FEASIBILITY STUDY OF HYBRID SYSTEM FOR RESIDENT AREA IN PULAU PERHENTIAN KECIL, TERENGGANU

NUR AYUNI JALALUDDIN

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Dedication to my beloved father, Jalaluddin Bin Mohd Ismail, my beloved mother, Jalilah Binti Abdullah , my lovely husband Hairy Ezren Bin Abd Rahman and my son Muhammad Danish Haiqal 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, Insya-Allah
Thank you everyone and only Allah can bestow just reward to all of you.

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ABSTRACT

The inclination to utilize renewable energy assets has become consistently in the course of recent decades, it because of warnings of global warming and the depletion of fossil fuels. The price of crude oil is increasing and no sign of downward pattern in the recent years. In Malaysia remote island is far away from grid supply and a heavy cost is involved in extending the grid. With the use of solution to generate electricity in cleanliness and environmental friendly, the renewable energy will be used in the remote island. This project will analyze the potential of renewable energy in remote island specifically in Pulau Perhentian Terengganu. The configuration of optimal hybrid technology system and the selection is based on the components, sizing and provide with the aim to achieve effective cost and efficient system are proposed. The use of renewable energy (RE) is one of the preferred solutions, namely solar photovoltaic (PV) and wind power. Combination of solar photovoltaic(PV) and wind power is high potential to be use because of these are abundant, inexhaustible and sources are freely available and can reduce of carbon emission in the generation system for a long run of use. Hybrid Optimization Model for Electrical Renewables (HOMER) software will used to simulate and analyze the hybrid system. The results is provide the generated by the photovoltaic system and wind energy system with total saving of net present cost (NPC) is about 31.5% , energy renewable fraction(RF) is 56.6% are calculated as a main environmental purpose and the optimum result of greenhouse gas emissions is reducing total of 40%

ABSTRAK

Kecenderungan untuk menggunakan aset tenaga boleh diperbaharui telah menjadi konsisten dalam perjalanan beberapa dekad kebelakangan ini, ia kerana amaran global pemanasan dan pengurangan bahan api fosil. Harga minyak mentah semakin meningkat dan tiada tanda pola menurun pada tahun-tahun kebelakangan ini. Di Malaysia Pulau Remote adalah jauh dari grid bekalan dan kos yang berat terlibat dalam memperluaskan grid. Dengan menggunakan penyelesaian untuk menjana tenaga elektrik dalam kebersihan dan mesra alam sekitar, tenaga boleh diperbaharui akan digunakan di pulau jauh. Projek ini akan menganalisis potensi tenaga boleh diperbaharui di Pulau Remote khususnya di Pulau Perhentian Terengganu. Konfigurasi sistem teknologi hibrid yang optimum dan pemilihan adalah berdasarkan komponen, saiz dan menyediakan dengan matlamat untuk mencapai kos efektif dan sistem yang cekap dicadangkan. Penggunaan tenaga boleh diperbaharui (RE) adalah salah satu penyelesaian pilihan, iaitu solar photovoltaic (PV) dan kuasa angin. Gabungan solar photovoltaic (PV) dan kuasa angin potensi yang tinggi untuk digunakan kerana ini adalah banyak, tidak habis-habis dan sumber-sumber yang boleh diperolehi secara percuma dan dapat mengurangkan pelepasan karbon dalam sistem generasi untuk jangka panjang penggunaan. Optimization hibrid Model (Homer) perisian Elektrik Tenaga Boleh Diperbaharui akan digunakan untuk simulasi analisis sistem hibrid. Keputusan adalah menyediakan yang dijana oleh sistem photovoltaic dan tenaga angin sistem dengan jumlah penjimatan kos kini bersih (NPC) ialah kira-kira 31.5%, tenaga boleh diperbaharui pecahan (RF) adalah 56.6% dikira sebagai tujuan utama alam sekitar dan hasil optimum pelepasan gas rumah adalah dikuarngakn sebanyak 40%.

