement features.

In the case of Blynk, the voltage measurement may be conducted using a sensor connected to a microcontroller or similar hardware. Subsequently, the data is transmitted to the Blynk platform for display or further processing. This introduces a layer of digital communication and the possibility of wireless connectivity, setting it apart from the hands-on methodology of a multimeter.

Comparatively, if we consider specific readings, the multimeter indicates a voltage of 4.90V, whereas the Blynk reading is slightly lower at 4.60V. This results in a difference of 0.30V between the two measurements. The hands-on, direct nature of the multimeter contrasts with the digital, potentially remote aspects of voltage measurement through Blynk, highlighting the diverse approaches these tools take in acquiring and presenting voltage data.

4.7.2 Wet Leaves Blynk Result

Table 4-8 Comparison between Blynk and Multimeter for Wet Leaves

Duration of fuel burning (seconds)	Voltage produced from multimeter (V)	Voltage produced from Blynk (V)
20	4.23	4.18
40	5.98	5.87
60	7.09	7.02
80	5.65	5.61
100	4.83	4.79

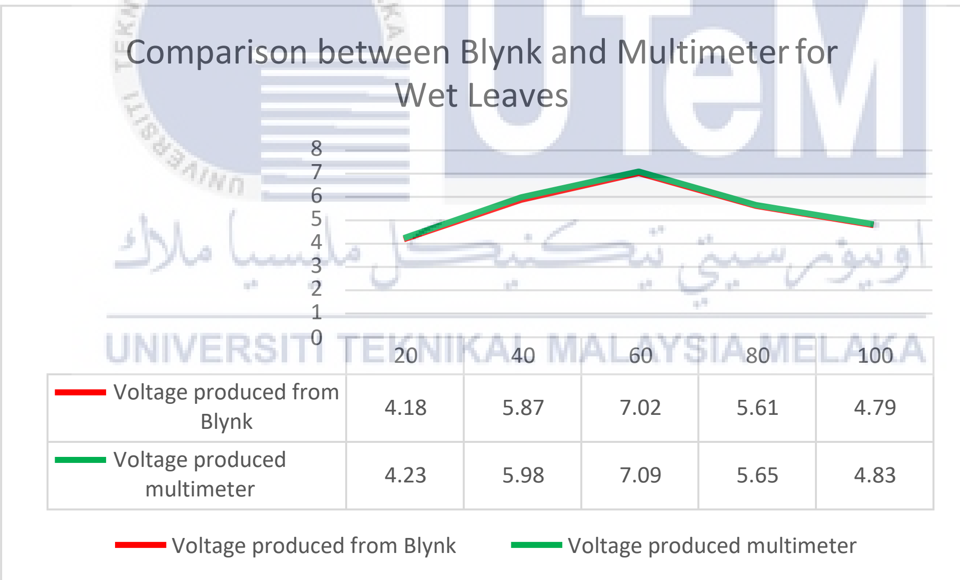

Figure 4-19 Comparison between Blynk and Multimeter for Wet Leaves

The primary difference in measuring voltage between a multimeter and Blynk lies in the instruments utilized and the approach to data collection. A multimeter is a tangible, portable device equipped with probes, facilitating direct measurement of voltage by connecting to the specific circuit or component in question. Conversely, Blynk serves as a software platform or application commonly employed for electronic device control and remote monitoring, potentially integrating voltage measurement capabilities.

In the scenario of Blynk, voltage measurement can be carried out using a sensor linked to a microcontroller or similar hardware. Subsequently, the data is transmitted to the Blynk platform for display or further processing. This introduces a layer of digital communication and the potential for wireless connectivity, distinguishing it from the hands-on methodology of a multimeter.

In terms of specific readings, a multimeter indicates a voltage of 4.23V, while the Blynk reading is slightly lower at 4.18V. This yields a difference of 0.05V between the two measurements. The direct, manual nature of the multimeter stands in contrast to the digital and potentially remote aspects of voltage measurement through Blynk, underscoring the diverse approaches these tools employ in capturing and presenting voltage data.

4.8 Experiment To Test Battery Charging Using Different Power Sources

The primary purpose of the biomass system is to simplify the recharging of lithium-ion batteries. An experiment was conducted to evaluate the efficiency of each power source in charging the batteries, to determine which source is superior in terms of charging. The experiment was carried out at five-minute intervals. The initial battery level was set at 80%.

