SIZING OF HYBRID PHOTOVOLTAIC AND WIND SYSTEM FOR BLOCK A RESIDENTIAL HOSTEL

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A project report submitted in partial
fulfilment of the requirement for the award of the
Degree of Master of Electrical Engineering

Faculty of Electrical and Electronic Engineering
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JULY 2021

To my beloved parents, thank you.

ACKNOWLEDGEMENT

First and foremost, it is almighty Allah for his guidance and protection throughout my whole life who gave me the opportunity my studies as well as “SIZING OF HYBRID PHOTOVOLTAIC AND WIND SYSTEM FOR BLOCK A RESIDENTIAL HOSTEL” For his guidance and security throughout my entire life. Also, this master project to complete. Therefore, I thank Almighty Allah at the very beginning, and all the glory goes to Him. I would like to express my enthusiastic gratitude and regards to Ts. Dr. Ahmad Fateh Bin Mohamad Nor for his continuous supervision, scholastic guidance, valuable suggestions, necessary instructions and counselling to carry out my project. Without his guidance and knowledge, I would not be able to finish this project.

He did his best to ensure I understood under his guidance the idea of the project. I would like to express my deep appreciation to the officials and other staff members of Universiti Tun Hussein Onn Malaysia (UTHM) and the Department of Electrical Power Engineering of the Faculty of Electrical and Electronics Engineering for their helpful guidance and suggestions, which helped me in completing the project work, in time. Also giving me the opportunity to gain experience and valuable knowledge. Most of all, the excellent facilities, adequate tools and equipment in laboratory are accurately appreciated.

Finally, I should like to express my deep appreciation to my parents and family for giving me continuous support and encouragement over my years of study and through my research, to express my sincere gratitude for the fact that this work would never have been possible without their support and patience.

Special thanks also go to my friends. To others who have helped me either directly or indirectly, your help will always be remembered. Last but not least, thank you all.

ABSTRACT

This Project discussed the sizing Process of stand-alone Photovoltaic (PV) and wind system to supply the required load for Residential hostel located in Parit Raja, Malaysia. Energy from renewable sources is clean, eco-friendly, efficient, and reliable. Solar and wind are gaining much importance in the present world. It is important to establish renewable energy in an isolated area where the availability of fuel is costly for grid expansion. The procedure of this research was the measuring and collection of the basic meteorological data of solar radiation and wind speed for Parit Raja. The project aims to size the stand-alone system was by using manual calculation and HOMER Pro software. However, solar and wind energy are known as dependable and widely available renewable energy sources in Malaysia, but the intermittent energy sources will cause the power generator to produce a fluctuating output when it's overcast or night-time, one can't power our system utilizing a stand-alone PV system since there is no solar radiation. Similarly, the varying wind speed will affect the amount of energy generated by a standalone wind turbine system. The simulation results showed that a hybrid system consists of 58kW photovoltaic modules with one wind turbine (20 kW), 15kW inverter, and 1 kWh battery storage (48batteries, 200 Ah, and 12 V) produced electricity for a residential hostel and cost of electricity of RM0.703 per Kwh. finally, the PV system ended up being the most cost-effective solution, while also being the most efficient in terms of energy usage.

