Faculty of Technology Management and Technopreneurship

RENEWABLE ENERGY ADOPTION FOR ENERGY COMPLEMENTARY: READINESS OF OFFSHORE WIND TURBINES APPLICATION IN MALAYSIA

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RENEWABLE ENERGY ADOPTION FOR ENERGY COMPLEMENTARY: READINESS OF OFFSHORE WIND TURBINES APPLICATION IN MALAYSIA

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DECLARATION

I declare that this thesis entitled “Renewable Energy Adoption for Energy Complementary: Readiness of Offshore Wind Turbines Application in Malaysia” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : .....

Date : .....

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Technology Management.

Signature	:	……...
Supervisor Name	:	……
Date	:	……

DEDICATION

I lovingly dedicate this thesis to my beloved parents, siblings, and husband who supported me along the way.

ABSTRACT

The rapid industrial growth and dramatic population are the major trends in Malaysia. These trends lead to a serious issue about the extensive use of fossil fuels. The demand for energy is predicted to continuously rise because of the extensive fossil fuels exploitation. If this trend of energy consumption is continuously uncontrolled, the fossil fuels are running ahead of supply and come to the limit. The renewable energy can provide clean sources of energy which is reliable and secure to society. This study analyzed renewable energy adoption, focusing on the readiness of offshore wind turbine technology adoption in Labuan Island, Sabah. Labuan Island, Sabah has been selected as a potential location to install the offshore wind turbine technology because of geographical advantage of the South China Sea. This case study is expected to provide great power energy with least environmental impact and high sustainability. This is because Labuan Island, Sabah is located within the windy area with no terrain features, buildings or other obstruction. This case study is also considered as an exploratory study with the method of qualitative methodology. The method is used for both data collection and data analysis. The technique used for primary data collection is through in-depth interview technique with semi-structured interview. With the concrete evidence provided, the outcome of this case study is proved at the end of this study through the constructed model of readiness of offshore wind turbine technology adoption in Labuan Island, Sabah. As a conclusion, the availability of national renewable energy policy, incentives and funding provided, the geographical advantage of the South China Sea, the climate advantage and great commitment from Tenaga National Berhad and The Ministry of Energy, Green Technology and Water, the offshore wind turbine technology in Labuan Island, Sabah has great potential to be adopted as a new renewable-based electricity generation in Malaysia.

ABSTRAK

Pertumbuhan perindustrian yang pesat dan penduduk secara dramatik adalah kejadian trend utama di Malaysia. Trend ini membawa kepada satu isu yang serius mengenai kepenggunaan bahan api fosil yang melebihi had kawalan. Permintaan untuk tenaga dijangkakan terus meningkat kerana bahan api fosil dieksploitasi dengan luas. Jika trend penggunaan tenaga ini berterusan dengan tidak terkawal, bekalan bahan api fosil akan sampai kepada hadnya. Tenaga boleh diperbaharui boleh menyediakan sumber tenaga bersih yang boleh dipercayai dan selamat kepada masyarakat. Kajian ini menganalisis penggunaan tenaga boleh diperbaharui, memberi tumpuan kepada kesediaan angin luar pesisir teknologi turbin diterima pakai di Pulau Labuan, Sabah. Pulau Labuan, Sabah telah dipilih sebagai lokasi berpotensi untuk memasang teknologi turbin angin luar pesisir kerana kelebihan geografi Laut China Selatan. Kajian disini dijangka menyediakan tenaga kuasa yang besar dengan kurang memberi kesan terhadap alam sekitar dan kemampanan tinggi. Ini kerana Pulau Labuan, Sabah terletak dalam kawasan berangin tanpa ciri-ciri rupa bumi, bangunan atau halangan lain. Kajian disini juga dianggap sebagai satu kajian dengan kaedah kualitatif. Iaitu kaedah yang digunakan untuk kedua-dua pengumpulan data dan analisis data. Teknik yang digunakan untuk pengumpulan data primer adalah melalui teknik temubual mendalam dengan separa berstruktur temuduga. Dengan bukti yang kukuh diberikan, hasil kajian disini dibuktikan pada akhir kajian ini melalui model yang dibina kesediaan angin luar pesisir teknologi turbin diterima pakai di Pulau Labuan, Sabah. Sebagai kesimpulan, adanya dasar negara tenaga boleh diperbaharui, insentif dan pembiayaan yang disediakan, kelebihan geografi Laut China Selatan, kelebihan iklim dan komitmen yang tinggi daripada Tenaga Nasional Berhad dan Kementerian Tenaga, Teknologi Hijau dan Air, angin luar pesisir teknologi turbin di Pulau Labuan, Sabah ianya mempunyai potensi besar untuk diguna pakai sebagai generasi elektrik berasaskan tenaga diperbaharui yang baru di Malaysia.