4.8.1 Experimental Charging Test Using Wood

Table 4-9 Battery Percentage Charging for Wood

Time applied (min)	Voltage produced (V)	Battery percentage (%)
5	4.35	81
10	6.98	82
15	8.36	83
20	8.77	84
25	8.97	85

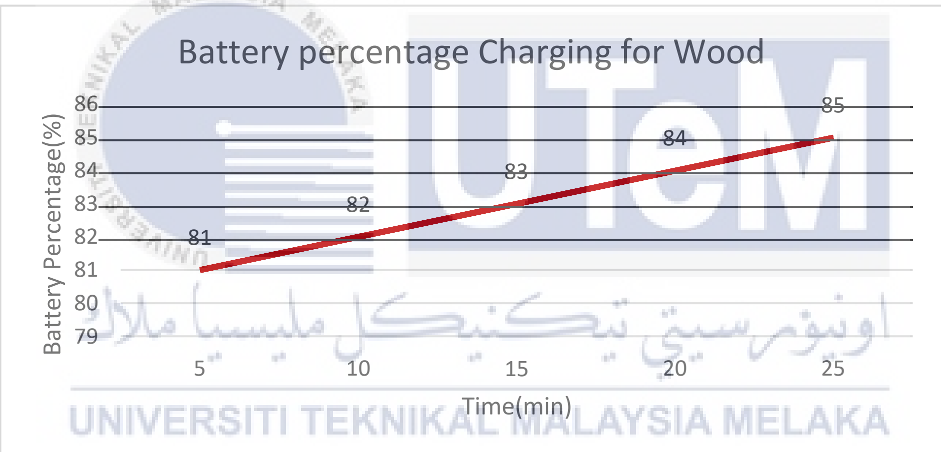

Figure 4-20 Battery Percentage Charging for Wood

4.8.2 Experimental Charging Test Using Leaves

Table 4-10 Battery Percentage Charging for Leaves

Time applied (min)	Voltage produced (V)	Battery percentage (%)
5	7.85	82
10	9.23	84
15	9.54	84
20	7.89	83
25	5.45	81

