Faculty of Electrical and Electronic Engineering Technology

VIABILITY STUDY ON DIFFERENT TYPE OF RENEWABLE ENERGY IN MALAYSIA USING HOMER

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Bachelor of Electrical Engineering Technology with Honours

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VIABILITY STUDY ON DIFFERENT TYPE OF RENEWABLE ENERGY IN MALAYSIA USING HOMER

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A project report submitted
in partial fulfillment of the requirements for the degree of
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DECLARATION

I declare that this project report entitled "VIABILITY STUDY ON DIFFERENT TYPE OF RENEWABLE ENERGY IN MALAYSIA USING HOMER" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Student Name : AMIZATUL AFZAN BINTI ZAHARUDDIN

Date : 11/01/2022

APPROVAL

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

Signature :

Supervisor Name : DR. AZHAN BIN AB. RAHMAN

Date : 11 JANUARY 2022

Signature :

Co-Supervisor Name (if any) :

Date :

DEDICATION

To my beloved mother, xxxxxx, and father, xxxxxx,

and

To dearest wife, xxxxxx and

My son, xxxxxx

(example only)

ABSTRACT

Energy is critical to a country's survival, as practically everything is dependent on it. Generally speaking, there are two types of energy available which is renewable energy and non-renewable energy. Renewable energy comes from natural resources such as solar, wind, tidal, and biomass, while non-renewable energy comes from fossil fuels. There are a lot of benefits to using renewable energy to generate electricity. However, according to National Energy Balance in 2010, the researcher found that 40% of Malaysia's electricity is generated from non-renewable energy. This paper will study different types of renewable energy in Malaysia to find the most suitable potential renewable energy based on the three main factors: geographical data, the technology used, and investment return. The application HOMER provides reliable data based on the selected locations to find the most viable renewable energy. Based on the initial results, Sabah has been chosen as a starting location for the study as the place has 2 out of 3 renewable energies available. The result shows the annual data by year the estimated cost for installing solar photovoltaics and wind turbine for the small scale location. Malaysia's energy status is provided in this study, particularly in the renewable energy sector, and can serve as a springboard for further research and development in this field.

ABSTRAK

Tenaga merupakan satu elemen penting untuk sesebuah negara dalam menjalani kehidupan pada setiap hari. Tenaga terbahagi kepada dua jenis iaitu tenaga yang boleh diperbaharui and tidak boleh diperbaharui. Tenaga yang boleh diperbaharui datangnya dari sumber alam seperti cahaya matahari, angin, dan biojisim. Biojisim ini menggunakan bahan lebihan aktiviti seperti perkebunan dan perladangan. Terdapat banyak kelebihan yang dapat diperolehi oleh sesebuah negara jika menggunakan tenaga yang boleh diperbaharui. Namun, berdasar kajian yang dijalankan oleh National Energy Balance pada tahun 2010, 40% arus elektrik di Malaysia masih diproses dari tenaga tidak boleh diperbaharui. Jadi, kajian ini dijalankan untuk mengkaji pelbagai jenis tenaga yang boleh diperbaharui di Malaysia supaya dapat mencari satu tenaga yang berpotensi dalam menjana elektrik. Kajian ini dijalankan berdasarkan tiga faktor utama seperti data kedudukan, teknologi yang digunakan dan pemulangan dalam menjana elektrik menggunakan tenaga yang boleh diperbaharui. Aplikasi HOMER digunakan di dalam kajian ini kerana untuk mengeluarkan maklumat yang dikehendaki, data tentang lokasi tersebut perlulah digunakan dan HOMER mempunyai data tentang lokasi tersebut berdasar lokasi yang dikehendaki. Berdasarkan data yang dianalisis, Sabah telah dipilih untuk menjalankan simulasi bagi mencari kesesuain tempat dan kos bagi pemasangan solar dan turbin angin. Kajian ini telah dapat menunjukkan status tenaga yang boleh diperbaharui pada peringkat awal dengan harapan makumat tersebut dapat menggalakkan lagi kajian di dalam sektor tenaga.

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My highest appreciation goes to my parents, parents in-law, and family members for their love and prayer during the period of my study. An honourable mention also goes to xxxxxx for all the motivation and understanding. And to xxxxx, thanks for …….

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δ	-	Voltage angle

LIST OF ABBREVIATIONS

V	-	Voltage
	-	
	-	
	-	
	-	
	-	
	-	
	-	

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CHAPTER 1

INTRODUCTION

1.1 Background

Energy is an essential part of a country as almost everything is related to using energy. For example, watching television, washing clothes, lighting the home, and others. Those activities show that energy is vital to human society. There are two kinds of renewable and non-renewable energy sources. Renewable energy is generated from natural sources that are constantly refilled but not renewable. In Malaysia, the primary source for electricity generation is fossil fuels, non-renewable energy. According to National Energy Balance in 2010, the researcher found that 40% of the country's electricity is generated from non-renewable energy. This has become a concerning matter because energy will run out. It is also significantly harmful to the environment as burning fossil fuels pollutes the atmosphere, which can cause chronic diseases related to respiratory problems. Moreover, the burning process also increases greenhouse gas emissions, changing weather patterns, such as increasing the temperature. So, we need to study the most suitable renewable energy that is the primary source to generate electricity in Malaysia.

The most potential renewable energy in Malaysia are solar, wind, and biomass. Solar energy is the type of energy that generates energy from radiant light and heat from the sun using photovoltaic and solar thermal technology. The irradiation during the North-East Monsoon increased due to winds from Central Asia to the South China Sea via Malaysia. With the technologies, solar energy usage has risen for homes and businesses. Malaysia is strategically located near the equator with a higher potential for solar uptake. Solar generation potential in Malaysia has estimated can reach up to 6500MW (Ahmad, et al., 2011).

Next, wind energy is one of the renewable energy in Malaysia. The wind is the air movement in response to pressure within the atmosphere. Wind turbines process the wind that has kinetic energy into mechanical power. Malaysia is well-known as a low-speed wind location since Malaysia has low-speed wind compared to the Indian Ocean and the South

China Sea with solid winds (Ibrahim, et al., 2015). 1.5 to 4.5 m/s is the average range of monthly wind speed (Zaharim, et al., 10–12 July 2017).

Biomass is renewable organic material that comes from plants and animals, for example, energy crops and waste from forests, yards, and farms. It contains chemical energy from the sun, and plants produce biomass through photosynthesis. There are various ways that biomass can create power which is burning. Mostly electricity that generated from biomass produced by direct combustion. To have high-pressure steam, biomass is burned in a boiler, and the stream flows over a series of turbine rotating blades that drive the generator and produce electricity. Bacterial decomposition is also another process for biomass. An anaerobic bacteria collect material waste in oxygen-free tanks producing methane and other natural gas renewables to be purified. The last process is gasification and pyrolysis. Malaysia is one of the largest palm oil producers, making it a substantial potential resource for biomass. (Ozturk, et al., 2017). It is an advantage for Malaysia as biomass is always available, and these resources are easily stored. It also can reduce waste while generating electricity.

This study aims to determine the state and locate the most viable renewable energies that can develop into the primary energy source for electricity generation. The benefits of renewable energy can bring many benefits the environment.

1.2 Problem Statements

Malaysia is rich in renewable energy, including solar, wind, and biomass. However, in this study, we need to find the most potential renewable energy among the others that available for today's environment.

The main factor that needs to be studied to implement renewable energy is the geographical factor. So, we should use an application that provides the current data of the location. Moreover, renewable energy will bring many benefits to Malaysia as it is unlimited resources and help to decrease the greenhouse gas emitted, leading to a clean environment. Therefore, the usage of renewable energy should be growing for a better future.

1.3 Project Objectives

- To analyse the renewable energy that has the highest potential in Malaysia.
- To monitor the essential factors that affect renewable energy by using Homer application.
- To develop the most viable renewable energy that can be implemented in Malaysia.

1.4 Scope of Project

- Study the types of renewable energy in Malaysia: solar, wind, and biomass. Then, analyse the most potential renewable energy that can be developed.
- Design and monitor all the data provided by the application
- Deciding which types of renewable energy are suitable in Malaysia based on the technology used, geographical factor, and investment return.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is about a comprehensive overview of the previous work based on the related topic about the project called a literature review. A literature review is written based on previous studies, including articles, thesis, journals, and others. It will help the researcher provide a foundation of knowledge about the topic and the various solutions used by the past researcher.

As a result, the researcher can identify the main point of the study to improve their progress regarding the past research. It also can prevent duplication of work and give credit to another researcher. The most important thing is that the researcher can expect the study's outcome through this chapter based on the other researcher's data.

2.2 PROJECT BACKGROUND

2.2.1 History of renewable energy in Malaysia

Renewable energy is a type of energy produced from natural resources continuously replenished and renewed. The most common natural sources are wind, solar, and various forms of biomass.

In Malaysia, renewable energy started in 1980 when Four Fuel Diversification Strategy was used to achieve a balance in the use of oil, gas, coal, and hydro in the energy mix, back. In 1997, the Kyoto Protocol was signed, an international agreement to limit greenhouse gas emissions. Other than that, Fifth Fuel Policy was signed in 1999 to gain more sustainable energy in the future by having a target of renewable energy providing 5% of electricity. The Small Renewable Energy Program (SREP) is also one of Malaysia's government initiatives to encourage connection from small renewable power generation plants to the national grid. This program allows renewable projects to sell their electricity output to TNB with a capacity of 10 MW, resulting in 28 approved biomass projects for 194 MW of grid capacity. Malaysia likewise promised to cut its greenhouse gas (GHG) emissions by 45 per cent as a percentage of its GDP by2015, compared to 2005. By the year2025, the government hoped to have achieved a 20% RE target. The evolution throughout the years shows that the importance of implementing RE in the country by Malaysia's government.

2.2.2 Renewable energy and Non- renewable energy

Renewable energy sources mean sustainable energy that cannot run out as it is produced from natural resources such as sunlight, wind, tides, and biomass. Meanwhile, non-renewable energy comes from sources that will run out and cannot be replenished over time. Examples are fossil fuels, coal, petroleum, and natural gas. Both energies have their pros and cons to produce energy in generating electricity. The tables below show the advantages and disadvantages of renewable and non-renewable energy.

Table 2.1. The advantages and disadvantages of Renewable energy.

Advantages	Disadvantages
Prevent the rising of global warming as the sources are non-pollutant that does not increase the carbon level and greenhouse gas.	Energy supply can be affected by unpredictable weather. As an example, solar photovoltaic do not have heat to generate electricity due to the weather.
Unlimited resources to generate electricity because natural energy sources can replace themselves.	Do not produce energy as much as non-renewable sources as Malaysia is still dependent on non-renewable energy.
Lower requirements on maintenance. For example, technology generating energy, wind turbines and solar panels have only a few or no moving parts.	Geographic limitations to finding suitable places that provide enough energy need a lot of study and research.

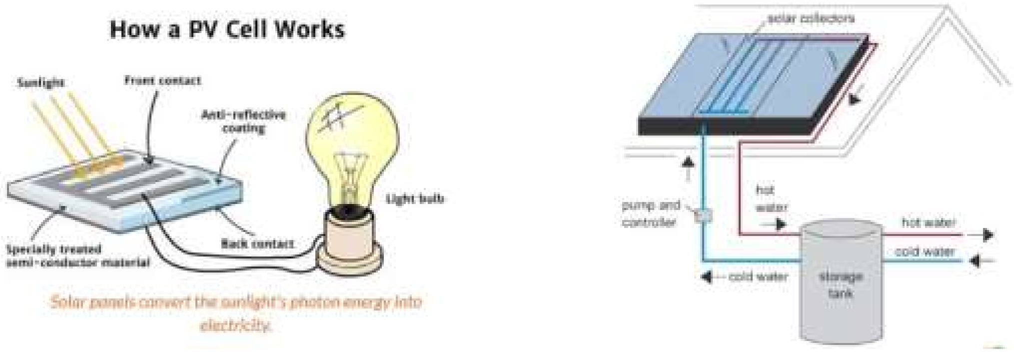
Table 2.2. The advantages and disadvantages of non-renewable energy.

Advantages	Disadvantages
Abundant and affordable as oil and diesel are used in powering vehicles.	It cannot be replaced once the source is unavailable.
Cost-effective.	The mining causes damages to the environment that create acid rain and greenhouse gases emitted increased.
Easier to produce for usage.	The prices of these sources will increase in the future because they will expire soon.

2.3 Solar energy

2.3.1 Technology used

Various types of technology are used in Malaysia to generate energy from sunlight. As an example, photovoltaic and solar thermal. The photovoltaic cell is an electronic component that generates electricity when exposed to photons or light particles. Photovoltaic capacity has been growing steadily since the start of the 21st century, led by the construction of massive solar farms. Photovoltaic works when the semiconductor materials absorb the photons emitted by the sun and generate the flow of electrons. Solar photovoltaic convert 5-15 per cent of solar energy into direct current (DC), then stored in batteries. The converter will convert DC to alternating current (AC) to be used in appliances. Solar thermal is used to produce thermal energy by harnessing solar energy. Solar thermal uses the sun's energy to create high-temperature steam that powers a turbine to generate electricity. The applications of solar thermal systems in Malaysia are divided into solar drying and solar water heating. The first is a simple, low-power, short-lived drying system. The other is a powerful, long-lived, high-efficiency system, but costly.



(a) (b)

Figure 2.1. (a) Solar PV (Solar Schools, 2018) (b) Solar thermal diagram.
(U.S. Energy,2020)

2.3.2 Geographical data

Based on the irradiation map below shows that Malaysia has potential because of its advantageous location near the equator. Malaysia has one of the most considerable potentials for solar adoption. Malaysia's monthly sun irradiation is predicted to be 400–600 MJ/m2. There is higher irradiation from Central Asia to South China Sea via Malaysia and Australia between November and March. Meanwhile, wind direction on the south-west monsoon, then the Malacca Straits between May and September from Australia to Sumatera Island. Malaysia, in general, has a high solar generating potential due to its hot and sunny weather throughout the year. Solar power generation has a possibility of up to 6500 MW. (Wan Syakirah Wan Abdullah, 2019)

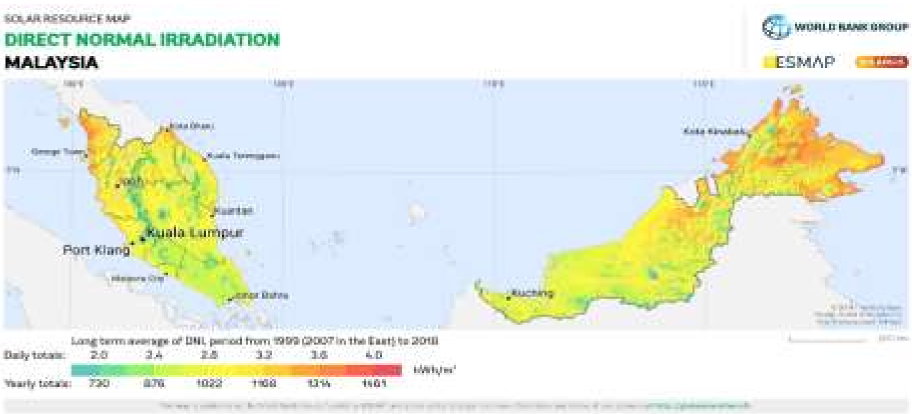


Figure 2.2 Irradiation on Malaysia's map. (Global Solar Atlas, 2018)

2.3.3 Return of investment

In Malaysia, solar energy system has been implied in warehouses, stores, and others. By installing a solar PV system, it helps to reduce corporate operating. Malaysia's government also provided an incentive that NEM (Net energy metering) allows for the self-consumption of electricity generated by solar photovoltaic (PV) system users. Any excess energy is exported to the grid. The more energy generated by the solar PV system, the greater the energy and monetary savings for the business. For example, IKEA Cheras in Kuala Lumpur has installed 3,852 pieces of solar panels on its roof, with a total system capacity of 1,001.52 kilowatt-peak (kW/p). This has an immediate impact, as the self-consume the energy generated with no waste created, instantly reducing our energy and operating costs, which can result to our customers through the continuous price reductions of our products.

Figure 2.3. IKEA store. (IKEA Stores, 2020)

2.3.4 Rising issue

In 2025, Malaysia's Government has set the goal of achieving 20% renewable energy generation. However, according to National Energy Balance in 2010, the researcher found that 40% of the country's electricity is generated from non-renewable energy. This has become a severe issue for the country because non-renewable energy cannot be replaced after it been depleted. To solve this matter, The Malaysian Photovoltaic Industry Association (MPIA) has launched MPIA Solar Roadshow 2020-2021. This platform is designed to provide policy information, programs, tax incentives, financing, insurance coverage, investment risks and returns, the PV system rooftop solar rental, and power purchase agreement (PPA). The target audience is in the commercial and industrial sectors since over four million buildings could potentially be installed using solar photovoltaic to harness free and renewable energy from the sun. Solar PV systems have been installed in less than 12000 buildings, or less than 1% of all facilities. (SEDA, 2020). This roadshow will attract those sectors into installing solar PV systems.