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LIST OF ABBREVIATIONS

RE	-	Renewable Energy
PV	-	Photovoltaic
HRES	-	Hybrid Renewable Energy system
WT	-	Wind turbine
GHs	-	Greenhouse gasses
CO2	-	Carbon dioxide
CO	-	Carbon monoxide
COE	-	Cost of energy
HOMER	-	Hybrid Optimization Model for Electric Renewable
NPC	-	Net Present Cost
NASA	-	National Aeronautics and Space Administration

CHAPTER 1

INTRODUCTION

1.1 Project Overview

Over the past few years, economic growth in Malaysia with higher subsidies with ensures reasonable and affordable energy prices. With the higher level for energy cost will damage the country's economy. Critical issue for energy security, climate change, energy prices, subsidy rationalization, intermittency of RE plant, and initiatives for energy efficiency will be rely on government agenda for sustainability. Nowadays, most of the countries use of Green Energy technology such as solar, wind and other renewable energy, to provide power sources to complement conventional power generation [1]

Power generation in Peninsular Malaysia depends vigorously on natural gas and coal. Natural gas from indigenous sources is one of power generation for more than two decades and to be continuing as an important component for years to come. Diversity of fuel starts with optimizing indigenous resources potential, particularly in renewable energy which including biomass, solar PV, Wind, mini hydro and other RE. Formation of SEDA in 2011 with the implementation of Feed- in Tariff provide further development of renewable energy includes among other palm oil wastes, mini hydro and solar PV. By 2020, RE project will contribute to 3% of

overall generation mix from the estimated RE installed capacity of 700 MW [1]

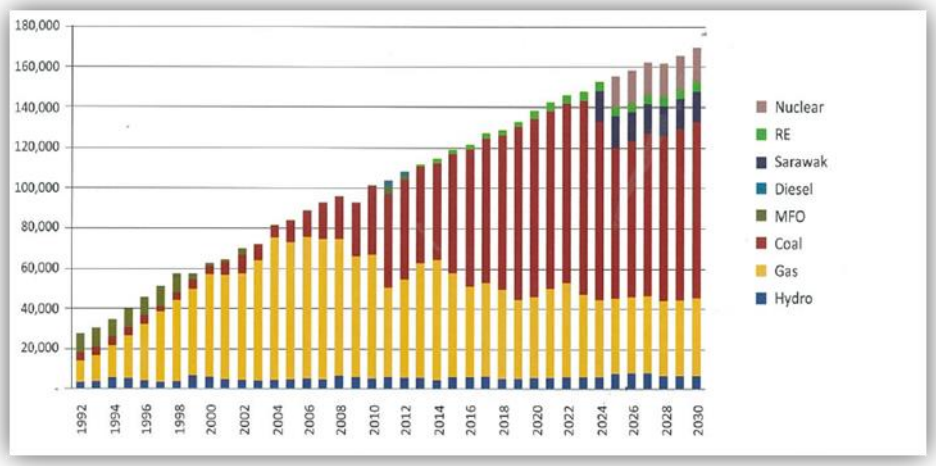

Figure 1.1: Generation energy mix

Figure 1 show the generations mix of energy, as for coal consumption, the power sector utilizes 21 million metric a tone of coal annually with current generating of capacity is about 9,477MW. Due to additional coal capacity of 5010MW in 2014, the coal-fired plants will make up 64% by 2020. Coal demand in Asian region is expected to growth by almost 50% in 2030 to meet electricity demand [1]. The demand for clean power supply made from renewable energy or environmental friendly energy sources is gain from time to time. In Malaysia, there is a guideline by the Department of Environment where the Malaysia's fuel power plants must practice an efficient clean gas/fuel technology and be able to deliver cleaner power supply to the country. During Copenhagen Accord in 2009, Malaysia has pledged to reduce 40% of its carbon emission per capita compared to 2005 [1]. In economic growth, diversity more towards gas based plants and hydro will be ultimate choice, but due to limitation of resources, the use of fuel for power generation is necessary in the energy mix. The use of renewable energy will definitely have to be on a more efficient technology due to reducing the fuel requirement for production and lesser carbon emission.

Starting on 1st January 2014, surcharge on electricity bills for RE Fund increased from 1.0% to 1.6%. The implementation of RE project in terms of capacity , it is expected the cumulative annual growth rate for the next 10 years will be more than 9% to reach at least 750MW of introduced limit comprises of consists of mini hydro, biomass , biogas and solar PV plants. Due to factor such as locations, technology development and potential limitation, RE is anticipated to play complementary role to fossil fuel. Figure 2 shows the generation mix for Peninsular Malaysia based on approval Generation Development plan.