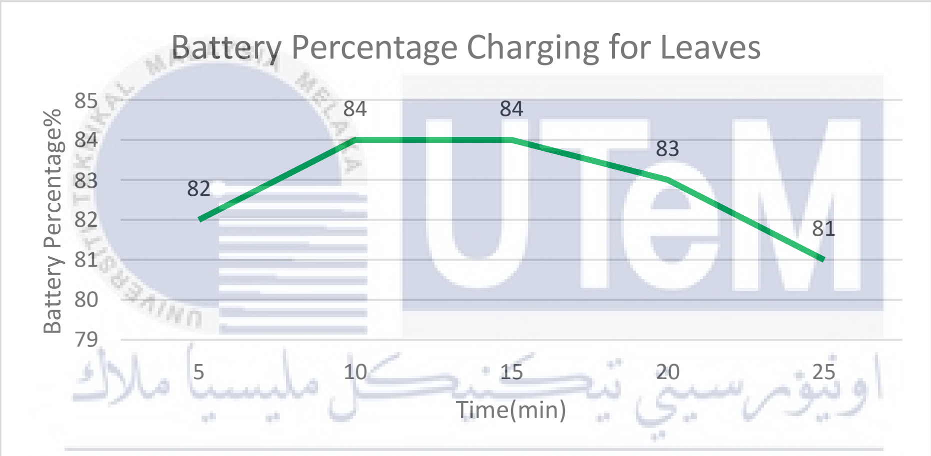

Figure 4-21 Battery Percentage Charging for Leaves

4.9 Comparison Between Voltage Produced For Different Types Of Material

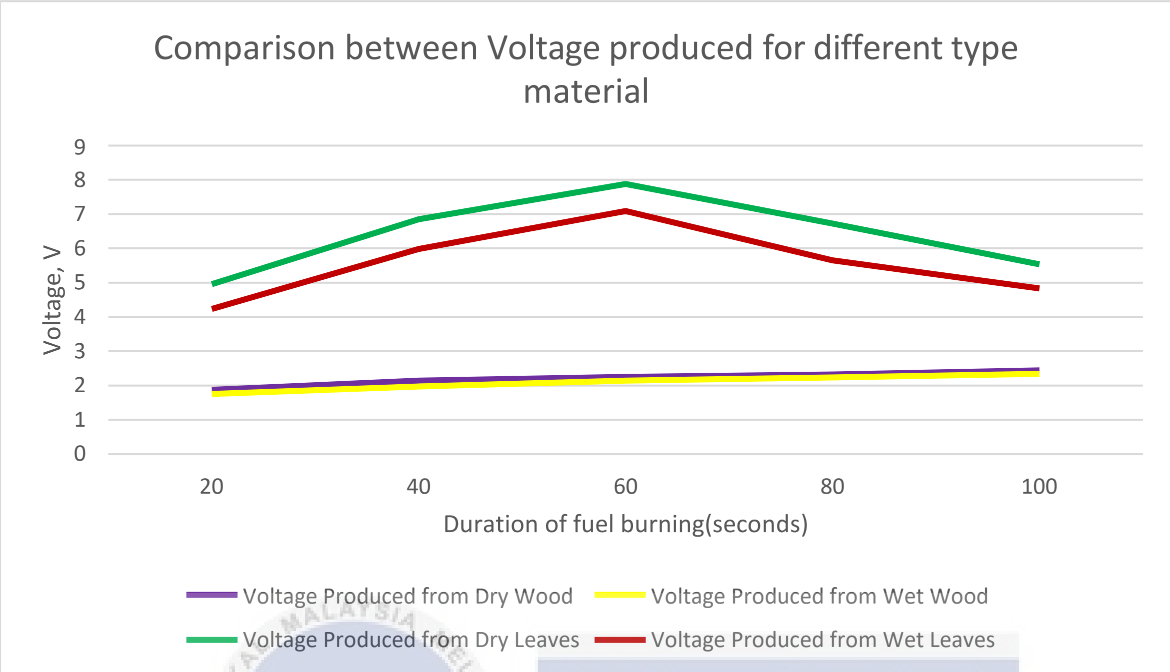

Figure 4-22 Comparison TEG Voltage Output from different raw materials

According to figure 4-22, the fuel burning time duration ranges from 20s to 100s. When comparing the voltage of dry and wet material leaves to dry and wet wood, the dry one shows a higher voltage. The burning of leaves is faster compared to wood, making it easier to quickly heat a thermoelectric generator. Wood generates a greater amount of voltage than leaves do during the course of the production process. Additionally, leaves have a higher combustion rate than wood, making them less effective for charging batteries. Wood is the optimum choice of fuel due to its slow and sustained burning, resulting in superior performance compared to leaves.

4.10 Summary

The findings of the study have been recorded and compared in both wet and dry circumstances for each source. The production of wet fuels is lower than the yield of dried fuels. The combustion lifetime of wood is longer than that of leaves. However, for testing purposes, the time limit was set to a maximum of 100 seconds in order to measure the output produced within the specified period of time. In addition, leaves generate more voltage and current compared to woods. However, leaves have a shorter burning duration, which causes a lower efficiency. Furthermore, leaves are less efficient for charging batteries compared to wood because of their greater combustion rate. Wood is the optimal fuel choice due to its slow and extended combustion, resulting in an ongoing rise in production.

CHAPTER 5

CONCLUSION

5.1 Introduction

This chapter highlights the goals, methods, and conclusions acquired from the data while discussing the effects of portable biomass energy storage employing various biomass energy sources. To further enhance the development of this system, this would be helpful for future initiatives.

5.2 Summary Of the Project

With this innovative portable biomass energy storage solution, trekkers and campers can now venture into the forests with the assurance that they will maintain connectivity with the modern world. This device allows them to charge their phones and other essential technological devices by harnessing the power of biomass, bridging the divide between nature and technology. No longer will they feel isolated in the wilderness, as this compact and eco-friendly energy storage system will allow them to remain connected, capture unforgettable moments, and even seek assistance in the event of an emergency. This extraordinary innovation allows people who like to explore the great outdoors without sacrificing connectivity or peacefully, ushering in a new era of harmonious coexistence between nature and modern living.