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LIST OF ABBREVIATIONS/SYMBOLS

OSWT	-	Offshore wind turbine
RE	-	Renewable energy
TNB	-	Tenaga National Berhad
KETTHA	-	Kementerian Tenaga Teknologi Hijau Dan Air
TEMIF	-	Technical, Environment, Managerial, Institutional, Financial
PESTLE	-	Political, Economic, Social, Technology, Legal and Environment
TA	-	Technology adoption
IRMA	-	Information Resources Management Administration

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Malaysia‘s vision by the year 2020 is to achieve a high-income developed nation status. The current trends of many developed countries are moving towards the sustainable power generating capacity and the capacity on exploiting various sources of renewable energy (RE) generation. This happened because of the world energy requirements are increasing at an alarming rate and the power demand is running ahead of supply. As Malaysia is one of the fastest developing countries in Southeast Asia, Malaysia seeks to increase the percentage of generating RE for power generation (Curley, 2011). However, to date, the RE capacity that contributes to the total power generating capacity is still less than 1%. In this current decade, the three largest RE contributors in electric generation capacity are solar, hydropower and biomass. According to Sustainable Energy Development Authority (2014), from the total RE installed capacity which is 243.4 MW, the solar photovoltaic contributed 39.7%, large and mini hydropower contributed 31.5%, biomass contributed 23.8% and biogas contributed 5.01%.

In order to pursue the green growth for sustainability and resilience through strengthening the energy security, this research is proposed to adopt the offshore wind turbine (OSWT) in Labuan Island, Sabah. OSWT is the wind energy that use wind farms installed at the coast to generate electricity and act as a compliment to the use of fossil fuels in power generation.

Thus, in exploring this research the researcher has outlines through eight sections. Section 1.2 is the research background. Section 1.3 is the problem statement of research. Section 1.4 is the significance of study. Section 1.5 is the research questions and section 1.6 is the research objectives. Section 1.7 is the scope of the research which outlines the development of this research. Finally, Section 1.8 is the summary of the work in this chapter.

1.2 Research background

Curley (2011) claims 80 % of global energy comes from fossil fuels such as coal, oil and natural gas. It caused the demands of energy continually increased at an astonishing rate. Majority the daily operations of these technologies need fossil fuels in powering them. This pattern of fossil fuels used will caused it soon to be depleted and the main cause of carbon emission which render climate change. This scenario has encouraged Malaysian Government to start focus on green technology in RE generation. Started in the Eight Malaysian Plan (2001-2005), RE was announced as the 5th fuel in the new Five Fuel Strategy in the energy supply mix.

Malaysian Government also currently works on hands-on application of RE with several number of on-going RE projects with the local power supply such as 8MW solar farm in Pajam, Negeri Sembilan (executed on September, 2011) which is on a closed landfill by Cypark Resources, 10.25MW solar farm in Gemas, Negeri Sembilan by Amcorp Properties (executed on May, 2013), 5MW solar farm in Alor Gajah, Melaka by Kumpulan Melaka Berhad (executed in December, 2012) (Li, 2015).Thus, renewable-based electricity generation is a good start. According to International Energy Agency (2010), the prospects of renewable-based electricity generation has hinged critically on government policies.

Based on the statement, Malaysian Government could monitor the management and implementation of RE policy. This action will help Malaysian Government in diversifying the portfolio of RE sources such as hydro, solar, wind and wave. A well-planned strategy is needed in adopting renewable-based electricity generation module in industries. The adoption of OSWT is one of renewable-based electricity generation which comes into two types; the onshore and offshore wind energy. The onshore wind adoptions are wind farms that installed on land while the offshore wind farms are installed off the coast. Both technologies are expected to attract policy makers and it has ability to support the continuous electricity need.

