A STUDY OF RESIDENTIAL AND COMMERCIAL BUILDING FOR HYBRID PHOTOVOLTAIC AND BATTERY SYSTEM

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A STUDY OF RESIDENTIAL AND COMMERCIAL BUILDING FOR HYBRID PHOTOVOLTAIC AND BATTERY SYSTEM

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Dedication to my wife, Siti Mazkurah Bt Mat Nor , and my son Muhammad Khalish Muizzuddin Bin Kasnilawazaidi whom support me, physically, mentally and emotionally, throughout my Master's study.

For my siblings and friends, appreciate your encouragement and help. To all my lecturers, you are my inspiration for today and future time, Insha'Allah.

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ABSTRACT

Demand for the use of fossil energy is constantly increasing every year around the world. This situation lasted from ten years ago until now. Due to the sudden increase in population each year, energy burden is also increase. Recently, Renewable Energy (RE) has emerged and used from a small percentage of global energy source. Solar energy is rapidly expanding across the globe to be used as electricity especially in the islands, resorts, villages and remote areas far from the grid lines. In Malaysia solar energy is easily available from sources of sunlight as Malaysia's position is at the center of the equatorial line. The absorption and storage of the sun's source is very high at peak hours between 1200 noon and 1700 pm. The Fit-in-Tariff (FiT) was introduced by the Malaysian government to increase the profit margin of Tenaga Nasional Berhad (TNB) every year. Subsequently the government made an exchange of the concept of electricity consumption from the Fit-in-Tariff to the Net Energy Metering (NEM). The concept is regulated by Sustainable Energy Development Agency (SEDA) which is divided into several categories for user. The actual load data is taken from the quarters of the National Youth Association of Higher Skills Institute for residential building and Nasuha Enterprise Sdn. Bhd. for commercial building. Then, solar and temperature data is downloaded online from the National Renewable Energy Laboratory (NREL) at the position of 2.135 latitude and 102,723 longitude. Results after running simulations on HOMER PRO software are shown on the sensitivity and optimization for both residential and commercial buildings.

ABSTRAK

Permintaan terhadap penggunaan tenaga fosil sentiasa meningkat setiap tahun di serata dunia. Situasi ini berlanjutan sejak dari sepuluh tahun yang lalu sehingga sekarang. Oleh kerana peningkatan populasi yang mendadak setiap tahun, beban tenaga juga meningkat. Baru-baru ini, Tenaga Boleh Diperbaharui (RE) telah muncul dan digunakan dari peratusan kecil sumber tenaga global. Tenaga solar kini berkembang pesat diserata dunia untuk digunakan sebagai tenaga elektrik terutamanya dikawasan pulau, pusat peranginan, kampung-kampung dan kawasan pedalaman yang jauh daripada talian grid. Di Malaysia tenaga solar mudah didapati daripada sumber sinaran matahari kerana kedudukan Malaysia berada di tengah-tengah garisan khatulistiwa. Penyerapan dan penyimpan sumber sinaran matahari tersebut sangat tinggi pada waktu puncak iaitu antara 1200 tengahari hingga 1700 petang. Tarif yang Ditetapkan (FiT) diperkenalkan oleh kerajaan Malaysia untuk meningkatkan keuntungan margin Tenaga Nasional Berhad (TNB) setiap tahun. Selepas itu kerajaan membuat pertukaran konsep penggunaan elektrik daripada Tarif yang Ditetapkan kepada Pemeteran Tenaga Baharu (NEM). Konsep tersebut dikawal selia oleh Agensi Pembangunan Tenaga Lestari (SEDA) yang dibahagikan kepada beberapa kategori untuk pengguna. Data beban sebenar diambil daripada kuarters National Youth Institute of Advanced Skills Pagoh untuk bangunan kediaman dan Nasuha Enterprise Sdn. Bhd. untuk bangunan komersil. Kemudian, data sinar matahari dan suhu dimuat turun dalam talian daripada National Renewable Energy Laboratory (NREL) pada kedudukan 2.135 latitud dan 102.723 longitud. Hasil selepas menjalankan simulasi pada perisian HOMER PRO dipaparkan pada keputusan kepekaan dan pengoptimuman bagi kedua-dua bangunan kediaman dan komersil.