ABSTRAK

Projek ini membincangkan proses ukuran sistem Photovoltaic (PV) dan sistem angin yang berdiri sendiri untuk membekalkan muatan yang diperlukan untuk asrama Kediaman yang terletak di Parit Raja, Malaysia. Tenaga dari sumber yang boleh diperbaharui bersih, mesra alam, cekap dan boleh dipercayai. Suria dan angin semakin penting di dunia sekarang. Penting untuk mewujudkan tenaga boleh diperbaharui di kawasan terpencil di mana ketersediaan bahan bakar mahal untuk pengembangan grid. Prosedur penyelidikan ini adalah pengukuran dan pengumpulan data meteorologi asas radiasi matahari dan kelajuan angin untuk Parit Raja. Projek ini bertujuan untuk mengukur sistem yang berdiri sendiri dengan menggunakan pengiraan manual dan perisian HOMER Pro. Walau bagaimanapun, tenaga suria dan angin dikenali sebagai sumber tenaga boleh diperbaharui yang boleh dipercayai dan tersedia secara meluas di Malaysia, tetapi sumber tenaga yang berselang-seli akan menyebabkan penjana kuasa menghasilkan output yang berubah-ubah ketika mendung atau pada waktu malam, seseorang tidak dapat menghidupkan sistem kita menggunakan sistem PV yang berdiri sendiri kerana tidak ada sinaran suria. Begitu juga, kelajuan angin yang berbeza-beza akan mempengaruhi jumlah tenaga yang dihasilkan oleh sistem turbin angin yang berdiri sendiri. Hasil simulasi menunjukkan bahawa sistem hibrid terdiri daripada modul fotovoltaik 58kW dengan satu turbin angin (20 kW), penyongsang 15kW, dan penyimpanan bateri 1 kWh (48 bateri, 200 Ah, dan 12 V) menghasilkan elektrik untuk asrama kediaman dan kos elektrik sebanyak RM0.703 setiap Kwh. akhirnya, sistem PV akhirnya menjadi penyelesaian yang paling menjimatkan, dan juga yang paling efisien dari segi penggunaan tenaga.

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LIST OF SYMBOLS AND ABBREVIATIONS

AC	-	Alternative current
COE	-	Cost of energy
Cp	-	Power coefficient
DC	-	Direct current
DOD	-	Discharge of depth
GHG	-	Greenhouse gases
MPPT	-	Maximum power point tracking
HAWT	-	Horizontal axis wind turbine
LSS	-	Large Scale Solar
NPV	-	Net present value
NPC	-	Net present cost
Np	-	Number of parallel
NREL	-	National Renewable Energy Laboratory
PV	-	Photovoltaic
PTM	-	Persatuan tadika Malaysia
RS	-	series resistance
RE	-	Renewable Energy
SEDA	-	Sustainable energy development authority
VAWT	-	Vertical axis wind turbine
WP	-	Peak watt

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CHAPTER 1

INTRODUCTION

1.1 Background Study

Nowadays, the usage of a fossil-fuel-based energy system is a growing environmental concern. Despite the efforts of governments and research organisations, renewable energy have a number of related issues, including their reliance on environmental conditions, limited lifetime, and high cost. To address these issues, hybrid systems are proposed as a theoretically possible and optimum option [1]. Renewable energy resources, alternative, sustainable, or nonconventional energy, are forms of energy derived from natural resources. Wind, solar, hydro, geothermal, biomass, and ocean energy are all in great demand worldwide, owing to the world's growing need for power.

However, with such captivating characteristics, it also come with a number of restrictions and problems. Their application is still rather restricted due to some of their disadvantages. The first, and most significant disadvantage, is their climate-dependent nature, which means that these energies fluctuate constantly and that the power accessible from them at any one place is not constant in magnitude. Nonetheless, this issue has been addressed to some extent by the use of hybrid technology coupled with other forms of renewable energy or with traditional systems such as diesel-engine driven generators[2].

Solar energy solutions are now widely recognised and rising in popularity in the global energy markets. However, research and development are required to ensure that renewable energy fulfils the demands of future generations. [3]. at the present, dependable and resilient energy systems are built on fossil fuel combustion, which continues to dominate the global energy landscape. Solar power becomes an exceptionally inexpensive choice for residential, commercial, and industrial applications, both on- and off-grid. Fossil fuels are non-renewable and directly contribute to global warming by releasing greenhouse gases into the sky. This has had a tremendous impact on the environment and on human health. Additionally, the volatile cost of fossil energy has a significant influence on energy security. Numerous alternative energy sources, such as hydro, solar, wind, biomass, and geothermal, may offer clean, continuous, and renewable energy [4].