Figure 2.4. Conference and exhibition for MPIA roadshow. (MPIA, 2020)

2.4 Wind energy

2.4.1 Technology used

The rotor's aerodynamic power is changed to electricity by a wind turbine. Lift and drag are produced because there is a difference in air pressure on both sides of the blade. Next, the drag and rotor spin is weaker than the lifting force. The rotor connects to the generator or a shaft and several gearboxes (a gearbox) to speed up a rotation so that the generator can be reduced physically. This aerodynamic force translation into a generator rotation generates electricity. The wind speed and air density cube equal the wind power content. Wind turbines are built to take advantage of the available wind energy at a given site.

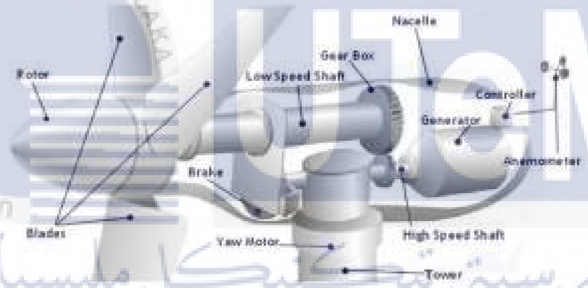


Figure 2.5. Wind turbine components. (Amna Ahmad, 2018)

2.4.2 Geographical data

Compared to other countries, Malaysia is noted for having a low wind speed area. Wind energy has yet properly harvested because Malaysia has a yearly average of wind speed of less than 2 m/s since wind turbines need at least 4 m/s wind speed to produce electricity.

According to meteorologists, the Indian Ocean and the South China Sea are the most common sources of strong wind in Malaysia. The monthly wind speed range means is 1.5-4.5 m/s. Since then, the great 9-11 m/s wind speeds can be used. In Peninsular Malaysia, high wind zones have been detected in Mersing, Johor, and Kuala Terengganu, whereas East Malaysia's highest wind potential regions include Kudat and Sabah. (Wan Syakirah Wan Abdullah, 2019) However, because of the monsoons, the implementation of wind energy in these areas may not be as straightforward as it appears at first glance. As a result, the wind speed in these areas may vary significantly from season to season and from year to year.

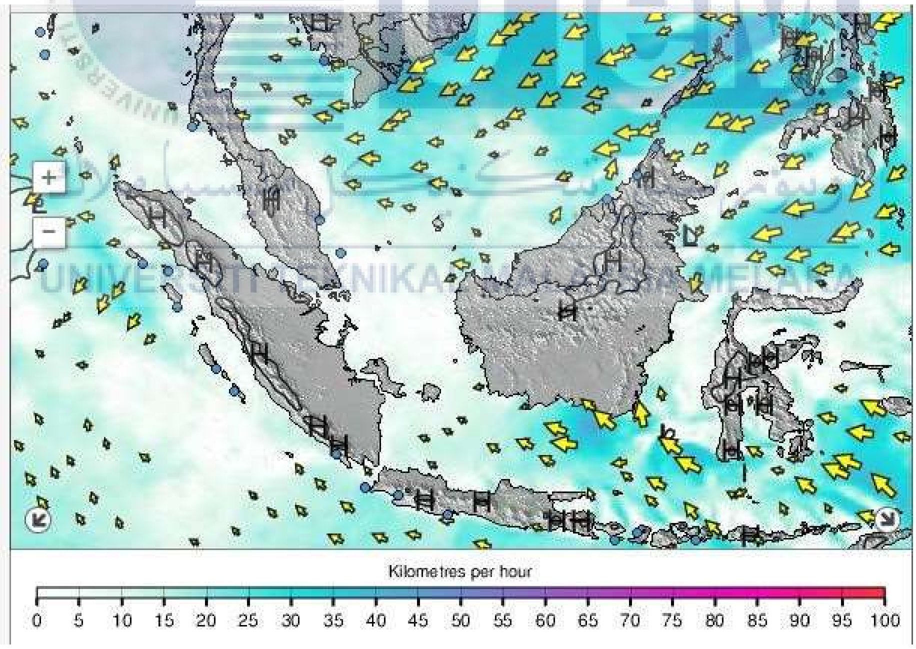


Figure 2.6 Wind movement. (Surf forecast, 2021)

2.4.3 Return of investment

The wind turbine investment in Malaysia can bring advantages as the wind still blows at night. Wind energy is "native" energy because it is available practically everywhere on the plant, reducing energy imports and creating wealth and local employment. Moreover, wind energy is not a pollutant compared to fossil fuels that produce toxic gases.

2.4.4 Rising issue

The government has conducted a significant amount of research to determine the potential for wind energy production in the country. A total of four wind turbines have been installed in Malaysia for educational and research purposes. These locations are Pulau Terumbu Layang-Layang in Sabah, Perhentian Island in Terengganu, Kudat in Kuching, and Setiu in Terengganu. Compared to other places in Malaysia, Pulau Terumbu has the highest potential for wind energy production, whereas Perhentian Island has been forced to close due to technical difficulties and a lack of convincing wind to generate energy in the area. (Conventus Law, 2020). Careful wind map assessment and energy harnessing technology research should be further conducted. However, more excellent government support would be required for the potential of wind energy in Malaysia to be successfully explored.

2.5 Biomass energy

2.5.1 Technology used

The technology used in biomass energy production is divided into two processes, gasification and pyrolysis. Gasification is when solid material with little oxygen is exposed to high temperatures to produce synthesis gas. This gas primarily constitutes carbon monoxide and hydrogen and can be used in a conventional boiler to generate electricity. Pyrolysis is a process that produces crude biomass heated at a lower temperature without oxygen. This oil may replace fuel oil or diesel in motors for power generation.

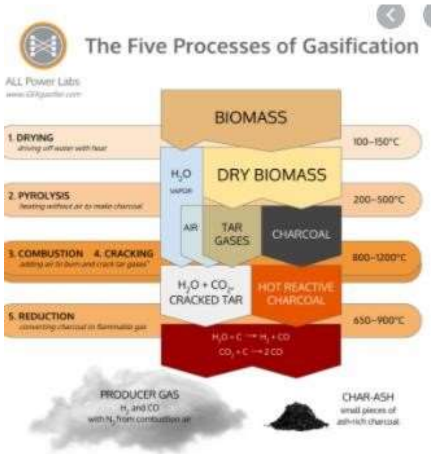


Figure 2.7 Process of gasification.
(ALL Power Labs, 2021)

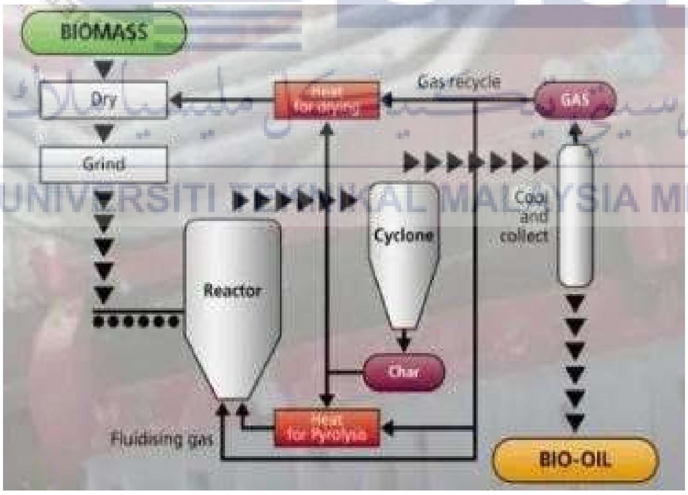


Figure 2.8. Process pyrolysis. (Salman Zafar, 2020)

2.5.2 Geographical data

Malaysia has conventional energy resources like oil, gas, and renewables, including hydro, biomass, and solar energy. Malaysia has tremendous agricultural biomass resources and wood waste resources available for immediate exploitation concerning biomass resources in Malaysia. The primary biomass resources in Malaysia are sugar cane, cassava, and corn crops. Then there are farm by-products such as rice stroke, cassava rhizome, and corncobs. Wooden biomass, such as fast-growing trees, wood waste from sawmills, and sawdust, among other things. Malaysia is the world's largest exporter of palm oil, having shipped more than 19.9 million tonnes of palm oil out of the country in 2017. The extraction of palm oil from palm fruit results in many residues in the form of palm kernel coatings, empty fruit bunches, and mesocarp fiber, among other things. This shows that Malaysia is suitable for biomass energy production as the waste can be produced to generate electricity.

Figure 2.9. Location of palm oil in Malaysia.
(Malaysian-German Chamber of Commerce and Industry, 2018)

2.5.3 Return of investment

In Malaysia, the waste can be the supply for biomass process to produce energy that generates electricity as there are abundant agricultural activities that left behind the waste. Utilising biomass extensively as a renewable energy source in Malaysia can reduce the country's reliance on fossil fuels. Another significant benefit is the reduction of net carbon dioxide emissions into the atmosphere, which reduces the global warming effects of carbon dioxide. This kind of energy process also reduces the amount of waste in Malaysia. The amount of solid waste generated per capita in Malaysia varies from 0.45 to 1.44kg/day, depending on the area's economic status. Thus, the environment's cleanliness can be improved by producing energy.

2.5.4 Rising issue

Biomass energy has become one of the potential renewable energy that can implemented in Malaysia as there are a lot of supply for the waste especially the solid waste. From the statistics by Malaysia government in 2012, averagely one person in rural areas generates about 0.73kg while one person living in urban areas generates more which is 0.83kg per day. A project by Malaysian government which is waste-to-energy (WTE) was launched by Malaysia's Housing and Local Government Ministry (KPKT). However, there are some concerning issue related to the development on the project which is gas emission that is produced from the energy generation process. Based on the research, the burning of 1 Mg of municipal waste in the incinerators is producing about 0.7 to 1.2 Mg carbon dioxide. (The legal 500, 2021). So, to reduce the amount of gas emission Government of Malaysia set a requirement that need to be follow by the operators. Another issue that related to the project is the cost of the incinerators that costly about RM100 per tonne for the operational cost of WTE plant which is so expensive for the local authority. (Vanisha Selvam, 2019). Government should create more program for private financial institutions to provide better financing to the industry players such as Green Technology Financing Scheme that is currently available under MOSTI.

Figure 2.10. Waste-to-energy plant.

(Ellis Burruss, 2013)

2.6 Literature review

2.6.1 Previous works by others

This section of the paper concluded the literature that have the same way in investigating the potential renewable energy to be developeded using HOMER software. First paper with the title "Optimal selection of renewable energy installation site in remote areas using segmentation and regional technique in Sarawak, Malaysia" (Aziah Khamis, 2020) image segmentation divided into three main techniques: color thresholding, circular hough transform, and K means. This method is specified in the remote areas in Sarawak, Malaysia, as this area has limitations due to complicated geographical factors and high costs. The advantage of this study is the locations of the potential regions have been obtained. Next, (Izadyar, 2016) investigated the potential hybrid renewable energy in rural areas in Malaysia by using HOMER software and Net Present Cost (NPC), identifying places with the maximum sun, wind, and hydroelectric potential. However, the report mentioned innovative designs and technologies to generate power in low-wind regions in Sabah and Sarawak in particular. Based on (Azah Mohamed, 2016), in order a system to work in maximum availability and minimum cost, the optimum sizing needs to be obtain because it is dependent on meteorological variables such as solar energy, ambient temperature, and wind speed to determine the size and performance of a hybrid power-generating system of this type. So, this research compares thetwo methods: the proposed optimisation method and HOMER software method. The results show that the proposed optimisation method provides more accurate results.

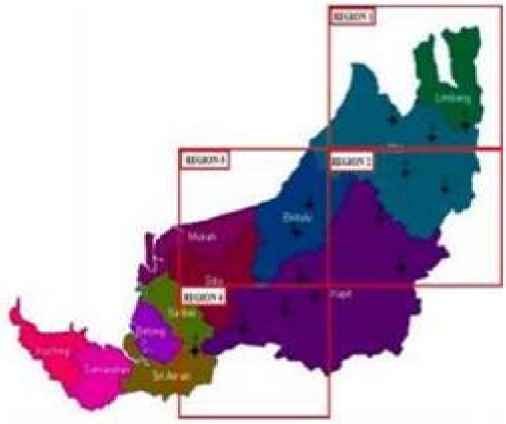


Figure 2.11. Map of Sarawak with selected regions (Izadyar, 2016)

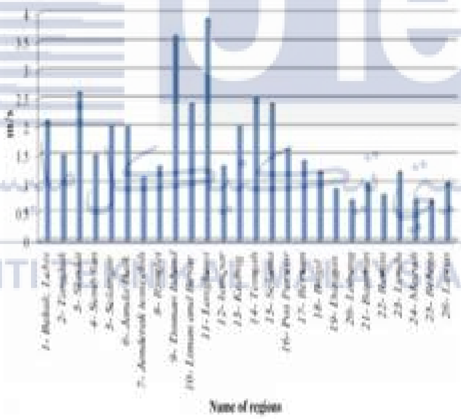


Figure 2.12. Annual average of daily wind speed regions.
(Aziah Khamis, 2020)

Next, a paper by (Wan Syakirah Wan Abdullah, 2019) with the title 'The Potential and Status of Renewable Energy Development in Malaysia' mentioned that Malaysia has a target to achieve 20% usage of renewable energy by 2025. This shows that there are opportunities for the area to be developed. Another research by (Syed Shah Alam, n.d.) It stated that sustainable renewable energy production, the government's effort, business sector involvement and awareness of users should be given priority. The government supporting the development of energy renewable can be a severe matter to others that also encourage Malaysian to promote saves energy and electricity. The main obstacles that become an obstacle are the limited information on renewable energy technologies, lack of awareness, and limited private sector engagement that emerged as significant barriers to sustainable renewable energy development. (Syed Shah Alam, n.d.)

Biomass appears to be an essential source of renewable energy and a significant energy source around the world until fossil fuels become dominant, and research has proved its potential for large-scale production before industrialisation. The hydrogen production study using SCW oil palm biomass gasification may serve as a future source of sustainable energy. (Anon., 2007). Based on the calculations, this technology the most potential hydrogen production created theoretically by oil palm biomass meets the present worldwide hydrogen requirement by more than 50 per cent. Malaysia alone produces approximately 47% of the world's supply of palm oil and is considered the biggest producer and exporter of palm oil in the world.(M.A.A. Mohammeda, 2011). When it comes to the usage of oil palm biomass as a clean energy source, hydrogen production from it has risen to the top of the list of priorities. There are a variety of thermo-chemical conversion technologies that can be used for hydrogen production from biomass. One such technology is gasification, a competitive method of converting solid biomass such as oil palm waste into a uniform gas mixture containing hydrogen, carbon monoxide, methane, and carbon dioxide.

Moreover, in agriculture and forestry, Malaysia is rich in natural resources. When paired with feedstock availability, this increases the country's reliance on a single source of raw materials. (Jing Yan Tock, 2010) Specify that additional agricultural biomasses, such as banana plant biomass, should be considered. As an alternative to palm oil waste, banana biomass can be used as a renewable energy source.(Mohd Shaharin Umar, 2013) Mentioned that this study uses a mixed methodology approach combining market surveys and interviews with regulators.

Options for researching the potential use of less sought-after resources are among the possible future tactics identified by this research. To maintain industrial development, wise measures must be implemented to offer infrastructure and benefits. The use of FiT tools suggests that a system modification is possible that will be more effective in the long run for the palm oil renewable energy industry.