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LIST OF ABBREVIATIONS

TNB	-	Tenaga Nasional Berhad
SEDA	-	Sustainable Environment Development Agency
NREL	-	National Renewable Energy Labs
PV	-	Photovoltaic
Fit	-	Feed in Tariff
NEM	-	Net Energy Metering
LCOE	-	Levelized Cost of Electricity
COE	-	Cost of Electric
NPV	-	Net Present Cost
O&M	-	Operation & Maintenance
AC	-	Alternating Current
Hz	-	Hertz
DC	-	Direct Current
Inv	-	Inverter
Conv	-	Converter
Batt	-	Battery
DG	-	Distribution Generation
UG	-	Utility Grid

LIST OF SYMBOLS

E	-	Energy
N	-	Number of parameter
P	-	Power
L	-	Load
I	-	Current
V	-	Voltage
T	-	Period
t	-	Time
K	-	Boltzman constant
q	-	Electron charge
η	-	Efficiency
^{o}C	-	Celsius
Pr	-	Probability
α	-	Cost of a PV array
β	-	Cost of a battery
P	-	Present factor
F	-	Future cost
C	-	Cost
%	-	Percentages

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The oil production has been gradually decreasing since reaching its peak at 862,000 barrel per day in 2004 due to its maturing reservoirs. In addition with the costs that remains increased year to year while fossil fuels depleting, sustaining a sTable development for Malaysia now is getting much harder. This becomes important for the government to establish energy in the most economically worthy to ensure the sustainability in development [1].

Today Malaysia become the suppliers for oil and natural gas in the world and is consistent in trying to fulfill the huge demands of domestic and international energy sector, in spite so, the national utility company is actually struggling to meet the demand as oil reserves is declining and baring the cost to sustain the electrical fixed that Malaysian are paying right now [1].

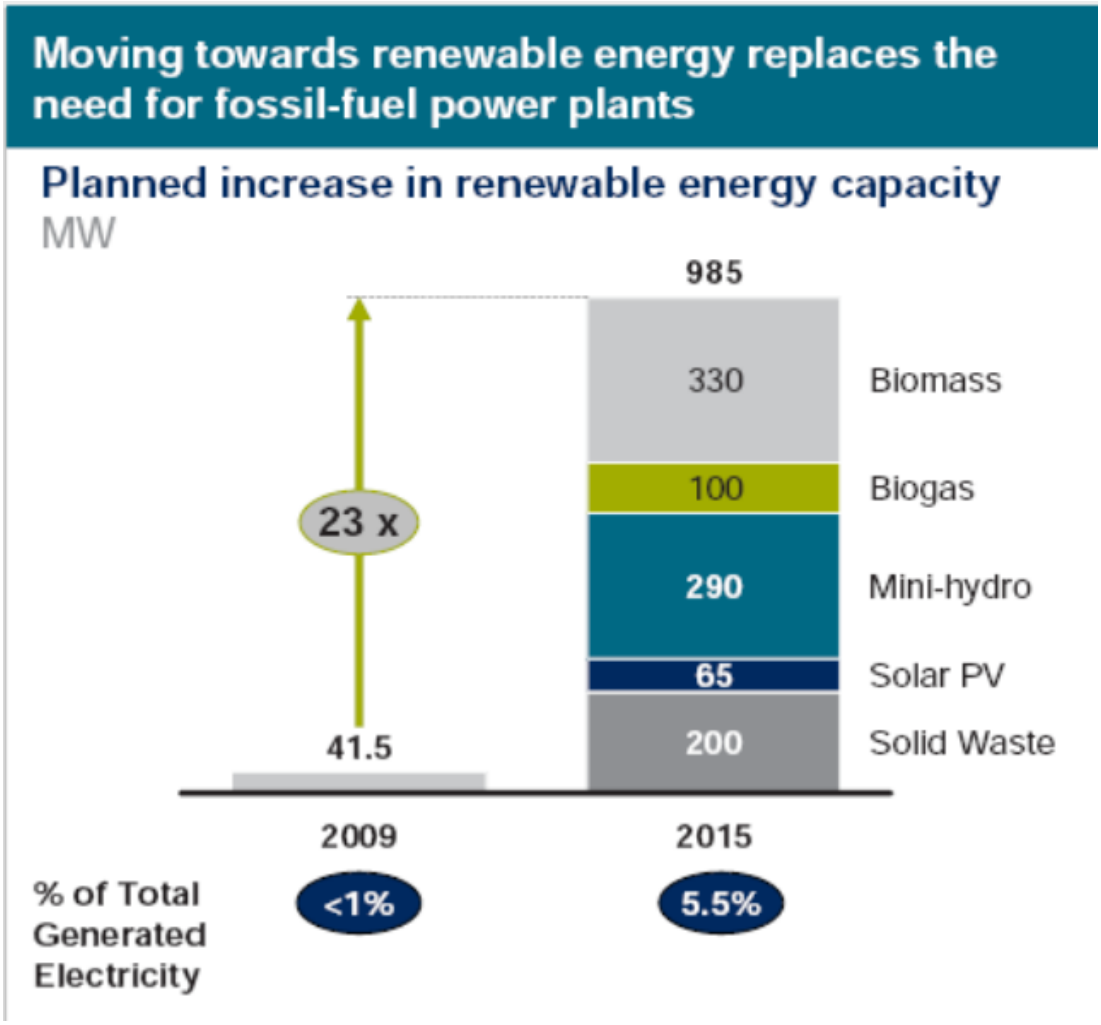

Figure 1.1: Planned increase in RE capacity [2]