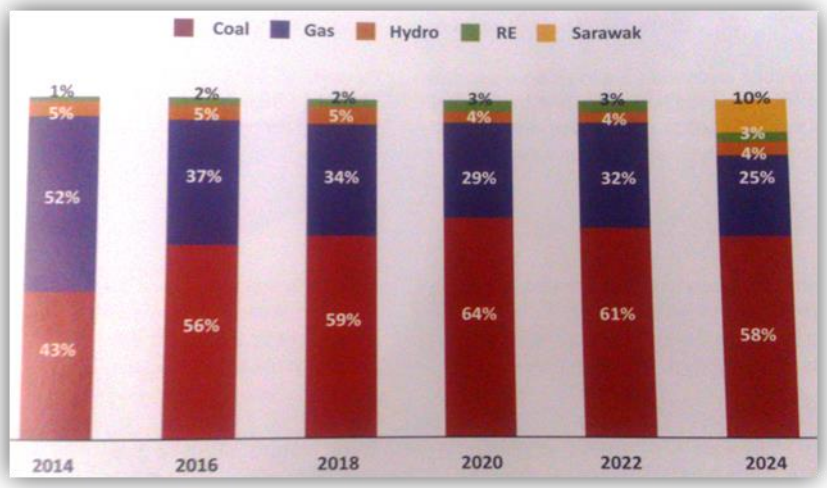

Figure 2: Generation mix of coal, gas, Hydro, RE and Sarawak

1.2 Background of Study

Remote areas which far away from grid supply and also higher cost in extending the grid is the main purpose of use renewable energy as alternative energy. A renewable energy resource for generation of electrical power like solar, wind, biomass and micro hydro has been observed for several years. Alternative energy offers non-polluting, free in their availability, continuous and economically system compare to conventional standalone power generation system. Hybrid renewable energy systems (HRES) are widely use and is the most appropriate solution to supply energy in isolated areas.

In this project will analyze the potential of renewable energy in Remote Island specific on residential area in Pulau Perhentian Kecil, Terengganu. The hybrid systems that combining of two or more technology are considered the best alternative energy with the aim to achieve an efficient system with providing 24 hours electricity supply and to reduce the dependency on diesel generator. Hybrid solar PV/Wind system are chosen due to high potential to be use because of these are abundant, inexhaustible, sources are freely available and can reduce of carbon emission, cost of energy, and economic in the generation system for a long run of use.

Their unpredictable nature and dependence on weather and climatic change, the variation of solar or wind may not match and fluctuate when distribution of load demand It is convenient to develop a system that consists of wind-turbine generator (WT), photovoltaic array (PV). The use of different energy sources will improve the efficiency and reliability of energy supply and reducing storage backup requirement to satisfy power demands in remote islands compared to one single RE sources.

1.3 Problem Background

Nowadays, growth of price on fossil fuel and unpredictable fluctuating diesel price with the high requirement such as transportation specifically in Remote Island is one of the major crises in cost effectiveness. Based on current reserves and consumption rate of fossil resources in the world will sustained about 122 years for coal, 42 years for oil and 60 years for natural gas [2, 3]. World Bank reported that 2.4 billion people rely on traditional energy sources, while 1.6 billion people do not have access to electricity [4]. With an estimated world average growth rate of 2.8%, the electricity demand is expected to be doubled in 2020. In this period, the

electricity demand in developing countries is projected to increase by 4.6% annually [5]

Reducing on dependency on fossil fuel is one of the solutions for 80% of global warming phenomenon which will cause a worst climate change and higher production on Greenhouse gasses (GHs) such as carbon dioxide (CO2) and carbon monoxide (CO). Global warming earth temperature increased by 0.76oC between the years 1850 to 2005 and the warming average rate over the previous 50 years was approximately twice for the last 100years [9]. Analysis have to carried out for the environment in remote island due to diesel generator pollutes and higher of CO2.