5.3 Future Works

This concept employs a small metal tray that can only hold five to ten TEG modules, limiting the system's output power. It is strongly advised that the present metal tray be replaced with a larger metal tray or any metal item in order to fit more TEG modules and hence provide higher output power. Aside from that, it is also recommended to utilize cold water instead of warm water to enhance temperature differences, which may aid generate greater output power. Not only that, but battery storage should be improved so that campers or hikers may charge their gadgets more regularly.

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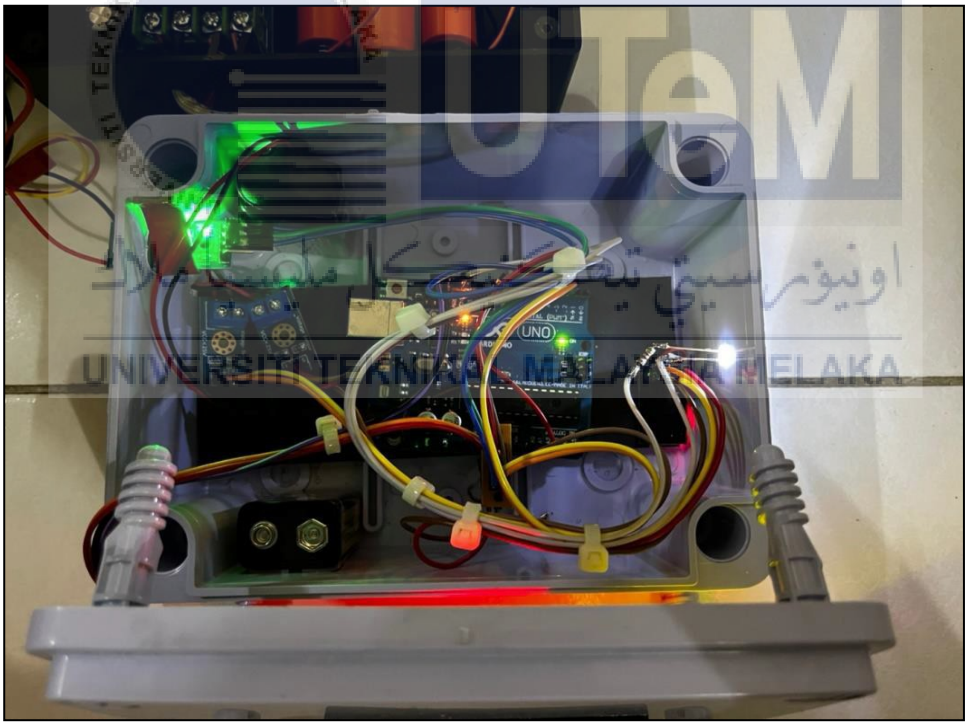
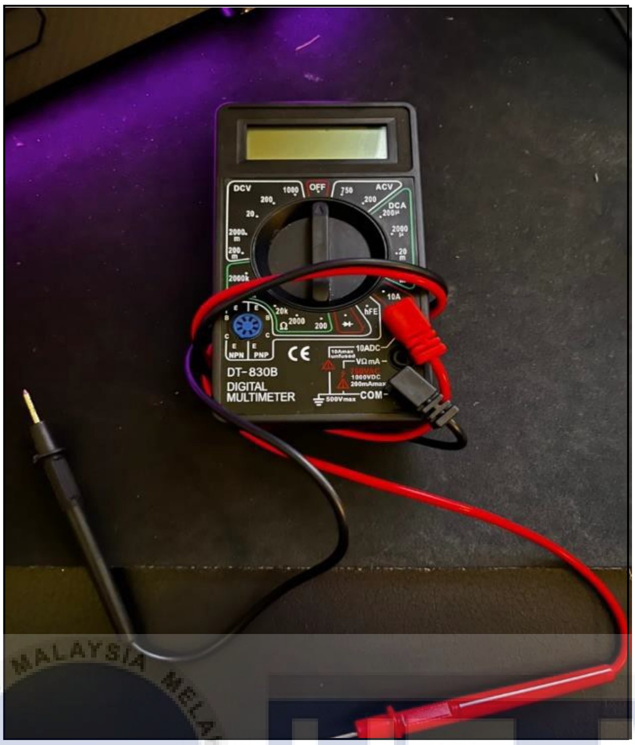
APPENDICES