Due to the availability of wind energy, it is one of the most often used renewable sources for common purposes. Natural renewable energy sources such as wind, sun, and water are used to generate power. Wind is the energy that can be harnessed to power wind turbines. Wind energy is difficult to forecast owing to the unpredictability of wind speeds in different areas, which results in unsteady wind turbines. [5]. It is generally recognised that the world's fossil energy supplies are finite, for example coal, gas and petroleum. With each day passing, the overall use of these resources grows. Renewable energy sources will be required to fulfil the rising demand for electricity in this terrible situation. Renewable energy is a clean energy source since it produces no pollutants or unwanted products that may have an adverse effect on the environment. [6].

As an alternative to conventional electricity, solar and wind systems are sustainable owing to their non-polluting behaviour. Renewable energy is a serious problem in today's world of global warming and pollution. Additionally, solar and wind energy studies are limited by geography and climate change; thus, a new development was discovered that can generate electricity without limitations, particularly in rural areas; this new development is a hybrid system that combines multiple renewable energy sources into a single power plant. Solar photovoltaic (PV) and wind energy have been demonstrated to be more promising, technically mature, and cost-effective sources of energy [7].

1.2 Problem Statement

The globe is seeing a rise in demand for energy consumption as a result of the world's growing population. This results in a significant reliance on natural resources, such as fossil fuels and natural gas, for power generation. However, standalone photovoltaic and wind hybrid energy systems offer a more economically feasible option for meeting the energy needs of the world's countless solitary customers. Although solar and wind energy are regarded as reliable and readily available renewable energy sources in Malaysia, their intermittent nature results in a variable output from the power generator. For example, in the absence of solar radiation, a single photovoltaic system cannot generate energy at night or on overcast days. Similarly, variations in wind speed have an effect on the quantity of energy generated by a stand-alone wind turbine system[8].

Dependence on a single source of energy for power generation results in a number of performance restrictions. The biggest disadvantage of being reliant on a single type of energy is the constant fluctuation in availability due to natural or man-made disasters. The main challenge is deciding which capacity is most suited to decrease the overall cost of the system while improving system dependability. By using a comprehensive mix of the two renewable resources, the fluctuating nature of solar and wind energy is somewhat mitigated, resulting in a more dependable and inexpensive overall system.[9]

In other words, both stand-alone systems are inefficient in generating energy, but the block A Hostel get to become self-sufficient in energy generation and disconnect from the electrical grid save for backup needs. The hostel is seeking an ecologically friendly, dependable, economically feasible, and price solution. As a result, a hybrid solar and wind turbine system was included into the project for day and night operation. During daytime hours, the solar system operates at its most efficient level on sunny days. Wind turbines that can operate throughout the day with lower carbon emissions and at night without affecting the climate with the exception of wind. The solar-wind hybrid system combines a solar energy system and a wind energy system. It will contribute to the maintenance of an uninterrupted power supply. During inclement weather, output may be moved from one plant to another.

To maximise the effectiveness of renewable energy systems throughout the day, a photovoltaic system is one of the best options for generating the needed load for the residential hostel.

1.3 Objectives

The major goal of the project is to harness the abundant renewable energy found in nature without causing harm to human life or the environment. The following are the main objectives of this research:

I. To size hybrid system of Photovoltaic (PV) and wind system.
II. To determine the energy of the PV and wind system;
III. To determine the cost performance of the system using HOMER software.

1.4 Scope of Study

The master project's scope of work is limited to the purpose of sizing and analyzing hybrid photovoltaic and wind systems in Parit Raja city of residential hostel. In addition, consider the following steps to complete the sizing and analyzing system.

I. The purpose of this project is to analyze the system's ability to operate in block A residential homestay on the basics of solar and wind systems environmental data obtained.
II. Two sources of energy which are solar and wind energy were chosen to carry out this project.
III. Selected sizing of the hybrid solar-wind system
IV. Selected load below 72,702 Wh/day
V. All the works and analysis are done by using manual calculations and HOMER software.