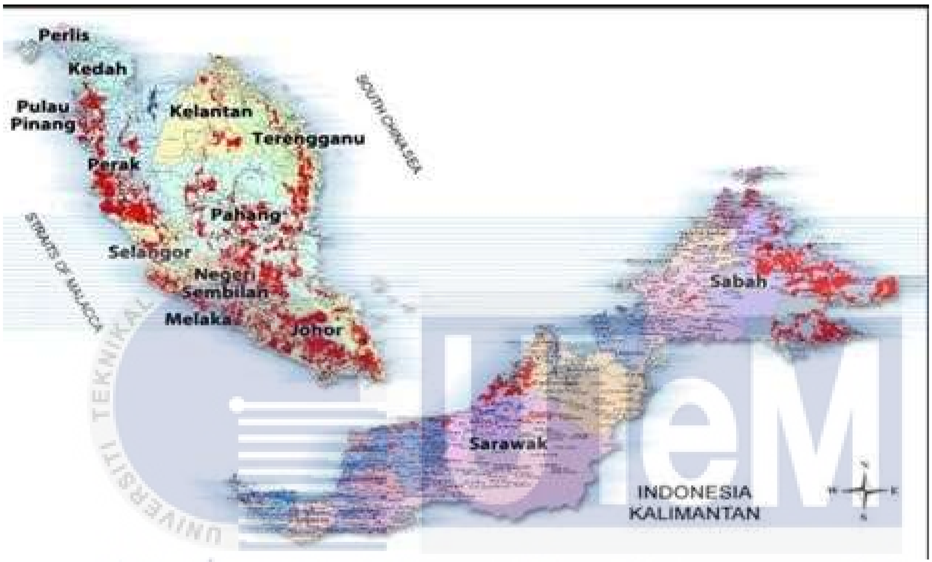


Figure 2.14. Demographic distribution of palm oil planted area in Malaysia. (Mohd Shaharin Umar, 2013)

2.6.2 Summary of Literature review

Table 2.3 Summary of Literature Review

No	Author	Title	Year	Remarks
1	A. Y. Azman student, A. A. Rahman, A. N. Azmi, F. Hanaffi, A. Khamis	Study of Renewable Energy Potential in Malaysia.		- The study is based on three primary factors: action, geographical dispersion, technology, and economic analysis. There are four types of renewable that focus in this study: solar, wind, biomass, and tidal. - Biomass has the potential to provide sufficient electricity in Malaysia. - Improve the development of biomass resources as it is available and lower cost. - Analyse additional renewable energy sources, such as hydro and geothermal energy.
2	Aziah Khamis, Tamer Khatib, Nur Amira Haziqah Mohd Yosliza, Aimie Nazmin Azmi.	Optimal selection of renewable energy installation site in remote areas using segmentation and	2020	- There are three primary strategies in identifying colour thresholds, circular transformations, and the K-means on the map.

		regional technique: A case study of Sarawak, Malaysia.		-The combination of photovoltaic and hydropower is the ideal rural hybrid. - The study only focused on some remote regions while there are other locations. - The methods are applicable to find the potential locations by the provided data.
3	Wan Syakirah Wan Abdullah, Miszaina Osman, Mohd Zainal Abidin Ab Kadir, Renuga Verayiah.	The Potential and Status of Renewable Energy Development in Malaysia.	2019	-The potential for Malaysia's renewable energy sector to meet its 20 per cent target by 2025 difficulties and opportunities - Geothermal is not discussed in the paper because of the geographical condition. - Malaysia will continue to rely on coal and natural gas in the future, but it will also have a more significant proportion of renewable energy. - More research needs to be initiated to obtain data for wind energy.

				- Solar energy has higher potential in Large Solar Scale technology.
4	Nima Izadyar, Hwai Chyuan Ong, Wen Tong Chong, Juwel Chandra Mojumder, K.Y. Leong b	Investigation of potential hybrid renewable energy at various rural areas in Malaysia	2016	- To better understand Malaysia's prospective locations, based on the comparison of total net present cost (NPC) for wind, solar and micro-hydropower. - New design and technology in the HRES design should be introduced - Less usage of diesel generators. - In this regard, the villages of Tioman are mainly unsuitable sites for the hybrid renewable energy system, while Langkawi offers the finest potential for wind and solar.
5	Azah Mohamed, Tamer Khatib	Optimal Sizing of a PV/Wind/Diesel Hybrid Energy System for Malaysia.	2016	- By using the method given in the HOMER application, a system that functions at the lowest possible cost and with the maximum availability can be designed. - According to the findings, the optimal

				sizing ratios for PV arrays and wind turbines in Kuala Terengganu are 0.737 and 0.46, respectively. - Building load demand can be supplied at the lowest possible cost by acquiring optimisation sizes.
6	Mohd Amran Mohd Radzi, Nasrudin Abd. Rahim, Hang Seng Che, Hideaki Ohgaki, Hooman Farzaneh, Wallace Shung Hui Wong, and Lai Chean Hung.	Optimal Solar Powered System for long houses in Sarawak by using HOMER tool.	2019	In Sebuyau, Sarawak, the ideal solar power system to lengthy power homes by four main steps: estimation, design, simulation by HOMER software, and optimisation work. -Based on the data obtained, it can allow the designer to develop solar energy. -By developing solar energy, conventional fossil fuel generators will decrease and be cost-free. - The study also should find other valuable resources for the longhouses.
7	Wei Yee Teoh, Say Yen Khu, Chee Wei Tan, Ing	Techno-economic and Carbon	2016	- To suggest the use of PV to reduce grid energy use and encourage

	Hui Hii, and Kai Wee Cheu	Emission Analysis for a Grid-Connected Photovoltaic System in Malacca		renewable energy using HOMER simulation to offer data for usage and renewable energy. - Based on the simulation, grid-connected PV system is more beneficial compared to a standalone grid. Although the cost is higher, it is a one-time investment that can work for a long time. - The study should consider the less costly material. - PV system can be used for developing renewable energy in Malaysia.
8	S. Bahramara, M. Parsa Moghaddam n , M.R. Haghifam	Optimal planning of hybrid renewable energy systems using HOMER: A review	2016	- Use HOMER software to access minimum investment and operational costs, including technical and pollution restrictions. - HRESs have been modeled in both stand-alone and grid-connected modes. - The parameters observed are wind speed, solar radiation, fuel price, component costs.

				-HRESs can be employed to supply local loads in rural, distant and unique urban areas.
9	N Abdullah, J Jamiluddin, F Y Hagos, N S N Azmi.	Experimental investigation on pineapple leaf fibre as biomass source for renewable energy application	2020	- The hand scrapping approach was utilised to evaluate Pineapple Leaf Fiber's potential as a substitute for existing biomass resources. - The PALF have higher cellulose content which have higher calorimetric value. -The PALF can be a good application, but the availability of the PALF should concern matter, besides using the oil palm empty fruit bunch and rice husk.
10	Heap-Yih Chonga, Wei-Haur Lamb	Ocean renewable energy in Malaysia: The potential of the Straits of Malacca	2013	- To examine the current situation of the renewables of the ocean, such as tidal dams, mare energy, wave energy, ocean thermal conversion and salinity gradient electricity. - Tidal current is the most potential option in the Straits of Malacca compared to others.

				- The development of the ocean renewable can be developed in Malaysia however, it lacked funds because of the planning is still in the early stages.
11	Fuad Noman,Gamal Alkawsi, Dallatu Abbas, Ammar Alkahtani, Seih Kiong Tiong, Janaka Ekanyake.	A Comprehensive Review of Wind Energy in Malaysia: Past, Present and Future Research Trends.	2020	-To review the current status of wind energy, including the main factors and the recommendations for improving wind research in Malaysia, are discussed in this document. -With- Lack of standardisation and wind data representation, hybrid power systems are used to solve the issue. - Three potential areas in Malaysia are suitable for renewable wind energy, but more research is needed.
12	S N Ashwindran, A A Azizuddin, A N Oumer2 and M Z Sulaiman	A review on the prospect of wind power as an alternative	2017	- Wind energy sector challenges in Malaysia: wind conditions, government policies and technologies

		source of energy in Malaysia.		- Selected areas of the eastern coast of Malaysia and selected Sabah and Sarawak region have the potential to harvest power. -Wind renewable energy can supply energy, but wind turbines must be built on the unstable regions of the Monsoon wind speed pattern.
13	Syed Shah Alam, Nor Fariza Mohd Nor , Maisarah Ahmad, Nik Hazrul Nik Hashim.	A Survey on Renewable Energy Development in Malaysia: Current Status, Problems, and Prospects	2016	- The limited availability of renewable energy technology information, lack of public awareness, and lack of participation by the commercial sector have been cited as significant obstacles to developing sustainable renewable energy sources. -Build awareness of renewable power, while higher education institutions include renewable energy programs in their academic curricula. - Sustainable renewable energy development, government initiative,

				corporate sector partnership, and user awareness should be given priority.
14	Rajmal Joshi.M, Aravind CV , Dr. R. Dhanasekaran, Charles Raymond, Se Yong En.	Comparison between Photovoltaic and Wind Turbine for Monetary and Non-monetary Costing	2018	-Evaluate its practicality in terms of efficiency and emission rates, and give recommendations. - As Malaysia's tropical environment has a relatively constant amount of sunlight and temperature throughout the day, solar energy has the highest renewable energy efficiency. -In this case, producing energy using the wind turbine is not incredibly efficient because the average wind velocity is under extreme conditions for spinning wind turbine blades.
15	Normazlina Mat Isa, Chee Wei Tan, AHM Yatim.	A techno-economic assessment of grid-connected photovoltaic system for a hospital building in Malaysia	2016	- An investigation of the GCPV for Malaysian hospital structures using software (HOMER) to optimise and analyse the sensitiveness of solar grid-connected systems. - The hospital's realisation of NeM will

				provide hospital owners with the benefit they can minimise their energy expenses.
16	S. Mekhilef	Renewable energy resources and technologies practice in Malaysia.	2018	-This study in Malaysia on the application, research, and development of energy resources for renewables and the use of renewable energy technologies (RETs). - In Malaysia, the energy sector still depends on traditional energy, like fossil fuels and natural gas. To conserve energy while also utilising environmentally friendly energy sources such as nuclear energy and photovoltaic, the government must be prepared to look for other alternative energy sources such as atomic energy and photovoltaic.
17	Tau Len Kelly-Yong, Keat Teong Lee, Abdul Rahman Mohamed, Subhash Bhatia	Potential of hydrogen from oil palm biomass as a source of	2007	- Present the possible availability of oil palm biomass that may be transformed into hydrogen in super-critical

		renewable energy worldwide		water via the gasification process. - It has been demonstrated that biomass can be used to generate hydrogen, which can be used as a renewable energy source.
18	Jing Yan Tock, Chin Lin Lai, Keat Teong Lee, Kok Tat Tan, Subhash Bhatia.	Banana biomass as a potential renewable energy resource: A Malaysian case study	2010	-Since banana has high growth rates, its availability, neutralise of carbon, and bearing fruit only once in life made the banana the chosen subject. -Combustion, water high-critical gasification, and digestion can converse biomass to energy which produces thermal energy and biogas. - Banana biomass energy, which accounts for most renewable energy needs, has a capacity of 4.6% in Malaysia for 2007.
19	M.A.A. Mohammed, A. Salmiatona, W.A.K.G. Wan Azlinaa, M.S. Mohammad Amrana, A. Fakhru'l-Razi, Y.H. Taufiq-Yap.	Hydrogen rich gas from oil palm biomass as a potential source of renewable energy in Malaysia	2011	- The essential role of demand for energy production because of future availability of raw materials is efficient and clean energy sources of

				carbon dioxide from biomass. -The palm oil business's current state in terms of contributing to sustainable and renewable energy is brief and up-to-date. - The deactivation of carbon deposition is a severe difficulty with the use of dolomite, which is a soft and delicate material, yet dolomite is cheap and easy to replace.
20	Mohd Shaharin Umar, Philip Jennings, Tania Urmee.	Strengthening the palm oil biomass Renewable Energy industry in Malaysia	2013	- Examine the long term practicability of many of the value chain's components, including the availability of supplies of palm oil biomass, bio-energy converting technologies, and grid expansion costs and alternatives. -In consultation with the industry, the government should intervene and set up the necessary infrastructure and incentives.

21	H. Fayaz, N.A. Rahim, R. Saidura, K. H. Solangi H. Niaz, M.S. Hossain.	Solar Energy Policy: Malaysia VS Developed Countries	2011	- A review of solar policy implemented by developed countries and Malaysia will be reviewed, discussing the successful current solar energy policies in developed countries. -The most beneficial energy policies implemented by developed countries are FiT, RPS and Incentives. - Malaysia's policies on renewable energy have limits, such as low level encouragement; lack of coordination and consistency within the policy framework; innovative regional policies; insufficient investment in technical research and development; incomplete and unhealthy funding and investment systems
22	N. Gomesh, I.Daut, M.Irwanto, Y.M.Irwan, M.Fitra.	Study on Malaysian's Perspective towards Renewable Energy	2013	-Malaysia's perspective on renewable energy, especially in the solar sector, through a study. - Renewable energy is warmly appreciated by

		Mainly on Solar Energy		many Malaysians, notably in the field of solar energy, as well as the urge for change in traditional energy methods.
23	Amanda Halima, Ahmad Fudholia, Kamaruzzaman Sopiana, Mohd Hafidz Ruslan.	Feasibility Study on Hybrid Solar Photovoltaic with Diesel Generator and Battery Storage Design and Sizing Using HOMER Pro	2018	- This paper includes a study on the technology for the development and size of hybrid renewable energy systems and the system's feasibility. -The load forecasting on energy demands has been projected to increase drastically since 2000. - A basic knowledge of sizing the system must be improved as the simulation will become easier
24	Siow Chee Loon and Jaswar Koto.	Wave Energy for Electricity Generation in Malaysia -Merang Shore, Terengganu	2012	- Before selecting the appropriate device type, several types of wave energy converter currently developed by the manufacturer were reviewed. - Attenuator type wave converter developed by Wave Star was considered one of the

				installation devices at the site. -Since the last time the device was used, it has been in standby mode for nearly half a year. - The wave height is less than what is required for the device to function correctly.
25	S.M. Shafiea, T.M.I. Mahliaa, H.H. Masjuki, A. Andriyanaa	Current energy usage and sustainable energy in Malaysia: A review	2011	-Investigation of various renewable energy and examine the energy and environmental issues. - This should be discussed in depth by critical stakeholders such as government, institutions, industry, and society. - It generally takes decades to replace one form of primary energy with another completely.
26	Yun Seng Lim, Siong Lee Koh	Analytical assessments on the potential of harnessing tidal currents for electricity generation in Malaysia.	2009	- The Princeton Ocean Model creates a three-dimensional numerical model for Malaysia that has calibrated against measurement. -Although Malaysia has tidal energy, which means a promising

				renewable energy source is available, several environmental cases should be studied and explained.
27	Nor F. Yah, Ahmed N. Oumer , Mat S. Idris	Small scale hydropower as a source of renewable energy in Malaysia: A review	2017	- To demonstrate the potential and current state of modest hydroelectricity in Malaysia at a low-level location and rural electrification. - Current issues of renewable energy plant design and education, energy tariffs, fossil fuel producers' financial rates and subsidies, and program-design, opposition and regulatory failure should be addressed.
28	Omar Yaakob, Tengku Mohd Ariff Tengku Ab Rashid, Mohamad Afifi Abdul Mukti	Prospects for Ocean Energy in Malaysia.	2006	- The existing oceanographic data in Malaysia and the possible energy sources are identified. - The current development of different ocean energy extraction methods will be examined.

29	H. Borhanazad, S. Mekhilef, R. Saidur, G. Boroumandjazi.	Potential application of renewable energy for rural electrification in Malaysia	2013	-Renewable energy sources might be regarded as the best choice for reducing rural energy poverty. - The potential for solar power for electricity is significant since maximum solar radiation in Malaysia amounts to roughly 6.027 kWh/m2 in Sabah and 5.303 kWh/m2 in Sarawak within one day.
30	A. Johari, S.H. Samseh, M. Ramli and H. Hashim	Potential use of solar photovoltaic in peninsular Malaysia.	2012	- Briefly discuss incentives and RE Act enacted by the government of Malaysia to guarantee dependability and security of long-term energy supply. - The Malaysian Government has made several initiatives to encourage people and businesses to engage in solar photovoltaics. - The favorable climate makes solar photovoltaics very viable for energy generation.

2.7 Summary of findings

Based on the articles and journals from the past researchers, there is a lot of renewable energy that can be studied in Malaysia. Renewable energy can be used as the primary energy to generate electricity instead of using non-renewable energy, which one day will deplete and run out. However, the viability of renewable energy should be the main factor before deciding which renewable energy should be the next primary energy source. The energy should be available in the country and easy to harvest. After reviewing all the information from the past researcher, the viability of renewable energy can be listed from the top to the last.

1) Biomass energy
2) Solar energy
3) Wind energy

There are three types of renewable energy that can be the main energy source in Malaysia to generate electricity from the list. These types need to be studied based on the three main factors: technology used, geographical data, and return of investment. Based on the main factors, the data obtained from the simulation using HOMER application needs to be analysed before deciding which renewable has the most potential as the primary renewable in Malaysia.

2.8 Summary

At the end of this chapter, the past researcher uses various types of methods to find the suitability of the specific renewable energy in the area. Other than that, some researchers found out that using hybrid renewable energy is more effective than only using one of the sources. This literature review compiles a study from 2006- 2020 that shows the past and present of the renewable energy which can broaden the knowledge about the topic. The past papers will help the researcher improve research methodology and generate ideas on how to study about the project.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The methodology is about a system of methods used that specifically procedures or techniques used to identify, process and analyse information about a topic. This section, allows reader to evaluate a study based on validity and reliability. This section is important as the step needs to be complete for the project completion. Each step must follow according to the time to prevent any problems occur at the end. Each process has to be done by the researcher so that, any problems should have enough time to find the solution.