Malaysia as we known located at equator line and a lot of floras and faunas live there. This country is one of the hot place because receive sunshine almost ten hours per day. That why it is very good to implement Photovoltaic (PV) energy or solar energy towards green technology. PV is one of solution to reduce carbon dioxide (CO_2) in the air because PV energy is clean. It also have potential to be an alternative power source to replace national grid that government very concern about of oil market price up and down every day.

Malaysia is in a luckily state because it is in the area which is gifted with natural energy resources such as solar, wind, hydro power electricity and biomass as well as implementing other energy resources from ocean energy, geothermal and nuclear in order to replace the conventional energy resources (oil, natural gas, coal).

A HOMER, Hybrid Optimization of Multiple Energy Resources consist of two or more combination of Renewable Energy (RE) sources that running together to increase system efficiency and energy balance in supply. PV system provides highest power in the middle of the day which coincides with the peak power on the utility grid. Hybrid power systems provide power to offset the grid when the sun were shine and will send back excess power to the grid for credit and used later. The hybrid power systems provide power for critical loads when the power on grid down. These power cannot provide power for all loads since the cost and volume of the batteries are prohibitive.

A grid-connected renewable energy system is a power system energized by single or multiple natural sources which are connected to the utility grid. This system can supply to the local loads or to sell some amount power to the grid based on Feed-in-Tariff that launched by policy makers. The capacity of the storage device for the system can be smaller since the grid can be used as a backup system. Many research was made in the field of grid connected PV system. Bidisha Roy et al. [3] perform the analysis of a grid connected PV household system in the West Bengal using Homer. Li et al. [4] have presented a study of a grid connected PV system in Hong Kong, and have showed that the energy payback period was estimated to be 8.9 years. They have also evaluated performance of each component of the model and finally they performed sensitivity analysis to optimize the system at different conditions [3].

The eastern and northern region of Malaysia has big potential for the application of solar energy because of the solar radiation level is high throughout the year. So, the usage of solar photovoltaic especially in Johor residential house, commercial building and office building must be increased in order to maximize the usage of renewable energy [5].