1.5 Thesis outline

This project report consists of five main parts:

a) Chapter 1: Introduction

This chapter explains-the project's introduction. It also outlines the project's context. This is also the creation of the sizing and analyzed hybrid of solar –wind system systems based on manual calculations and HOMER software® with details. Also, problem statement, project priorities, scope of work, and overview of reporting.

b) Chapter 2: Literature Review

This chapter fundamentally assesses and addresses earlier studies and results for this field and how this initiative is concerned. Also, will provide a history of solar and wind such as hybrid PV and wind. In previous studies will be analyzed and discussed to combine the target of this project.

c) Chapter 3: Methodology

This chapter focuses on Methodology and the formulation of sizing, modeling methods will be provided and highlighted Based on solar radiation and wind speed analysis by using homer software.

d) Chapter 4: Results and Discussion

This chapter focuses on the interpretation of outcomes and discussion based on manual calculations and optimization Results analysis will be evaluated and a discussion of different results will be determined.

e) Chapter 5: Conclusion and Recommendation

This chapter a particular conclusion is drawn on the basis of the findings of the project will be finalized and summarized.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter describes the project's literature review. It will be focused on the information that has been collected from a journal, articles, thesis that related to previous studies of sizing and analysis hybrid of photovoltaic and wind system for the residential hostel, in Parit Raja. These renewable energy, with free access and a nice environmental impact, are ubiquitous. Practically and at fixed costs, their convergence remains beneficial for electricity production in isolated regions. The use of one of the optimization sizing methods has been discovered to assist with ensuring optimum energy reliability and minimal system costs for the potential deployment of hybrids. [10]

2.2 Introduction

For some years, there has been a rising interest in renewable energy resources. Unconventional energy sources are non-polluting, abundant, and reliable. These characteristics make alternative resources appealing for a wide variety of applications. Renewable energy sources, on the other hand, exhibit unexpected random behaviour, while others, such as solar radiation and wind speed, exhibit complimentary characteristics. Exploitation of renewable energy sources such as wind and solar is becoming more important and economical. Renewable energy technology has gradually increased in popularity in recent years as a means of meeting energy demands. Due to the intermittent nature of solar irradiation and wind speed, which have a significant impact on the resulting energy production, wind turbine, and power generation systems, the reliable supply of electricity to consumers under varying atmospheric conditions and the associated cost of the total system are essential[10].

Alternative energy sources are non-polluting, abundant, and non-stop. In general, hybrid power systems are classified into two types: stand-alone and grid-connected. Photovoltaic and wind energy systems are extremely reliable, have extended maintenance intervals, and do not require fuel [11].

Another significant disadvantage of a stand-alone photovoltaic system is its reliance on fluctuating sunlight hours, which results in low capacity utilisation and the requirement for energy storage and backup systems [12].

In many cases, wind and solar power technologies have shown their dependability and cost-effectiveness when used in standalone or parallel power systems. Wind turbines have made a substantial contribution to the world's energy demands. Wind energy generates one kilowatt-hour for every kilowatt-hour of greenhouse gas generated by conventional generating facilities [13].

Energy has always been the most critical factor in a country's economic and social development. Malaysia is blessed with renewable energy resources such as hydro, wind, solar, geothermal, and tidal waves, yet the most of them are underutilised. With rising fuel prices, particularly crude oil prices on the worldwide market, the Malaysian government had seen the potential for renewable energy as a method of guaranteeing the sustainability of energy supply[14].

Governments across the world are being compelled to invest in alternative energy sources such as wind energy, solar energy, and modest hydroelectricity, among others [15]. Malaysia has recognised the need of renewable energy as a complement to traditional methods of power generation due to the global growth in energy demand. Malaysia has created many energy policies that have elevated the country to a position of prominence in south-east Asia's energy output. However, the adoption of wind energy as an alternative source of energy is a major topic of debate due to the intermittent nature and fundamental uncontrollability of wind energy [16].