The relation between this chapter and the project is designing a simulation to find the availability of the RE in Malaysia by using HOMER. This project will be carried out by the steps based on the schedule. Based on the schedule, the routine and activities should be done within the period of time. So, the project can be finished according to the timeline without any problems happening.

3.2 Methodology

Figure 3.1 shows the flow chart for the project methodology that study the availability of various types of renewable energy in Malaysia and the purpose of finding the most suitable RE that the main factors can develop.

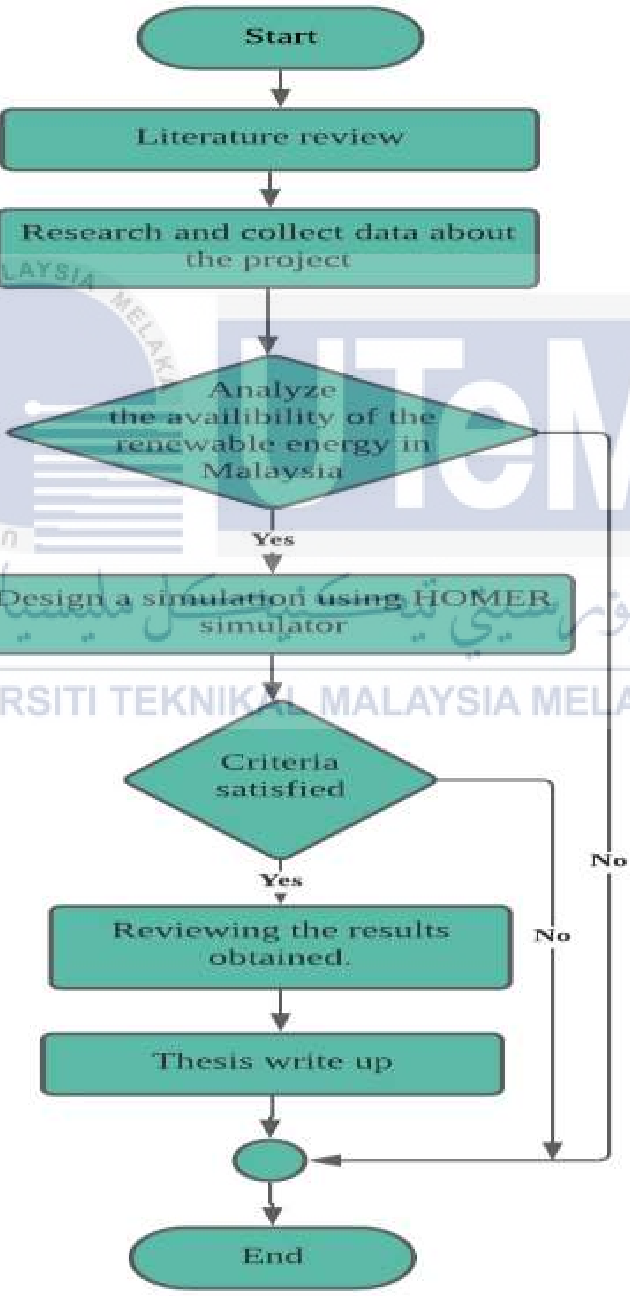
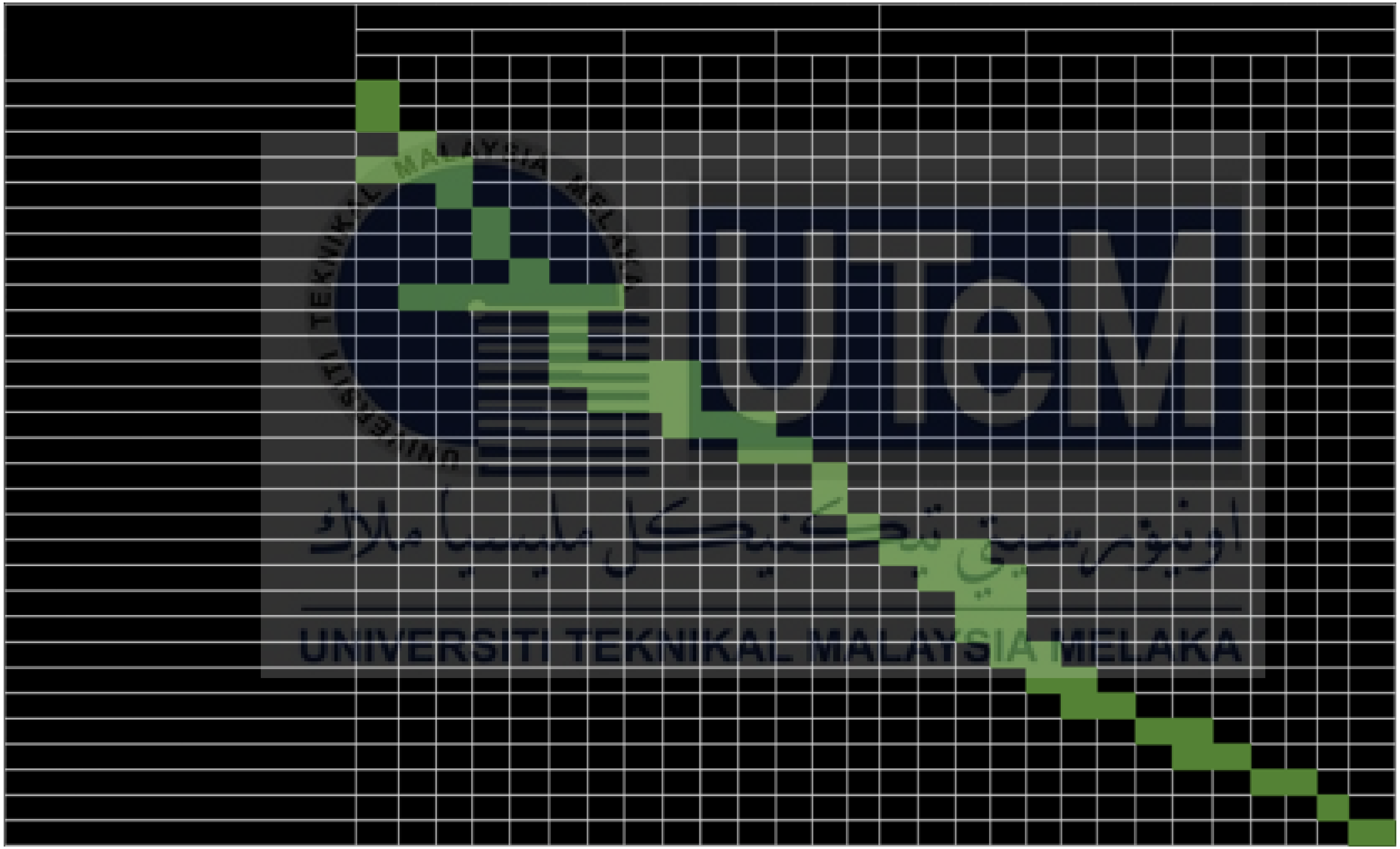


Figure 3.1 Project methodology flow chart

Based on the flowchart above, the process starts with a literature review that shows the previous works from other researchers that provide various methods of the project to find the data. Next, the researcher needs to do research on their own and collect their data to be compared to find suitable ones. Then, the data will be studied to see the available renewable energy in Malaysia. Then, designing a simulation based on the three main factors: the technology used, geographical factors, and investment return. If the main criteria are passed, the data will be reviewed once again before deciding which renewable energy is the most suitable to develop in Malaysia.

3.2.1 Gantt Chart



3.2.2 Simulation setup

For this subtopic, the images will show how the simulation would be done from step to step to obtain the results for the specific renewable energy, which is solar radiance and wind speed.

<u>Solar radiance:</u>

Step 1: Enter the specific location that needs to be observed.

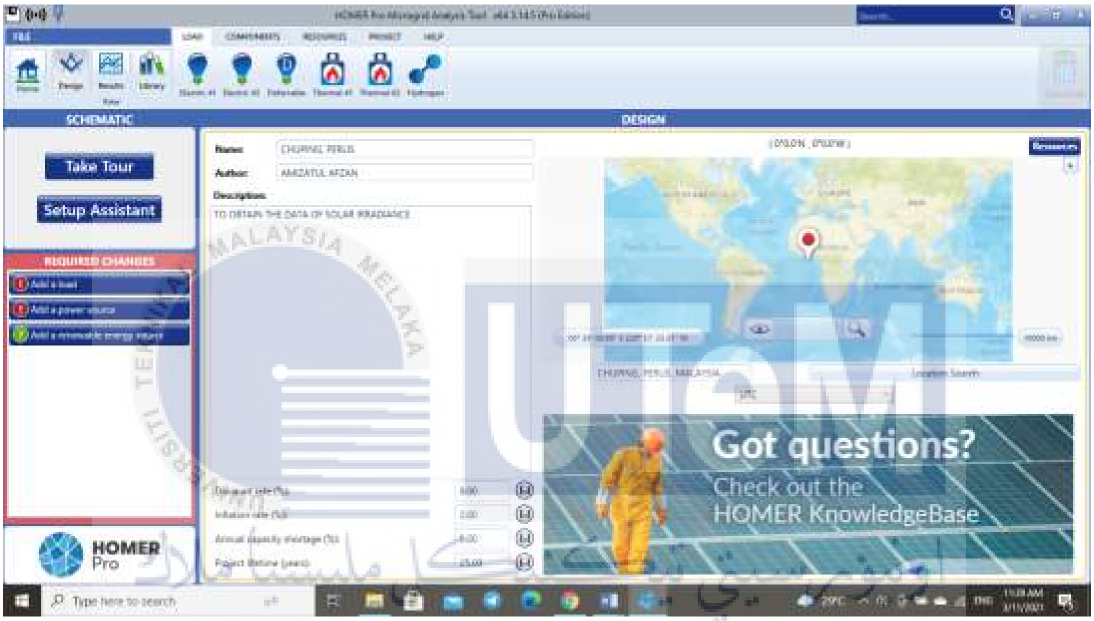


Figure 3.2 Simulation setup for solar radiance

Step 2: Search the location until it marked on the map

Figure 3.3 Simulation setup for solar radiance

Step 3: Download the resources that the HOMER application has provided. From the resources, they can know the information for the location.

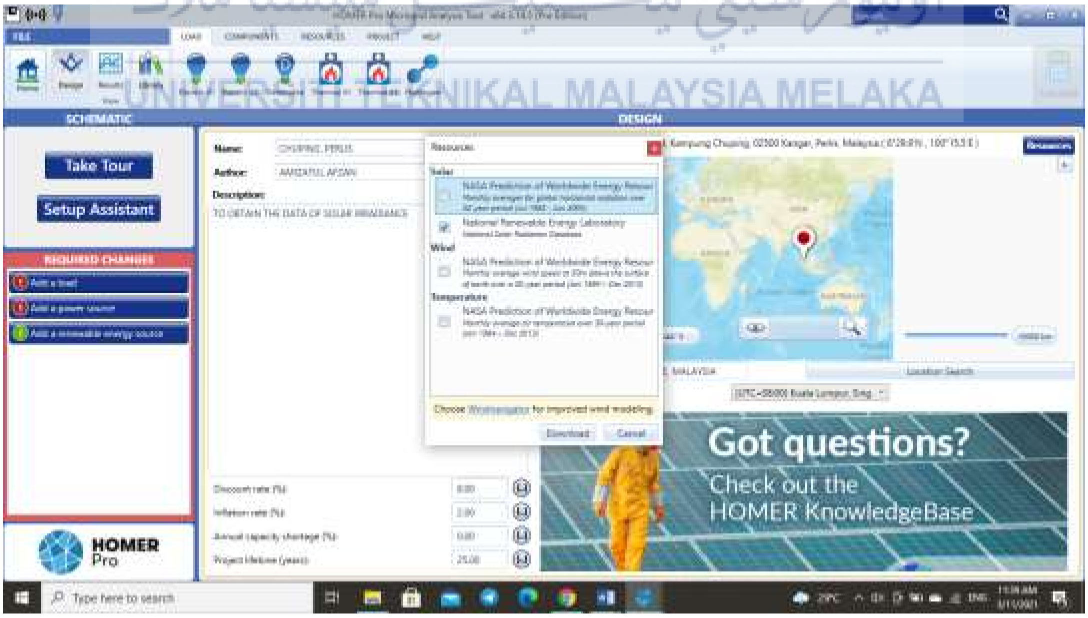


Figure 3.4 Simulation setup for solar radiance

Step 4: Generate the graph to get the annual average solar radiance by clicking the graph section.

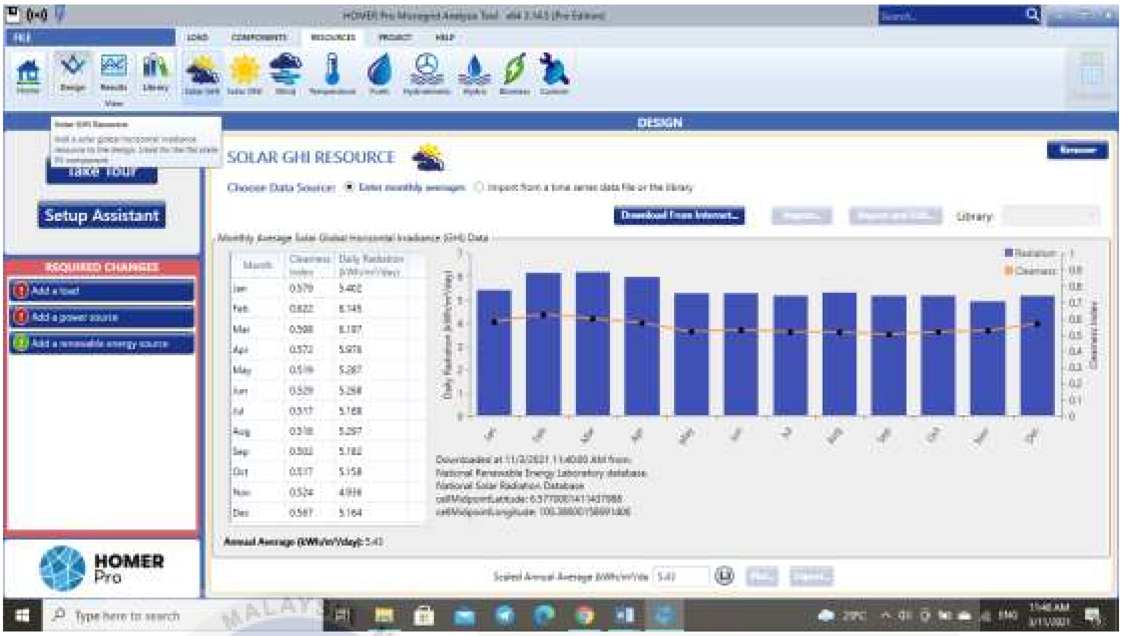


Figure 3.5 Simulation setup for solar radiance

Step 5: Next, we selected the load, converter, battery and components to generate the electricity as we can see from the image, solar panel is being selected.

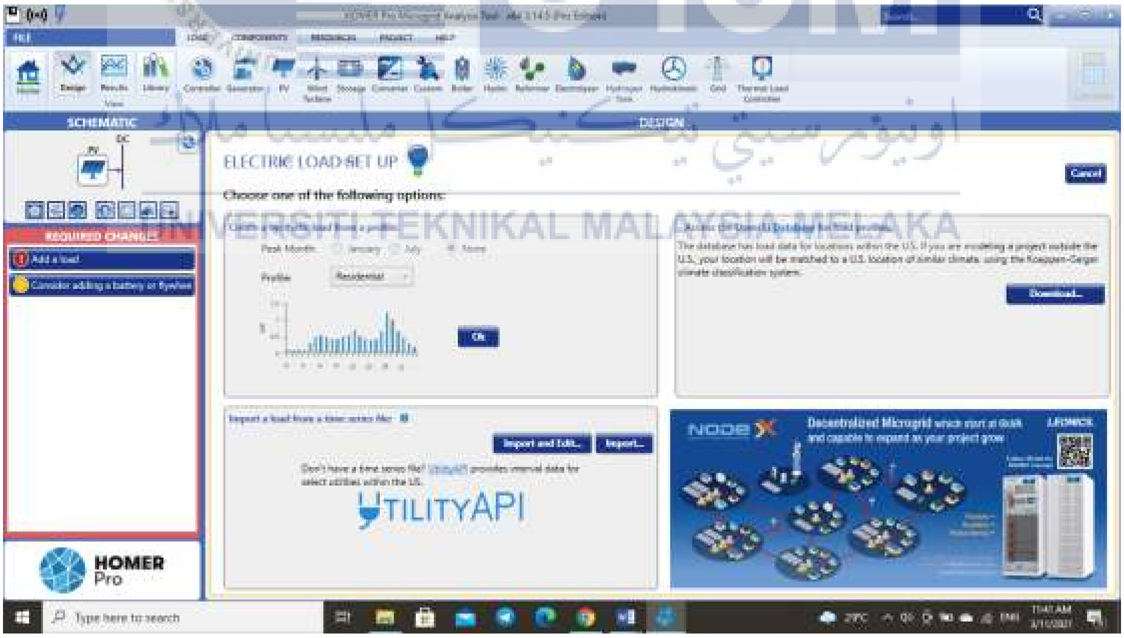


Figure 3.6 Simulation setup for solar radiance

Step 6: To obtain how much cost is needed, the HOMER will calculate based on the lifespan of the components including the maintainence.