Appendix A Portable Biomass Energy Storage With Iot Monitoring System For Domestic Usage


B3 (%)= 106.85
PLT(v)= 0.20



Appendix B Measurement Equipment



Appendix C Coding for IoT System Blynk App

```
#define BLYNK_TEMPLATE_ID "TMPLcZArH274"
#define BLYNK_DEVICE_NAME "IOT FYP"
#define BLYNK_AUTH_TOKEN "vLML8NGYce-UV1DxQn8aLvEkoYPRojfj"

#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27,16,2);

int ldr =6;
int Pin8 =8;
int Pin9 =9;
int LED =10;
int offset1 =20;
int offset2 =20;

#define BLYNK_PRINT Serial


#include <ESP8266_Lib.h>
#include <BlynkSimpleShieldEsp8266.h>

char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "anaksoleh@2.4";
char pass[] = "7143ytjt";


#include <SoftwareSerial.h>
SoftwareSerial EspSerial(2, 3); // RX, TX

#define ESP8266_BAUD 9600
ESP8266 wifi(&EspSerial);

void setup()
{

  Serial.begin(9600);
  EspSerial.begin(ESP8266_BAUD);
  delay(10);

  lcd.init(); //initialize the lcd
  lcd.begin(16,2);   // iInit the LCD for 16
  lcd.backlight();

  pinMode(ldr,INPUT);
  pinMode(Pin8,INPUT_PULLUP);
  pinMode(LED,OUTPUT);
  pinMode(Pin9,OUTPUT);
```

```
  Blynk.begin(auth, wifi, ssid, pass, "blynk.cloud", 80);

}

void loop()
{
  int volt1 = analogRead(A0);
  double percentage = map(volt1,205,455, 0, 2500) ;
  percentage/=24.8;

  double voltage1 = map(volt1,0,1023, 0, 2500)+ offset1 ;
  voltage1/=100;

  lcd.setCursor(0, 0);
  lcd.print("B3 (%)= ");
  lcd.print(percentage);
  lcd.print(" ");
  Serial.println(percentage);
  Serial.print("%");
  delay(10);
  Blynk.virtualWrite(V2,percentage);

  int volt2 = analogRead(A1);
  double voltage2 = map(volt2,0,1023, 0, 2500) + offset2;
  voltage2 /=100;
  Blynk.virtualWrite(V0,voltage1);

  lcd.setCursor(0, 1);
  lcd.print("PLT(v)= ");
  lcd.print(voltage2);
//Serial.println(voltage2);
//delay(500);
  Blynk.virtualWrite(V1,voltage2);

  if ((digitalRead(Pin8)==1)||(digitalRead(ldr)==1)){
  digitalWrite(LED,HIGH);
}

else{
  digitalWrite(LED,LOW);
  Blynk.run();

}

}
```

Appendix D Gantt Chart

BDP1	WEEK													
PROGRESS	1	2	3	4	5	6	7	8	9	10	11	12	13	14
BDP 1 briefing by JK PSM, FTKEE														
Project Title Confirmation														
Chapter 1 Draft Discussion with Supervisor														
Report Writing: Chapter 1 (introduction, Problem statement, Objective, Scope)														
Chapter 1 Draft Submission														
Chapter 2 Draft Discussion with Supervisor														
Report Writing: Chapter 2(Literature Review)														
Chapter 2 Draft Submission														
Chapter 3 Draft Discussion with Supervisor														
Report Writing: Chapter 3 (Methadology)														
Chapter 3 Draft Submission														
Chapter 1,2 and 3 Correction														
Chapter 1,2,3 Final Submission														
Construct Presentation Slide														
BDP 1 PRESENTATION AND ASSESSMENTS														

BDP2	WEEK													
PROGRESS	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Full Hardware Preparation for the project														
Hardware Testing														
Construct Actual Project														
Actual Project Troubleshoot														
Create Data Table for Analysis														
Full Project Testing and Experiment														
Collect the Data From the Experiment														
Organize Data														
Analysis Data														
Draft Report BDP 2 Submission to Supervisor														
Correction and Recommendation for Draft Report BDP 2														
Full Report BDP 2 Writing														
Presentation Preparation for BDP 2														
Full Presentation of BDP 2														
Report Submission														