The newly revised Net Energy Metering (NEM) system offers an equal rate for power purchases and sales for NEM members. Renewable energy is now produced in Malaysia mostly through biomass, biogas, solar, wind, and micro-hydro. As of December 2018, Figure 2.1 shows the installed electrical supply capacity mix for the whole Malaysian peninsula (Peninsular Malaysia, Sabah, and Sarawak). Figure 1(a) depicts the total installed capacity of non-renewable energy sources, which is dominated by fossil fuels: gas (43%), coal (37%), hydro plants bigger than 100 MW (19%), and diesel generators (1%). On the other side, renewable sources (grid-connected only) include solar (67 %), biomass (11%), biogas (10 %), LSS & NEM (6 percent), mini-hydro (5%), and solid waste (all of which are depicted in Figure 1(b) (1%). Renewable energy sources contribute a total of 625 MW, or 2% of Malaysia's total energy capacity. Malaysia's Green Technology Master Plan, on the other hand, seeks to expand the capacity of renewable energy sources to 20% by 2025 [17]. Malaysia has received investments totalling RM 10 billion in the rapidly developing photovoltaic (PV) or solar energy industry. Under the Suria 100 initiative, the ministry has begun to expand power output from renewable energy sources like as mini-hydro in Kundasang and Hulu Langat, biomass in Semenyih and Sandakan, biogas in Seri Kembangan, and solar sources [18].

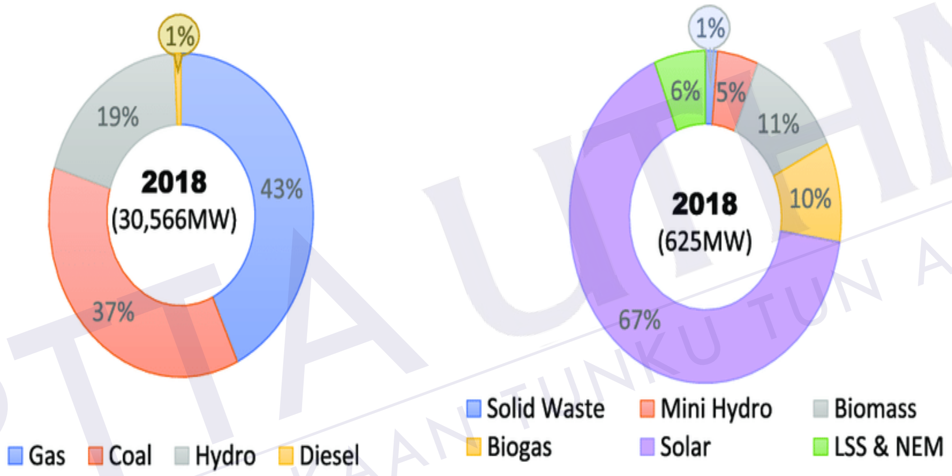

Figure 2.1: Installed energy capacity in Malaysia

2.3 Solar Energy

Renewable energy (RE) sources, like clean energy, are possible contenders for sustainable energy solutions to meet growing concerns about global warming and the slow depletion of fossil fuels. Solar energy, in particular, offers the greatest potential for environmentally benign power generation and delivers modern energy to billions of people in developing nations who continue to rely on traditional energy sources. Solar irradiation is abundant, and thus solar power technology, which is considered to be one of the most cost-effective and capable of providing about 10% of the world's electricity by 2050, is expected to meet the majority of the world's electricity demands (energy experts believe that between 50% and 80% of aIl electricity could be generated by renewable energies in 2050) [19].

The solar is another sustainable energy source. The scientific challenge is to develop the best cost-effective method for collecting, converting, storing, and utilising this renewable energy resource. The Sun radiates around 3.81023 KW of energy. Around 70% is absorbed by the ocean, land masses, and clouds, while the remainder is returned to space. Except for tidal and geothermal energy, all Res receive their energy from the Sun. Solar energy is rapidly increasing appeal in residential, commercial, and industrial settings. Solar energy is a viable alternative to conventional power generating. It is critical that solar energy is put to a variety of different applications. With around 37,007MW of solar photovoltaic power built in 2013, the world's solar photovoltaic power capacity rose by almost 35% to 136,697 MW, as seen in Figure 2.2.