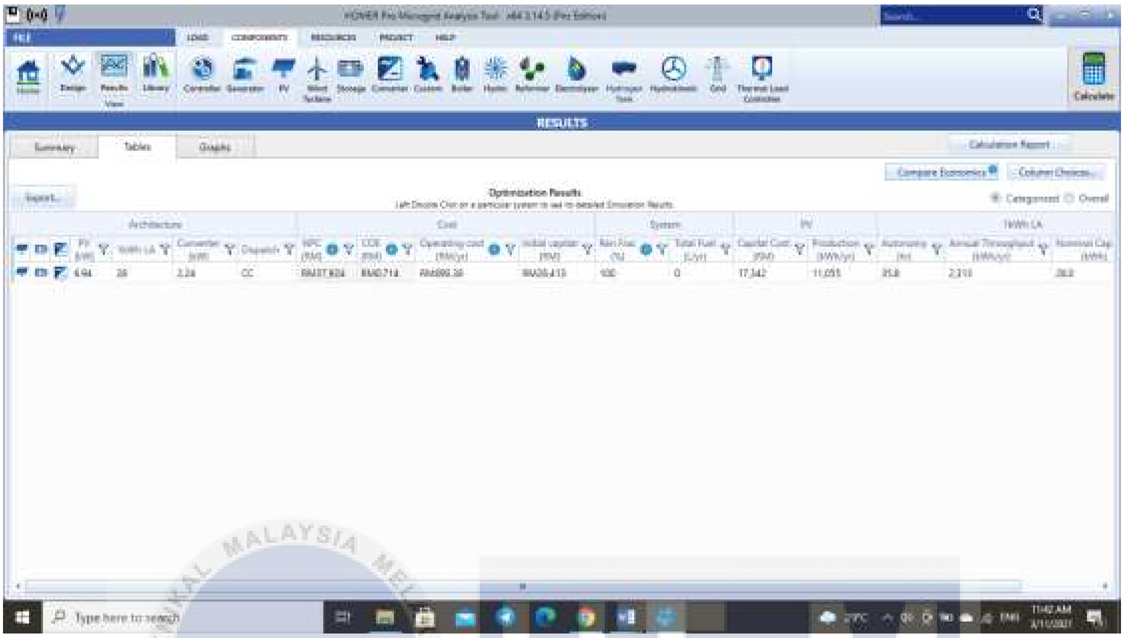


Figure 3.7 Simulation setup for solar radiance

Wind speed:

Step 1: Enter the specific location that needs to be observed

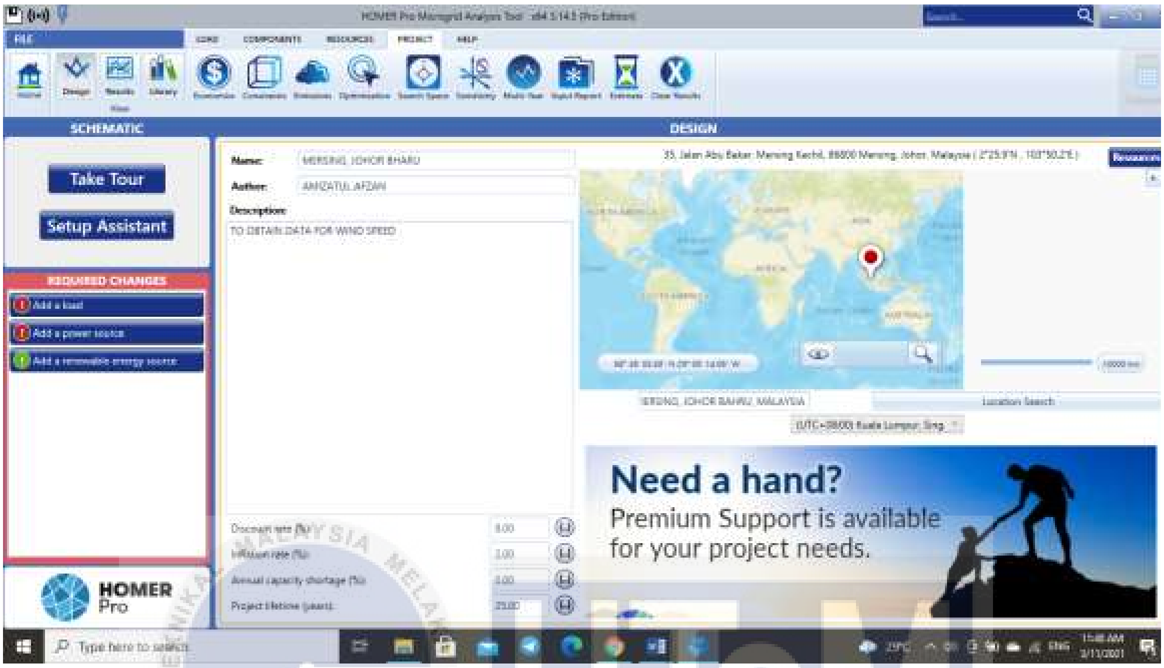


Figure 3.8 Simulation setup for wind speed

Step 2: Search the location until it marked on the map

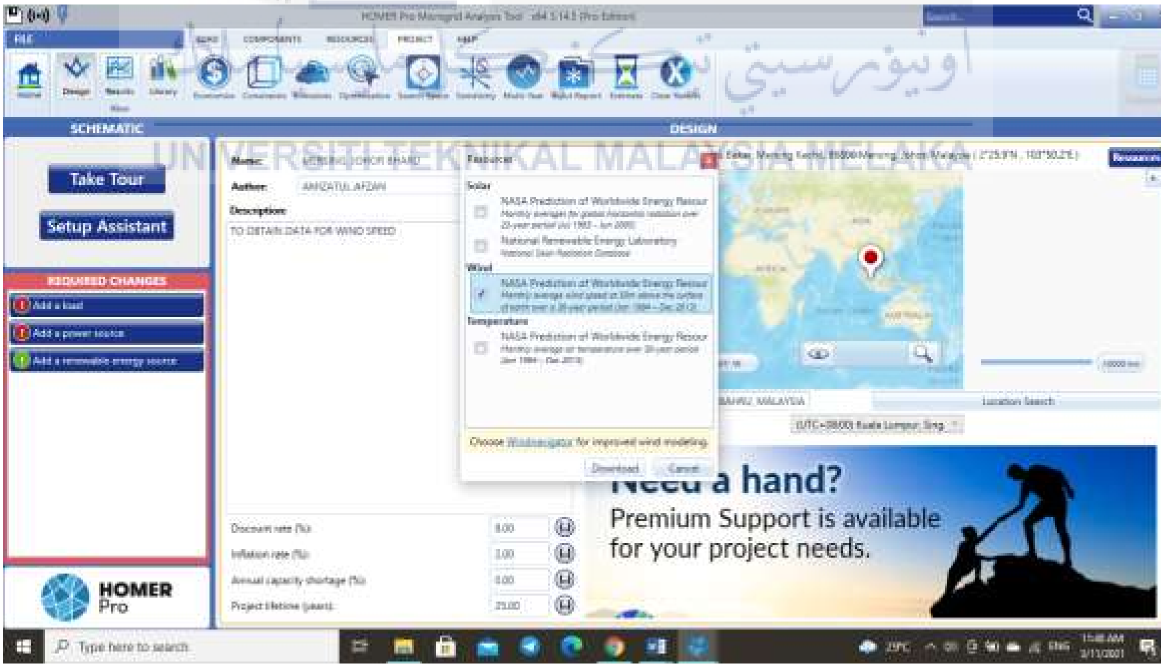


Figure 3.9 Simulation setup for wind speed

Step 3: Download the resources that have been provided by HOMER application. From the resources, it will show the information for the location.

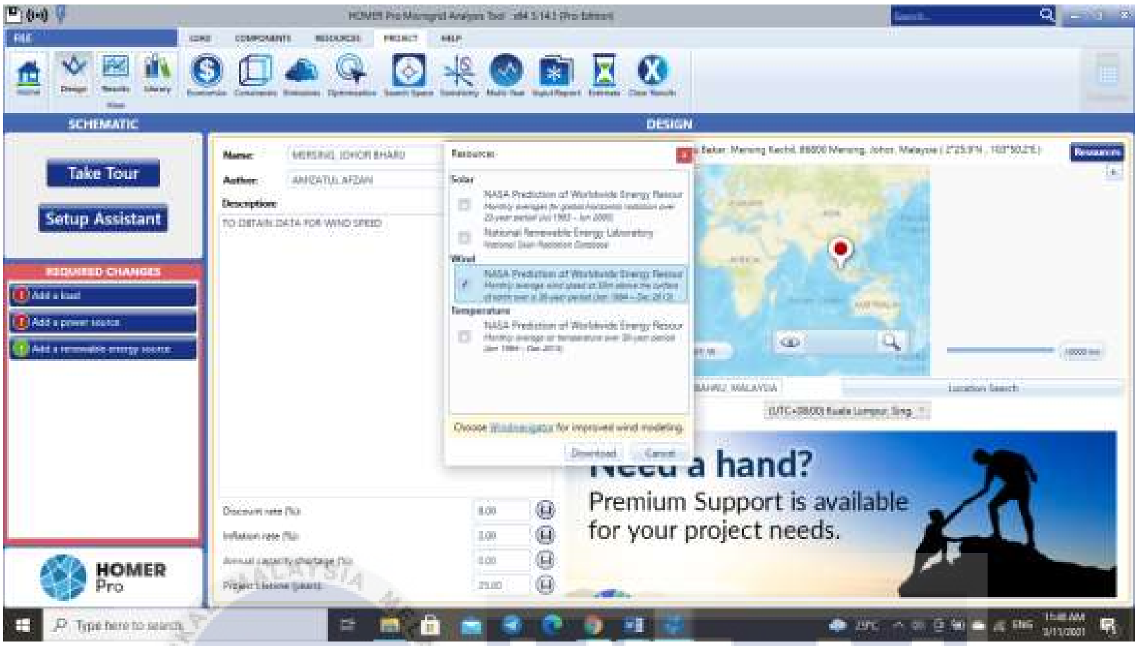


Figure 3.10 Simulation setup for wind speed

Step 4: Generate the graph to get the annual average wind speed by clicking the graph section.

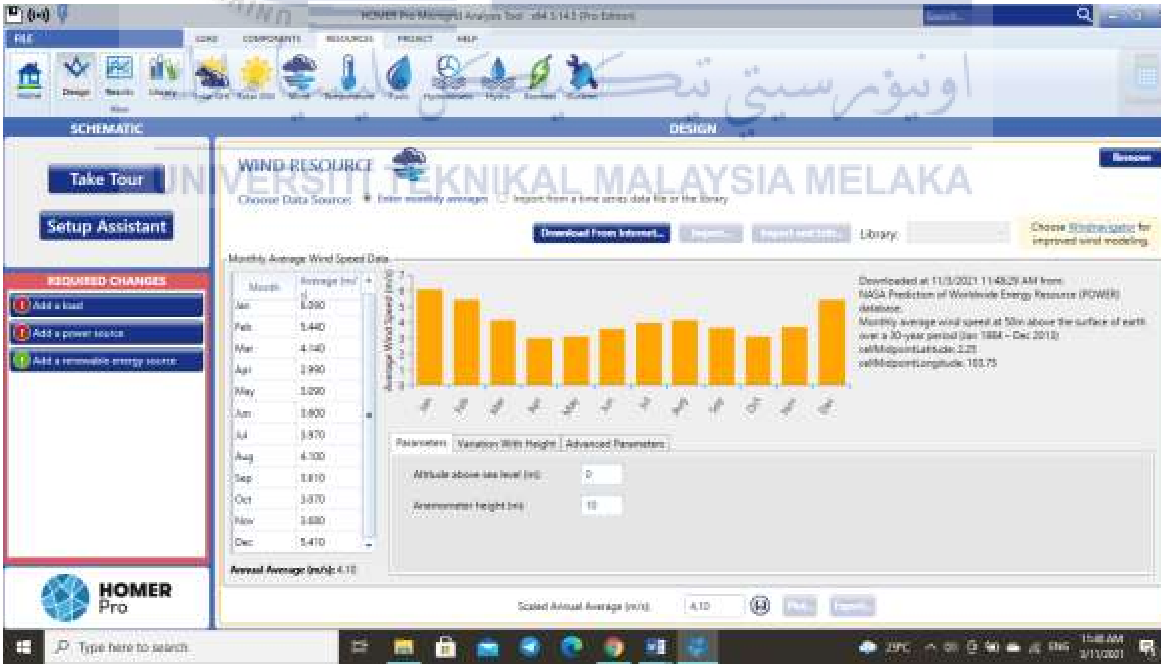


Figure 3.11 Simulation setup for wind speed

Step 5: Next, we selected the load, converter, battery, and components to generate the electricity. As we can see from the image, the wind turbine is being selected.

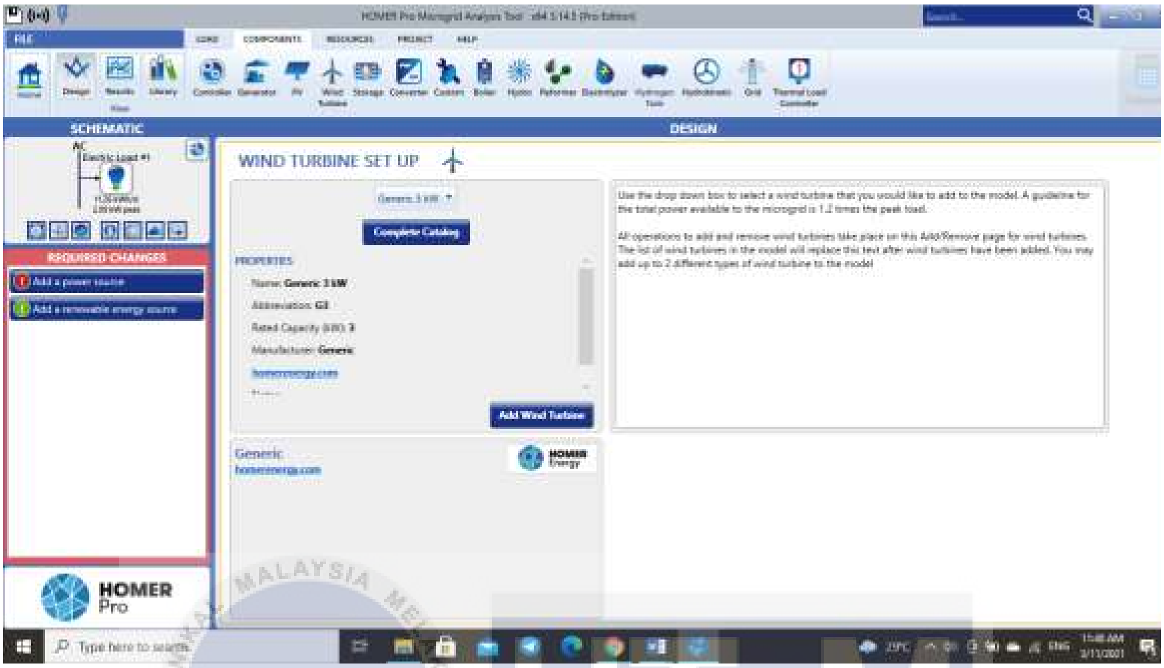


Figure 3.12 Simulation setup for wind speed

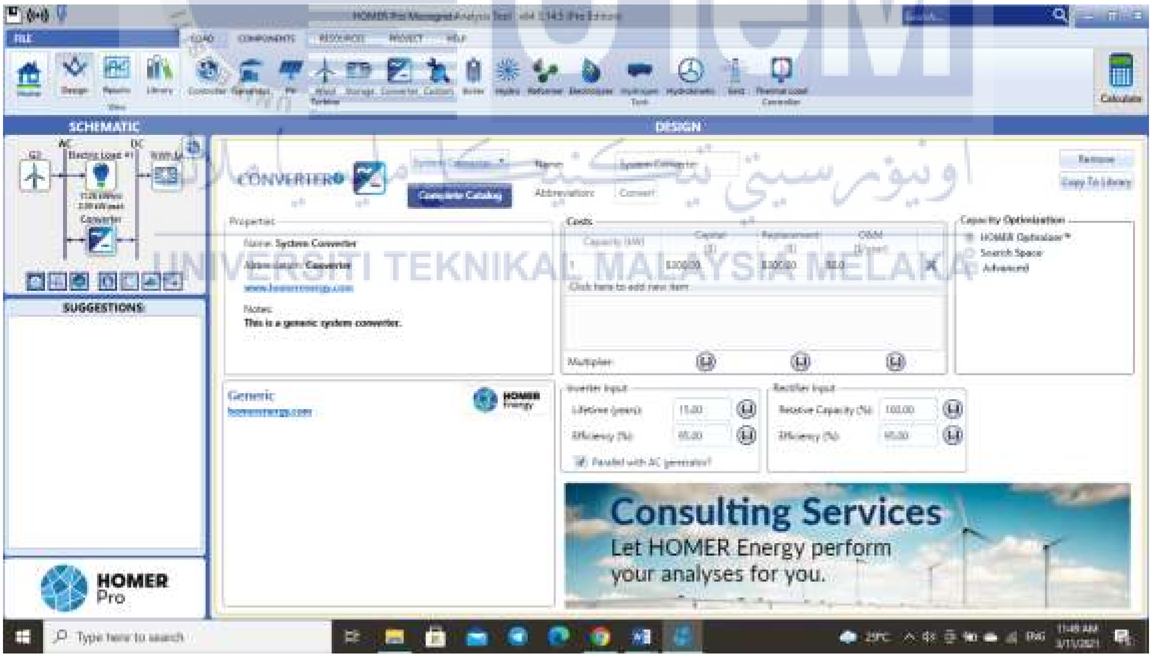


Figure 3.13 Simulation setup for wind speed

Step 6: To obtain how much cost is needed, the HOMER will calculate based on the lifespan of the components, including the maintenance.