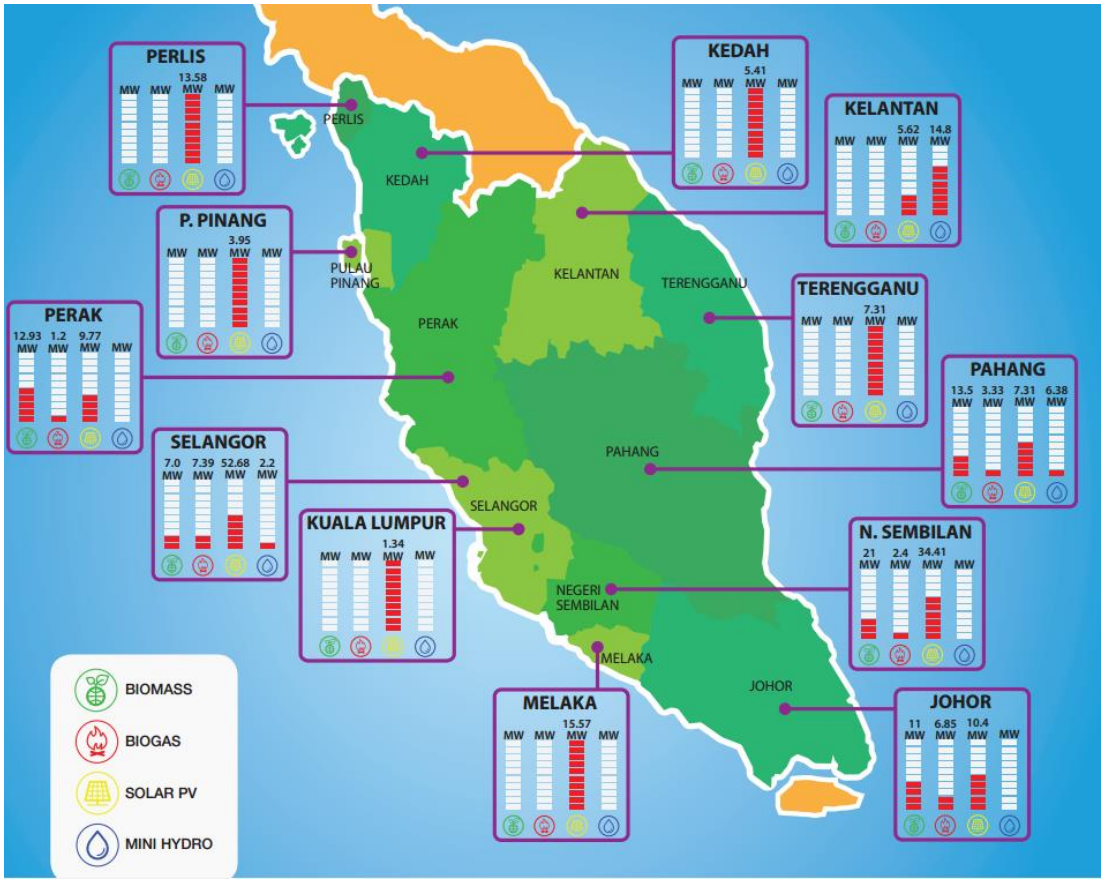

Figure 1.2: Peninsular Malaysia RE project [6]

Malaysia is blessed with vast renewable sources of energy such as biomass, solar, biogas and mini hydro. In line with the Five Fuel Strategy, the policy has a target of RE being the source of 11% of electricity generation, which amounts to 2,080 Mega Watt of installed capacity by 2020. As of the second quarter of 2015, the Peninsula has a total licensed capacity of 358.23 Mega Watt, mostly fuelled by solar (187.17 Mega Watt), follow by biomass (114.93 Mega Watt), mini hydro (29.88 Mega Watt) and biogas (26.25 Mega Watt) with the Central area being the largest RE contributor. The high capacity of solar energy installation is triggered by the attractive rates offered under the Fit-in-Tariff (FiT) scheme as well as the readily available resource factor as Malaysia is geographically located at the equator [6].

1.2 Problem Statement

Frequents blackout in electricity at night causes daily work disruption. For home residents, electrical appliances such as televisions, irons, washing machine and others cannot be used when electricity is cut off for a long time. For commercial buildings, the operation at that time had to be stopped due to lack of support electricity.

This situation occurs once every month for four hours causing losses of hundreds of thousands of Ringgit that the company needs to bear. For the residential, they had to put up a candle to light up the environment of the house.

In addition, monthly bills received by residential and commercial buildings are very high due to the use of electrical appliances such as iron, refrigerator, lighting, washing machine, television, herbal processing machine, packaging machine, conveyer, and so on. All of these electrical products use large energy loads.

Therefore, an alternative way to overcome this problem is to simulate hybrid solar photovoltaic and battery systems with HOMER PRO software. This system is suiTable for installation in this area because the sunlight received for about nine hours from 0900 am to 1800 pm and the temperature record is also high between 31 to 37 degree Celsius.

1.3 Objectives of Project

The objectives of the project are:

a) To simulate hybrid photovoltaic and battery system with grid connected using HOMER PRO software.
b) To evaluate the economic viability of residential and commercial buildings using HOMER PRO simulation software.
c) To analysis the economic parameters of residential and commercial buildings based on HOMER PRO simulation software.

1.4 Scope of Project

The project are restricted within the below limitations:

Location of the case study is government quarters building at National Youth Institute of Advanced Skills Pagoh, Muar Johor for residential building and Nasuha Enterprise Sdn. Bhd. at Pagoh, Johor for commercial building. Collection of energy loads, weather and temperature levels are recorded. Duration of unavailability of electricity in residential and commercial building are not recorded.

The system is a hybrid photovoltaic and batteries with grid connected. This system is design using HOMER PRO software. The simulation in HOMER PRO includes Net Energy Metering (NEM) concept. HOMER PRO software will compute all parameters such as Levelized Cost of Electricity (LCOE) Net Present Cost (NPC) and Operating & Maintenance (O&M).

The losses of production at commercial building is not investigate. This case need at least twelve month or more to investigate duration of unavailability of electricity and the losses at commercial building. All simulations made on HOMER PRO software do not take into the real life situation.

1.5 Thesis Outline

Chapter 1 generally describes on the photovoltaic system. This chapter also provides information on the objectives of the study, problem statement and the scope of the study.

Chapter 2 focuses on the previous work done to optimizing and sizing the PV system to achieve the optimization. This chapter also include the Net Energy Metering concept that will be used in the Homer Pro software.

Chapter 3 discusses on the modeling of the PV System using Homer Pro software. This chapter also provide information of PV system, converter, electrical appliances and real data of load, irradiance and temperature at study location.

Chapter 4 analyzed the result obtained from Homer Pro software. The analysis of parameters sensitivity will be discussed in this chapter.

Chapter 5 explains the conclusion of the hybrid Photovoltaic and Battery system and the suggestion for future works.

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