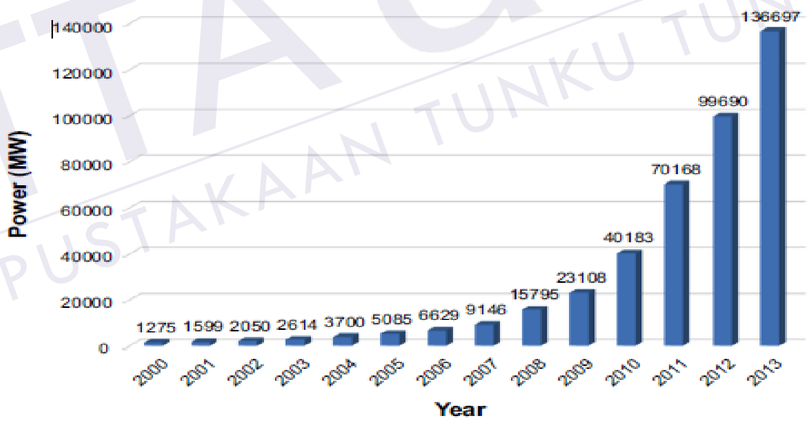

Figure 2.2: Global solar power cumulative capacity [20].

Malaysia's climatic conditions are favourable for the development of solar energy, owing to the year-round availability of sunlight. Malaysia is located in the South China Sea, between latitudes 1° and 7° north and longitudes 100° and 119° east longitude, with an average monthly solar radiation of 400-600MJ/m2, as seen in Figure 2.3.

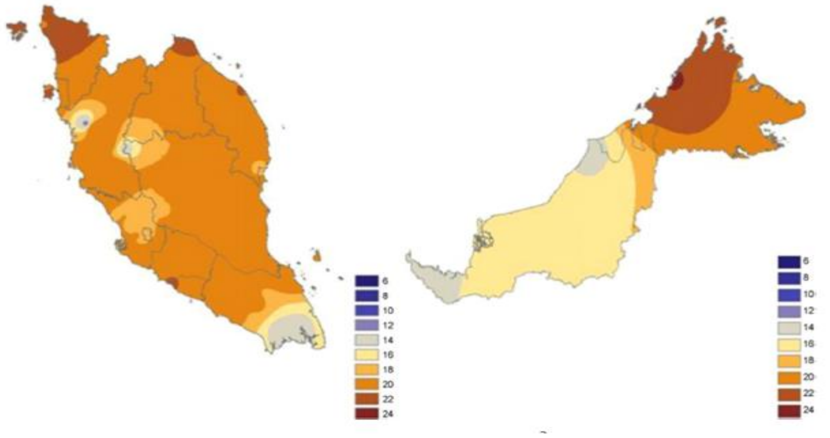

Figure 2.3: Annual average solar radiation (MJ/m2/day) [20].

Due to solar energy's low greenhouse gas emissions, it is being employed in a variety of ways more than ever before (GHG). The abundance of solar energy in Malaysia was recognised in the 2003 SREP as one of the Resources of the Future. The climate of Malaysia is characterised by stable temperatures, low wind speeds, dry conditions, and substantial precipitation.

The most of Malaysia's mean daily solar radiation is between 4.7 and 6.5 kWh/m2, which results in a steady temperature. In December, it was projected that daily solar radiation would be 0.61 kWh/m2, and between August and November, it had increased to 6.8 kWh/m2. The annual mean temperature fluctuates between 26°C and 28°C, and due to the country's wet climate, considerable solar radiation is received; nevertheless, cloud cover filters off a substantial quantity of sunshine. Kota Kinabalu, Bayan Lepas, and George Town have the greatest sun radiation, according to the information found in Table 2.1.

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