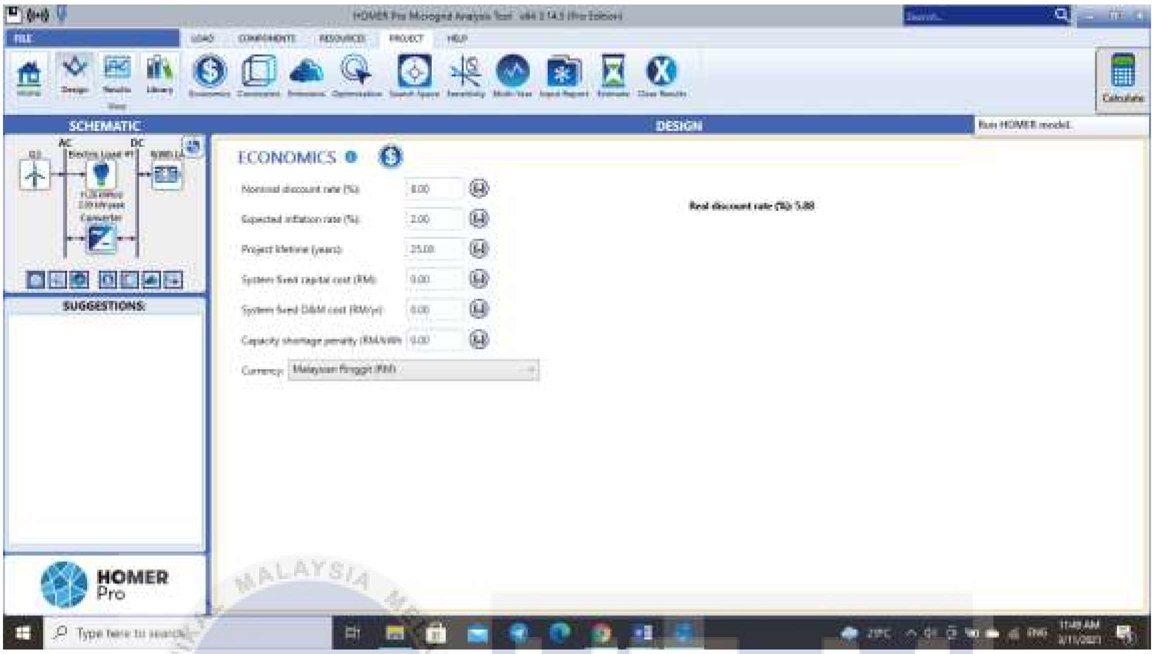


Figure 3.14 Simulation setup for wind speed

3.3 Summary

This chapter describes the methodology of the study about "The Viability Study of Different Type of Renewable Energy in Malaysia". The methodology of this project contains on how the study should be done based on the important factors which are geographical data, technology used and return of investment. This is an important chapter as it is a way to ensure that the project can be done based on the correct sequence of the project methods.

The primary method that the developer has used is using HOMER software to collect the essential data for the renewable energy that has been studied. The data from the software will be determined based on the project's three main factors. Other than that, the past researcher data is used in this project as a piece of additional information to the study. The data is based on the various methods to find the stability of renewable energy in a specific area. This chapter also includes a Gantt chart to ensure that the project is on time management.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

In this chapter, the results from the simulation will be discussed based on the main factors: geographical data, technology used, and return of investment. The data obtain from the simulation will be analyses whether the results is achieving the main objectives of the study that have been conducted.

4.2 Analysis for the simulation

Based on the simulation that has been done, the results will show two main data: the average annual value and the cost of installation. The average annual value will determine the geographical data of the locations is suitable for the implementation of solar or wind energy. For the cost installation, the data will discover the return of investment for each of the location based on their geographical data. The locations for the simulation have been selected based on the geographical map from past researcher that studied the data of the renewable energy. For the simulation, the locations have been stimulated to 5 potential locations that may have the highest potential to be developed in Malaysia. The simulation will be done for solar and wind energy while for the biomass energy, the data that includes the geographical data and return of investment will be study based on the current data in biomass power-plant in Malaysia. There is various type of biomass resources that needs to be examine that leads to which type of the resources that have the highest potential.

4.3 Results simulation for Solar radiance

Location: Kota Bharu, Kelantan

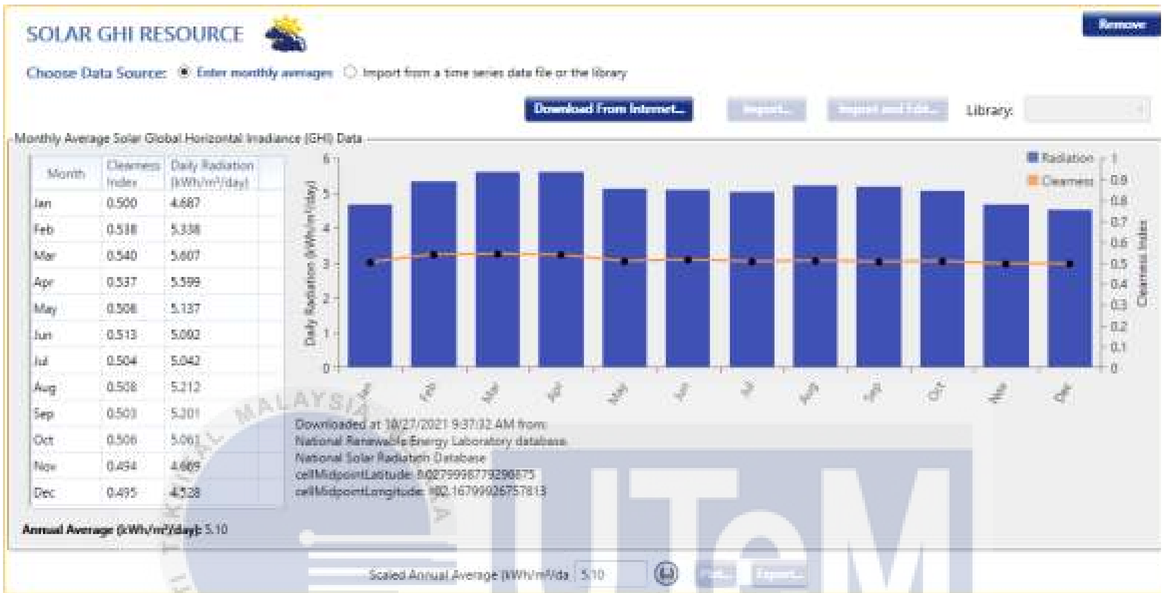


Figure 4.1 Annual graph for solar radiance

Schematic Design:

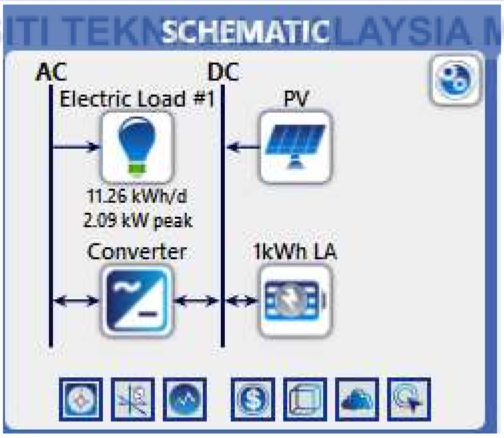


Figure 4.2 Schematic Design

Net Present Cost (NPC) of 25 years.

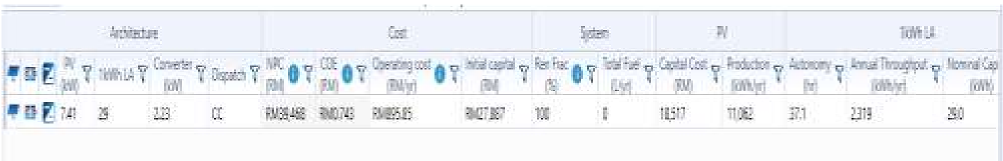


Figure 4.3 Net Present Cost

Location: Chuping, Perlis

Figure 4.4 Annual graph for solar radiance

Schematic Design

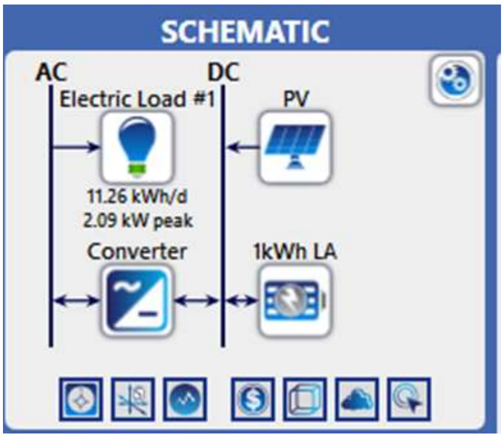


Figure 4.5 Schematic Design

Net Present Cost (NPC) of 25 years

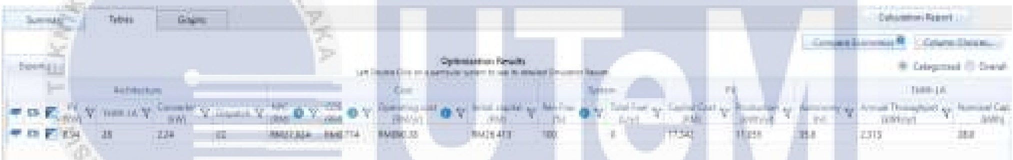


Figure 4.6 Net Present Cost

Location: Kuala Terengganu, Terengganu

Figure 4.7 Annual graph for solar radiance

Schematic Design

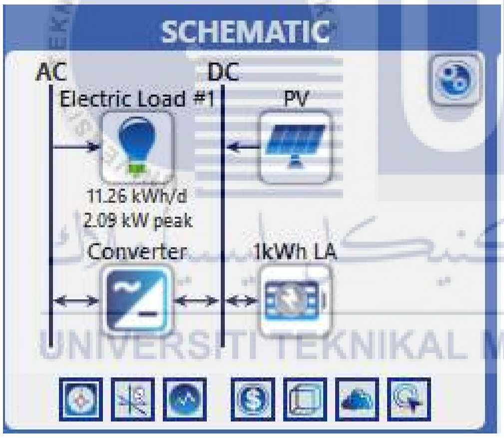


Figure 4.8 Schematic Design

Net Present Cost (NPC) of 25 years

Figure 4.9 Net Present Cost

Location: Kuala Kangsar, Perak

Figure 4.10 Graph for solar radiance

Schematic Design:

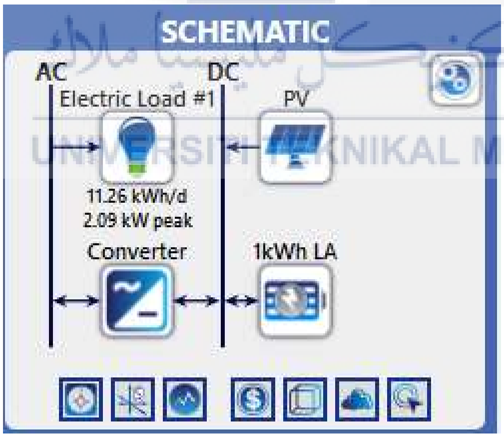


Figure 4.12 Schematic Design

Net Present Cost (NPC)

Figure 4.13 Net Present Cost

Location: Raub, Pahang

Month	Clearness Index	Daily Radiation (kWh/m²/day)
Jan	0.534	5.155
Feb	0.571	5.770
Mar	0.558	5.826
Apr	0.555	5.751
May	0.523	5.220
Jun	0.539	5.227
Jul	0.533	5.216
Aug	0.522	5.297
Sep	0.518	5.360
Oct	0.523	5.307
Nov	0.519	5.036
Dec	0.531	5.020

Figure 4.14 Graph for solar radiance

Schematic Design

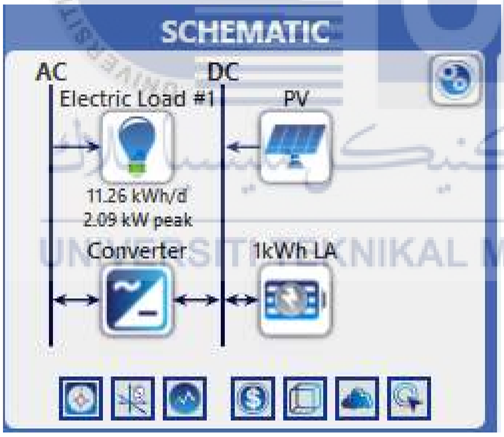
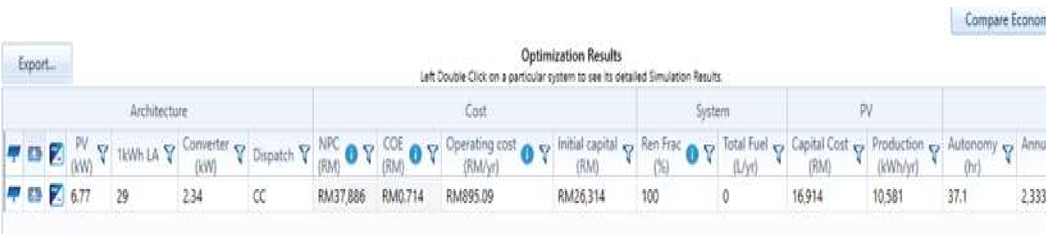


Figure 4.15 Schematic Design

Net Present Cost (NPC)



Architecture				Cost				System		PV			
PV (kW)	1kWh LA	Converter (kW)	Dispatch	NPC (RM)	COE (RM)	Operating cost (RM/yr)	Initial capital (RM)	Ren Frac (%)	Total Fuel (L/yr)	Capital Cost (RM)	Production (kWh/yr)	Autonomy (hr)	Annu
6.77	29	2.34	CC	RM37,886	RM0.714	RM895.09	RM26,314	100	0	16,914	10,581	37.1	2,333

Figure 4.16 Net Present Cost

4.4 Results simulation for wind speed

Location: Mersing, Johor

Figure 4.17 Graph for wind speed

Schematic Design

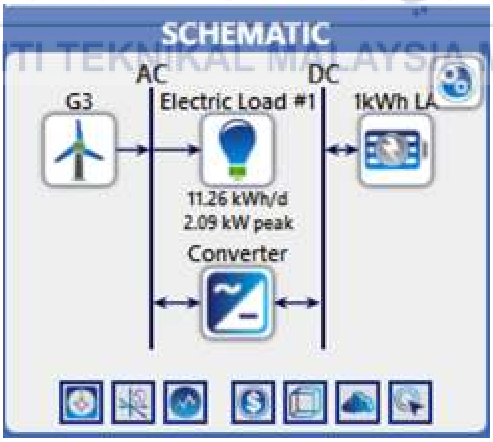


Figure 4.18 Schematic Design

Net Present Cost:

Figure 4.19 Net Present Cost

Location: Pulau Redang, Terengganu

Figure 4.20 Graph for wind speed

Schematic Design

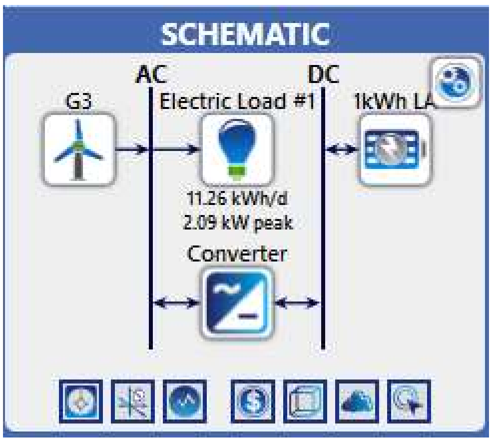


Figure 4.21 Schematic Design

Net Present Cost (NPC):