1.4 Problem Statement

Remote Island residential, often have experience of electrical power outages. Implementation of renewable energy (Solar Photovoltaic/wind/hydro) is appropriate solution to supply electrical energy in remote area. Renewable energy can be fluctuated, a combination of solar PV and wind needed to distribute and maintain a constant source of power with battery and diesel as backup generator when the lack of renewable energy sources. Preferred solution on this problem in hybrid power system that providing high reliability, cost effective due to less of fuel requirement. It has been reported that in remote area, the solar and wind hybrid system is better than single PV or wind energy since it will make rapid change in the output power.

To implement of hybrid system, real data collection from electrical load, energy sources including solar radiation and wind speed from meteorological data generation in terms of locations and climatic conditions

should be taken into account. The analysis must to be made at the earlier stage of inception especially for wind energy due to in Malaysia the wind resources depends on the availability in location of site. However for wind speed actual data only can receive from the nearest station which is Kuala Terengganu. The details on assessment and performance on wind speed of the wind energy profile must be estimated at first stage of project proposal.

Wind assets fluctuate with the season of day, season, height above the ground and sort of location. The dispersion of wind speed is vital for the configuration of wind farm, power generators and different applications, for example, irrigation. Proper sitting in windy locations far from large obstructions will improves a wind turbines performance. In order for the wind energy systems to be competitive, they have to be adapted to the local wind energy climate and demand [7]

The detailed knowledge of the wind energy climate of a particular site, the easier it is for designers of wind energy systems to optimize the innovative technology. However, the development of new wind energy projects continues to be hampered by the lack of reliable and observe and analyse the precise of wind energy data in numerous parts of the world including Malaysia.

Malaysia experiences two main whether seasons: southwest monsoon (May/June to September) and northeast monsoon (November to March) [10]. Wind speed during the southwest monsoon is lower than 3.11m/s but during northeast monsoon speed could reach up more than 4.17m/s [8]. Differ from average insolation of solar which has higher average throughout the year except for November and December.

1.5 Project Objective

The aims of this project are to perform the feasibility study and analyze the potential of hybrid system at Pulau Perhentian Kecil with reducing of diesel consumption. The following are the objectives of this project:

1. To study a suitable hybrid system configuration to meet the load requirement reliably, continuously and sustainably
2. To study the potential of improving the existing system by implementing hybrid solar with PV/wind sources
3. To optimize/simulate the component size of hybrid solar PV / winds turbine systems as an alternative system for resident of Pulau Perhentian Island in terms of cost effectiveness, C02 emission and cost of energy using HOMER software

1.6 Project Scope

Feasibility study on the configuration for optimal hybrid system including of wind, photovoltaic, diesel generator and battery is selected based on components and sizing with appropriate operating strategy to provide a reliable, cost-effective system [10] and environmental friendly.

The proposed system is assessed on the:

i) Cost of investment

ii) Net Present Cost (NPC)

iii) Load demand

iv) Fuel consumption

v) Cost of energy and CO2 emission.

The simulation were carried out using the HOMER software based on load data, renewable resources data obtained from the Malaysian Meteorological Centre, TNB and NASA. The system component specification, cost and information of optimization such as number of component is taken into account in order to obtain the best possible system.

1.7 Organization of Report

This project has been planned properly from the starting until the end of submission. This project is to compare the combination of hybrid system for reducing several point including cost and the end of the project the author will conclude the suitable hybrid system that can be used in Pulau Perhentian specifically for resident area. Report will consist of five main chapters; Introduction, Literature Review, Methodology, Simulation and Analysis, and Conclusion

Chapter 1: Introduction, the author will discuss on the overall about this proposal project which including the explanation on crucial aspect of generally on project overview, background of study, problem background/statement ,objectives of the project and scope of the project

Chapter 2: Literature Review will completely dedicate in explaining about the renewable energy, hybrid system and component in term of solar, wind, battery and sizing equation methods

Chapter 3: Methodology will explain how the author completes the project. The author will explain on the several of hybrid model, which will be used as a main model to determine the suitability of the hybrid combination. The calculation is made and comparison with simulation of the system will be explained. The proposed method is tested with different combination and results are presented and the simulation of the result will be discussed

Chapter 4: Will explain mainly on the result obtained from the HOMER simulation. ***Chapter 5:*** Concluded on the result obtained in Chapter 4 and recommend future works to be conducted.

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