Figure 4.22 Net Present Cost

Location: Pulau Pangkor, Perak

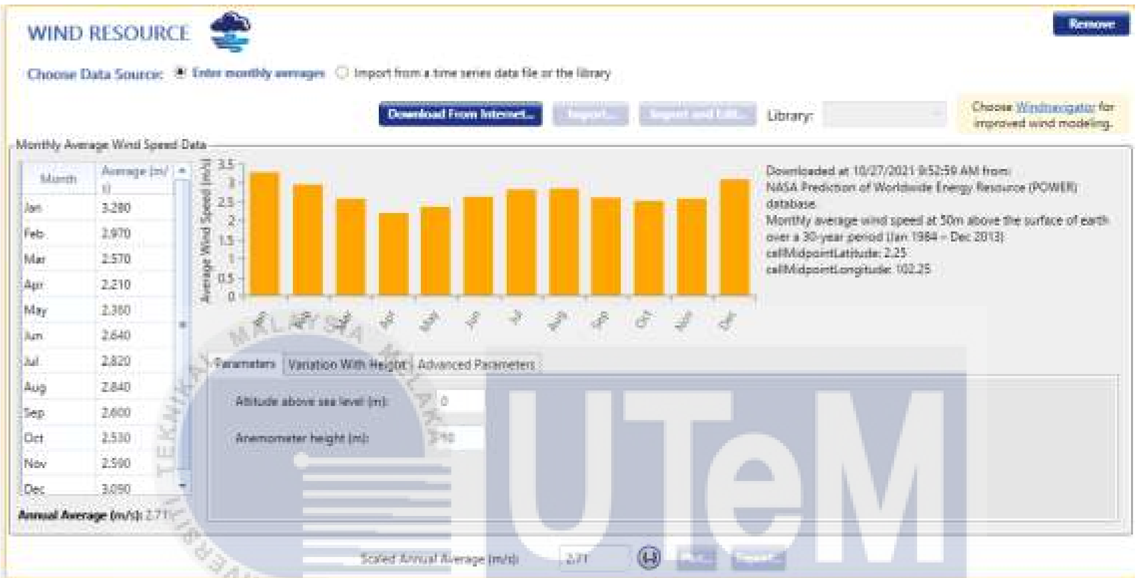


Figure 4.23 Graph for wind speed

Schematic Design

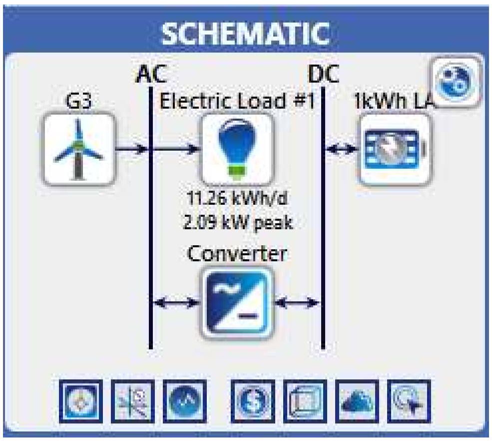


Figure 4.24 Schematic Design

Net Present Cost (NPC)

Architecture				Cost				System		G3			1kWh LA	
G3	1kWh LA	Converter (kW)	Dispatch	NPC (RM)	COE (RM)	Operating cost (RM/yr)	Initial capital (RM)	Ren Frac (%)	Total Fuel (L/yr)	Capital Cost (RM)	Production (kWh/yr)	O&M Cost (RM)	Autonomy (hr)	Annual Throughput (kWh/yr)
35	185	8.82	CC	RM923,685	RM17.48	RM18,264	RM687,571	100	0	638,000	14,338	6,300	237	2,706

Figure 4.25 Net Present Cost

Location: Langkawi, Kedah

Figure 4.26 Graph for wind speed

Schematic Design

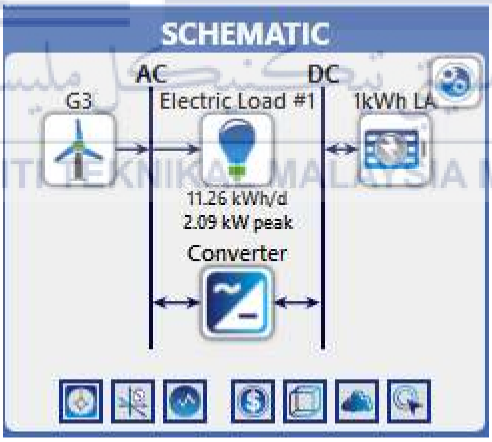


Figure 4.27 Schematic design

Net Present Cost (NPC):

Optimization Results

Architecture					Cost				System		G3				
ID	1kWh LA	Converter (kW)	Dispatch	NPC (RM)	COE (RM)	Operating cost (RM/yr)	Initial capital (RM)	Ren Frac (%)	Total Fuel (L/yr)	Capital Cost (RM)	Production (kWh/yr)	O&M Cost (RM)	Autonomy (hr)	Annual Throughput (kWh/yr)
8	111	5.79	CC	RM258,065	RM4.09	RM6,112	RM179,038	100	0	144,000	20,980	1,440	142	1,721

Figure 4.28 Net Present Cost

Location: Pulau Tioman, Pahang

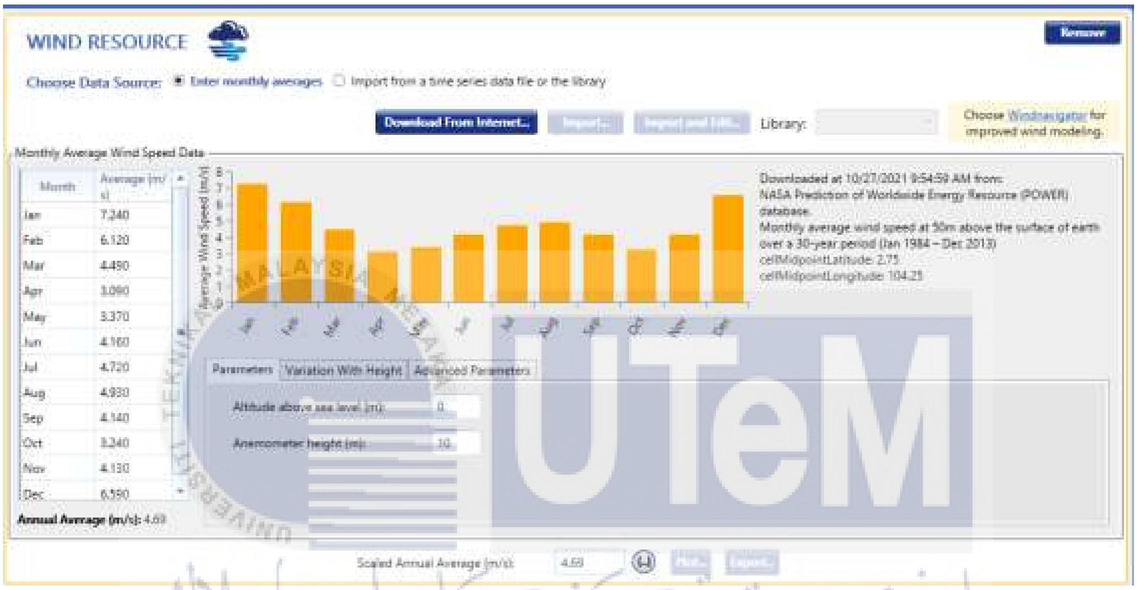


Figure 4.29 Graph for wind speed

Schematic Design

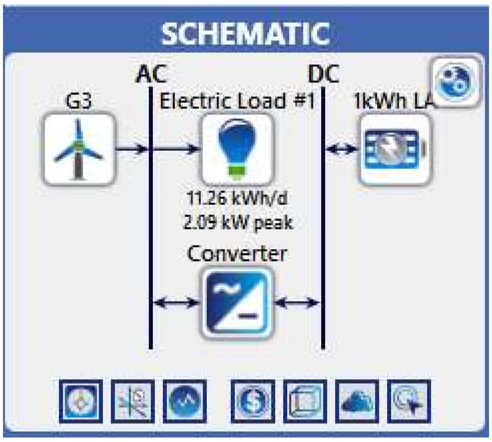


Figure 4.30 Schematic Design

Net Present Cost (NPC)

Figure 4.31 Net Present Cost

4.5 Analysis based on the results for solar energy

Table 4.2 Annual solar radiance from January to December by using Natural Renewable Energy Laboratory (NREL) according to cities.

MONTHS	KOTA BHARU	CHUPING	KUALA TERENGGANU	KUALA KANGSAR	RAUB
JANUARY	4.687	5.402	5.109	5.212	5.155
FEBRUARY	5.338	6.145	6.044	5.904	5.770
MARCH	5.607	6.197	6.035	5.851	5.826
APRIL	5.599	5.976	6.107	5.747	5.751
MAY	5.137	5.287	5.389	5.230	5.220
JUNE	5.092	5.268	5.404	5.264	5.227
JULY	5.042	5.188	5.268	5.134	5.216
AUGUST	5.212	5.297	5.467	5.249	5.297
SEPTEMBER	5.201	5.182	5.472	5.274	5.360
OCTOBER	5.061	5.158	5.360	5.289	5.307
NOVEMBER	4.669	4.936	4.876	4.985	5.036
DECEMBER	4.528	5.164	4.899	5.163	5.020
AVERAGE	**5.100**	**5.430**	**5.450**	**5.360**	**5.350**

Table 4.2 Average annual solar radiance by cities

Location	Average annual Solar radiance (kWh/m^2/month)
Kota Bharu, Kelantan	5.100
Chuping, Perlis	5.430
Kuala Terengganu, Terengganu	5.450
Kuala Kangsar, Perak	5.360
Raub, Pahang	5.350

Table 4.3 Installation cost

Location	Cost by year
Kota Bharu, Kelantan	RM 895.85
Chuping, Perlis	RM 890.38
Kuala Terengganu, Terengganu	RM 896.37
Kuala Kangsar, Perak	RM 893.81
Raub, Pahang	RM 895.09

Based on the tables above, Kuala Terengganu has the highest average annual solar radiance compared to the other 4 locations. Chuping has the second-highest value with 5.430 (kWh/m^2/month). The third highest is Kuala Kangsar, with 5.360 (kWh/m^2/month). The two lowest values are Raub and Kota Bharu, with the respective values of 5.350 and 5.100 (kWh/m^2/month). Next, the calculated cost provided by Homer software shows that the lowest cost per year is Chuping, Perlis with RM 890.38. The second-lowest-cost is Kuala Kangsar with RM 893.81, and the third-lowest is Raub with RM895.09. The two highest costs are Kota Bharu and Kuala Terengganu, with RM 895.85 and RM 896.37.

4.6 Analysis Based on the Results for wind speed

Table 4.4 Wind speed by cities from January to December

MONTHS	MERSING	PULAU REDANG	PULAU PANGKOR	LANGKAWI	PULAU TIOMAN
JANUARY	6.090	6.060	5.900	5.720	7.240
FEBRUARY	5.440	4.950	5.420	4.750	6.120
MARCH	4.140	4.360	4.110	3.890	4.490
APRIL	2.990	3.420	3.010	3.160	3.090
MAY	3.090	2.860	3.310	3.320	3.370
JUNE	3.600	2.760	3.950	3.720	4.160
JULY	3.970	2.910	4.380	3.790	4.720
AUGUST	4.100	2.860	4.580	4.170	4.930
SEPTEMBER	3.610	2.650	3.950	4.050	4.140
OCTOBER	3.070	3.340	3.210	4.050	3.240
NOVEMBER	3.680	4.900	3.560	4.590	4.130
DECEMBER	5.410	6.430	5.120	5.880	6.590
AVERAGE	**4.10**	**3.96**	**4.21**	**4.26**	**4.69**

Table 4.5 Average annual speed by cities

Location	Average annual Wind speed (m/s)
Mersing	4.10
Pulau Redang	3.96
Pulau Pangkor	4.21
Langkawi	4.26
Pulau Tioman	4.69

Table 4.6 Installation cost

Location	Cost per year
Mersing	RM 7271
Pulau Redang	RM 7271
Pulau Pangkor	RM 18,264
Langkawi	RM 6113
Pulau Tioman	RM 6981

Based on the results that have been simulated by HOMER software, Pulau Tioman has the highest wind speed, which is 4.69 m/s, and the second-highest in Langkawi with 4.26 m/s. Next, Pulau Pangkor with 4.21 m/s, and the second-lowest in Mersing with the value of 4.10 m/s. The lowest wind speed is Pulau Redang, with only 3.96 m/s.

Pulau Pangkor has the highest cost for the calculated cost compared to the other 4 locations. The total cost is RM 18,264, two times more than the cost in Mersing and Pulau Redang with RM 7271. This made Pulau Pangkor is not a suitable location to develop the wind turbine. The two lowest costs are Pulau Tioman and Langkawi, with RM 6981 and RM 6113.

4.7 Biomass data analysis

The table 4.7 shows the list of biomass power plants available in Malaysia. There are 4 biomass power-plant in Sabah while the other two is from Selangor. The biomass power-plant in Sabah use the same technology and type of fuel which are steam turbine and empty fruit brunch. Steam turbine is a technology that generate steam to produce electrical energy by burning the biomass fuel. The fuel which is empty fruit bunch will insert into a combustor or furnace to be burned with excess air to heat the water in the boiler that create the steam, then the steam from the boiler expanded through the steam turbine and spins to run the generator that produce electricity. From figure 4.32, it shows how the steam turbine system works. Next, gas turbine is used for Jana Landfill power-plant, the technology use biogas as a fuel. Biogas is produced from anaerobic decomposition or thermochemical conversion of biomass. Figure 4.33 explained the anaerobic digestion process that produce the biogas. The chart in figure shows the generated power by each of the power-plant in Malaysia. TSH has the highest power generated which is 14MW compared to the others four power-plant.

Table 4.7 Biomass power-plant in Malaysia

PLANT	LOCATION	GENERATED POWER (MW)	TECHNOLOGY USED	TYPE OF FUEL
TSH BIOENERGY	TAWAU, SABAH	14	STEAM TURBINE	EMPTY FRUIT BUNCH
KINA BIOPOWER	SANDAKAN, SABAH	11.5	STEAM TURBINE	EMPTY FRUIT BUNCH
SEGUNTOR BIOENERGY	SANDAKAN, SABAH	11.5	STEAM TURBINE	EMPTY FRUIT BUNCH
RECYCLE ENERGY	SEMENYIH, SELANGOR	8.9	STEAM TURBINE	REFUSE DERIVED FUEL
JANA LANDFILL	PUCHONG, SELANGOR	8	GAS TURBINE	BIO GAS
KWANTAS OIL	KOTA KINABALU, SABAH	9.8	STEAM TURBINE	EMPTY FRUIT BRUNCH

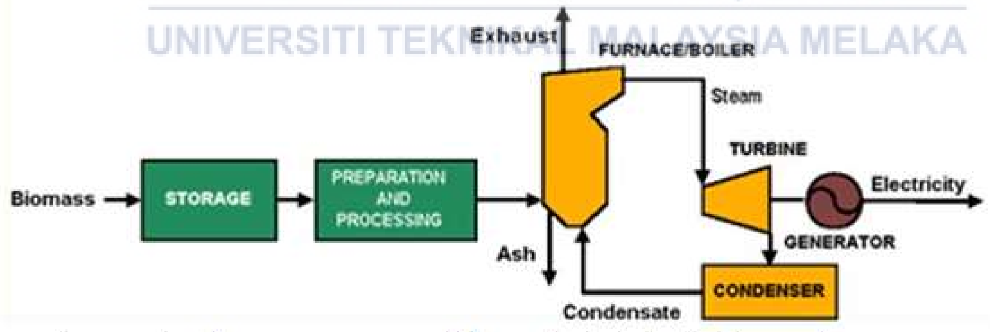


Figure 4.32. Steam turbine system (National Institute Building Science, 2021)

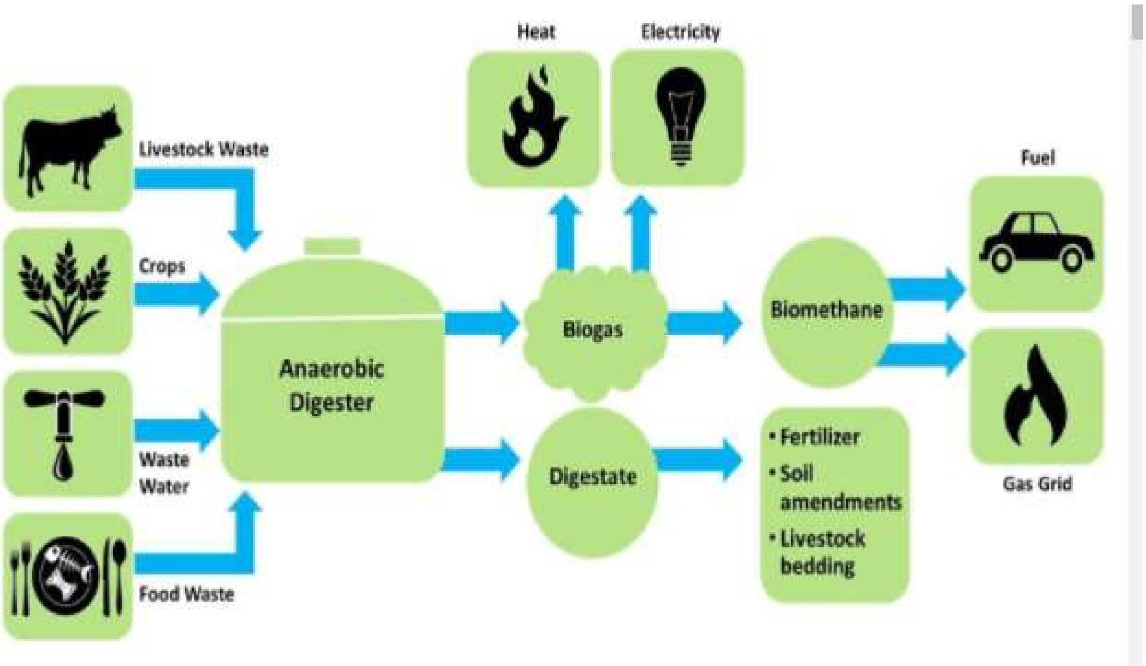


Figure 4.33. Anaerobic digestion process (Sara Tanigawa, EESI)

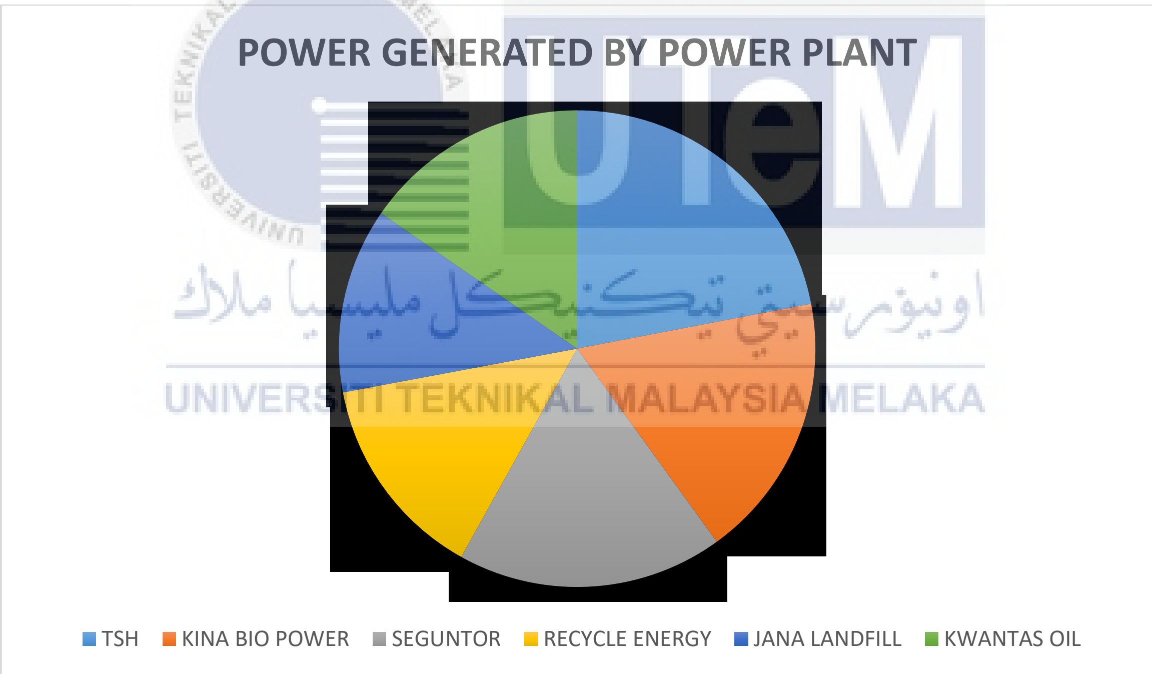


Figure 4.32 Chart for power generated by power plant in Malaysia

Location: Tawau, Sabah

Power plant: TSH Bioenergy

Figure 4.33 Annual Prices of Crude Palm Oil in 2018

Figure 4.34 Annual prices of Crude Palm Oil in 2019

Based on the figure in 4.33 and 4.34, the annual prices for both years are 2256.67 RM / tonne and 2153.33 RM / tonne. The prices are the cost of processing the Fresh Fruit Bunches (FFB) into Crude Palm Oil (CPO) and Palm Kernel (PK). CPO generate large quantity of biomass waste that can be use in for Biomass power-plant. TSH's biomass power-plant has a renewable energy power purchase agreement with Sabah Electricity Sdn Bhd to supply up to 10MW of green electricity which proof that the biomass resources can be use to generates electricity from solid by-product of the CPO. From the annual graph in 2018, CPO price declined from RM2086 per tonne to RM1995 per tonne due to the industry uncertainty and economic volatility. The industry uncertainty happened because of the risks in the oil palm industry as TSH Biomass power-plant is a latecomer to the industry. In December 2018, Malaysia's B10 biodiesel programme was launched for the transportation sector that helps the palm oil stockpile which resulting in boost annual biodiesel consumption by 700,000 mt (metric tonne) – 80000 mt (matric tonne).

Location: Kota Kinabalu, Sabah

Power plant: Kwantas Oil

Table 4.8 The production in 2018 and 2019.

Production	**unit**	**2018**	**2019**
Fruit Bunches (own)	tonne	326,623	286,726
Fruit Bunches (third parties)	tonne	289,117	234,443
Palm kernel	tonne	31,008	26,394
Crude palm	tonne	128,549	107,610

Table 4.9 The biomass by-product in 2018 and 2019

Primary waste	**Utilisation**	**2018**	**2019**	**Units**
Empty Fruit Bunches	Fertiliser and biomass fuel	27104	97011	Tonne
Mesocarp Fibers	Fertiliser and biomass fuel	63879	109085	Tonne
Shells	Biomass fuel	14978	14311	Tonne
POME	Fertiliser	318373	356959	M^3

Based on the table in 4.8, the data shows the value of production from the palm oil mills and plantations. The value of production in 2019 is lower compare to production in 2018. For the table 4.9, the primary waste from the previous table are divided into 4 types which are empty fruit bunches, mesocrap fibers, shells and POME (palm oil mill effluent). The biomass waste by-products are used as the organic fertilizer and biomass fuel. From the data value from both table, it shows that the waste from the CPO (Crude Palm Oil) process is utilizing into something useful instead of become a pollution to the environment. The data shows the potential of the palm oil and plantation to create their own biomass power-plant that provide their own electricity.

4.8 Data analysis based on the type of Biomass Resources

Based on the data provided by Malaysia Industry- Government Group for High Technology:

Chart 1 below provides the graphical summary of the value creation for the types of biomass studies.

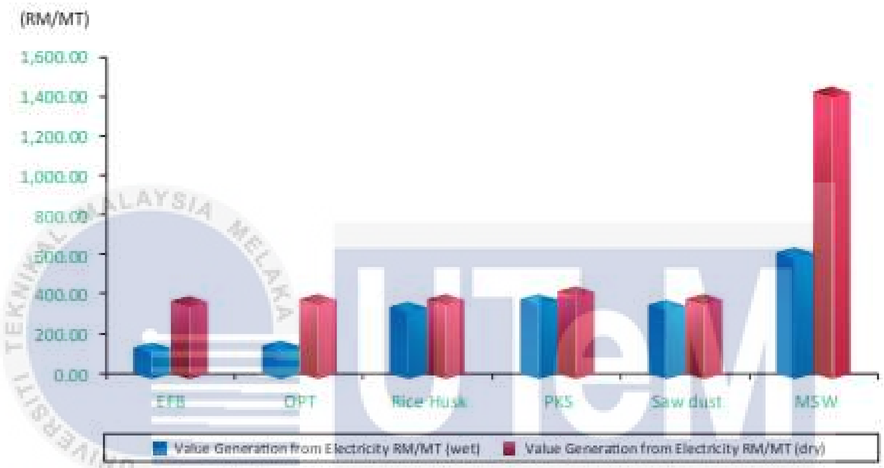


Figure 4.35. Value generation from electricity. (MIGHT, 2014)

The chart above shows the types of biomass that consists of:

- Palm Empty Fruit Bunches (EFB)
- Palm Kernel Shell (PKS)
- Oil Palm Trunks (OPT)
- Wood Saw Dust
- Rice Husk
- Municipal Solid Waste (MSW)

The value was determined based on the following factors which are calorific value, moisture content and revenue generation from sale to grid electricity based on Feed-in Tariffs (FiT) rate under the Renewable Energy (RE) Act 2011.Value creation of power generation from biomass is calculated based on FiT rate under the RE Act 2011.FiT rate under the Renewable Energy Act 2011 is assumed to be RM0.31 per kW/hr for biomass and RM0.41 per kW/hr for MSW.

The major factor is the difference in calorific values between the biomass in wet and dry forms. EFB and OPT have high moisture content, therefore require extensive drying process for efficient conversion to energy. Next, palm EFB and OPT give the lowest value in wet forms while rice husk, PKS, and saw dust gives larger but comparable value for electricity generation. Lastly, MSW shows a significantly high value generation because of its high calorific value (21,671 MJ/MT) and the presence of high calorific contents such as plastics, paper, leather, textiles and wood in the MSW

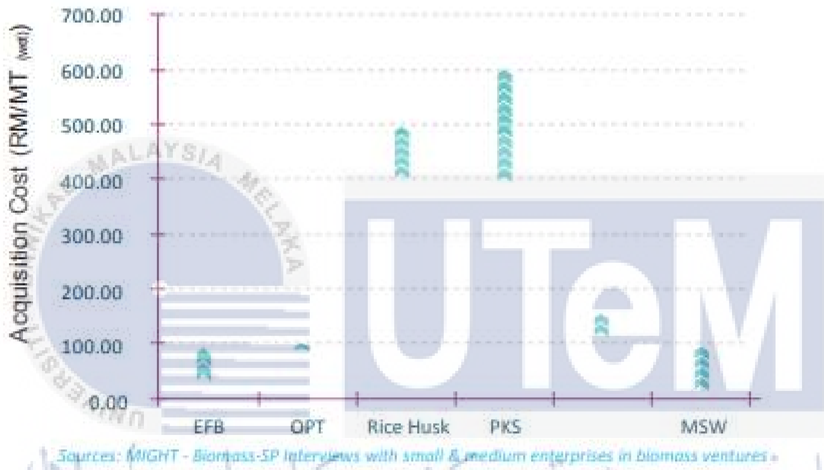


Figure 4.36. Acquisition Cost (MIGHT, 2014)

The chart above contains biomass acquisition costs which feedstock purchase, transportation, and collection costs. This costs are important to determine the revenue generation from the sale of electricity to grid based FiT rates under the RE Act 2011 with biomass based power generation. From the chart, PKS and rice husk shows larger cost variance as compared to others. The high cost is because of the supply and demand market of biomass resources is still new and there is no standard for buying and selling the biomass resources.

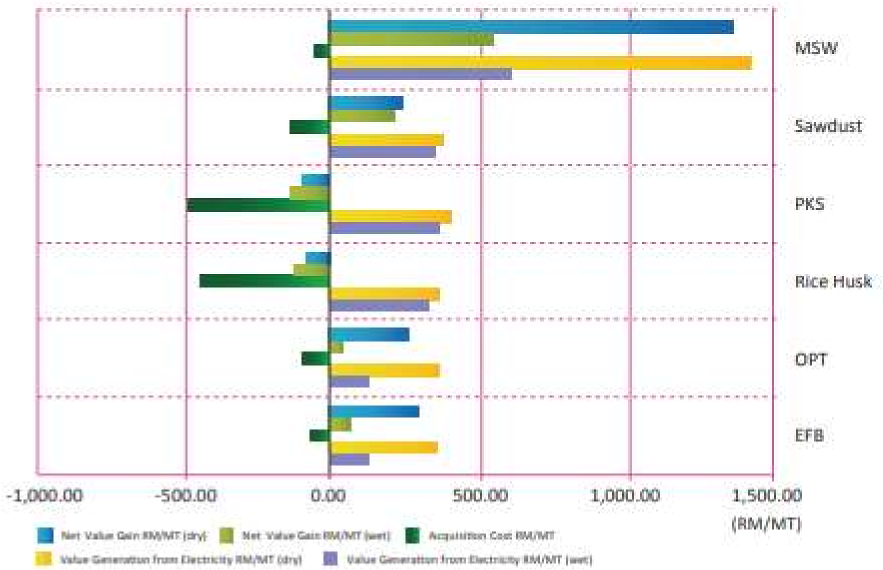


Figure 4.37 Net value creation. (MIGHT, 2014)

Based on the chart above, MSW has the highest net value creation and the second highest is OPT. Then, EFB and saw dust. Rice husk and PKS is at the lowest with negative net value creation due to their competing uses that mark up the acquisition costs that influenced by the power generation. MSW has the highest net value creation because of the high calorific which is the presence of plastics, paper, leather, textiles and wood. EFB and OPT need to obtain more commercial ventures so it can increase the acquisition costs.

4.9 Summary

This chapter presented the results and analysis obtained from the live data provided by HOMER application for solar and wind energy. For biomass energy, the results and analysis is made from the data of production and the value of biomass resources. The type of biomass resources also been analyzed based on the potential value creations. The value is based on 3 main factors which are calorific value, moisture content and revenue generation from sale to grid electricity based on Feed-in Tariffs (FiT) rate under Renewable energy (RE) Act 2011.

Based on the simulation results for solar energy, for the geographical data, Kuala Terengganu has the highest value of annual average solar radiance compared to the other 4 locations. For the installation cost, it has the second lowest cost. So, Kuala Terengganu could be the location to implement the solar energy.

Next, for wind energy that based on the geographical data, Pulau Tioman has the highest value of annual average wind speed as it is located in island. The installation cost for the location is average compared to Pulau Redang that has the highest but low wind speed. Pulau Tioman is the ideal location due to highest wind speed and average installation cost.

According to data research, Sabah has the most power-plant due to their large palm oil region. The availibility of the biomass waste should not be a problem as there are around 1.54 million hectares the size of total palm oil in Sabah. For the types of biomass resources, Municipal Solid Waste (MSW) is the most potential type of resources based on the 2 main points which are calorific value and moisture content. MSW is also has the highest availibility as the waste has become a problem to our country. By using MSW as the main biomass resources, the environment pollution can reduce while electricity can be generate.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In this chapter, conclusion will be made by discussing whether this project is meet the objectives that have been stated in the early of the chapter. The data obtained from this project should be analyse before making any summary. This chapter also included the future recommendationA which is about the improvements that should be made in order for the project to be more successful.

Based on the objectives of the study, the highest potential renewable energy in Malaysia is Biomass as the resources is available across the country which is the Municipal Solid Waste (MSW) while the other 2 renewable energies which are solar and wind do not have constant availability. The essential factor also has been monitor by using Homer application to determine which location has the highest potential for each of the renewable energy. The essential factors are geographical data and the cost of installation that has been simulated through the Homer application. The most viable renewable energy can be implemented by developing the selected location and the data of the resources.

5.2 Future Works

The study on the viability of different type of renewable energy using HOMER application can be improved in the future in order for this project to achieve the main objectives.

First, to find the most viable renewable energy, a lot of locations needs to be analyse beforehand because there are many potential locations with different type of renewable energy located in Malaysia.

Next, for the biomass resources to develop the renewable energy, the government should provide more incentives as it can benefit the investors for the biomass industry. The relevant agencies and government bodies should involve more to bring forward the biomass renewable energy. Lastly, through all the recommendations, the project should be done according to the objectives and achieve the exact results to deciding which renewable energy is the most viable ones.

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Solar PV cell diagram.

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APPENDICES

Appendix A Example of Appendix A

No.	Parameters	No.	Parameters
1.		25.	
2.		26.	
3.		27.	
4.		28.	
5.		29.	
6.		30.	
7.		31.	
8.		32.	
9.		33.	
10.		34.	
11.		35.	
12.		36.	
13.		37.	
14.		38.	
15.		39.	
16.		40.	
17.		41.	
18.		42.	
19.		43.	
20.		44.	
21.		45.	
22.		46.	
23.			
24.			

Appendix B Example of Appendix B

Time	Residential	Industrial	Commercial