The purpose of OSWT adoption emphasizes in this research is because it complements to the fossil energy in powering electrical grid. According to Chiang et. al., (2003), the annual offshore wind speed in Malaysia is around 1.2 to 4.1 m/s with the highest potential is in the east Peninsular Malaysia with annual vector resultant wind speed of 4.1 m/s. However, Argentina's RE firm, IndustriasMetalurgicasPescarmona SA (IMPSA) who has collaborated with TenagaNasionalBerhad (TNB) in determining the actual wind generation potential in Malaysia mentioned that the wind along Malaysian-Thailand border and South China Sea area is believed to stream at nearly 15 m/s for the wind speed (Ali et. al., 2012). Normally, a wind speed of at least 4 m/s is needed to turn the blades of a wind turbine (Ali et. al., 2012).

Based on the academic scholar statement which are the potential wind speed to blow is between 4.1 m/s (at east Peninsular Malaysia) and 15 m/s (at Malaysian-Thailand border and South China Sea), while the wind speed needed to turn the blades of a wind turbine is at least 4 m/s. Therefore, Labuan Island which located at the South China Sea is critically acted as a promising site for installing OSWT technology.

As OSWT adoption needs the stability of wind speed, this research is not only focusing on the factors and strategies to adopt the OSWT but this research also provides the researcher to know more on the availability of wind speed with potential locations to adopt this RE technology. According to Islam et. al., (2011) who have done research on evaluation of wind energy potential in Malaysia mentioned that wind energy potential at Labuan and Kudat by using 2-parameter Weibull distribution with results the small-scale wind energy can be generated at the turbine height of 100m. Based on the academic scholar review about the wind speed in Malaysia to adopt the OSWT, more in-depth studies has to be carried out in Malaysia in order to explore the readiness of OSWT adoption in Malaysia.

1.3 Problem statement

Malaysia has entered into the age of RE. The Malaysian Government has identified RE as the nation fifth fuel. The Five Fuel Strategy for energy mix in the Eight Malaysian Plan (2000-2005) has explained clearly about Malaysian fifth fuel (Sustainable Energy Development Authority, 2016). The fifth fuel means the fuel generated from the RE after the oil, gas, coal and hydro. Currently, the RE generated in Malaysia is from solar valley, hydropower stations, biomass and biogas. These are all the RE that has been generated on land. Meanwhile, in the world there are several applications on marine RE such as the offshore wind farms, wave energy and tidal energy (Robertson et. al. 2013). Since Malaysia has not been vigorously in the exploitation on marine RE, the application of OSWT in Malaysia enhanced to increase the RE mix through the exploration of new RE on marine site. One of the developed countries such as Denmark has been generating the electricity power since 1970‘s through the commercialization of OSWT technology in order to control the use of fossil fuels and the global warming pollution. Similarly in Malaysia, the rapid industrial growth and the ever increasing population caused the extensive use of fossil fuels and pollute the atmospheric. The fossil fuels such as coal, petroleum and natural gas have been continually use for generating electricity, industrialization activities and fulfilling almost all human activities. Therefore, the current RE such as solar energy, biomass and biogas energy and hydropower stations also could not minimize the use of fossil fuels in fulfilling the power demand. Presently in reality the fossil fuels have been continually comes to the limit. Hence, the RE adoption of the OSWT in Malaysia is critically helps to reduce the dependency on fossil fuels and save the environment from pollution.

1.4 Significance of study

The findings of this research are aimed to justify the factors and strategies of possible adoption of OSWT in Malaysia. The adoption of this RE based electricity generation will also benefits the human health, environmental from pollution and gives competitive advantages to Malaysia. This study also creates an urgency of responsibility to Sabah Electricity SendirianBerhad (SESB) which an electrical company that responsible to generates, transmits and distributes electricity mainly in Sabah and Federal Territory of Labuan.

1.5 Research questions

Social, economy, environment and energy security are closely interlinked. According to European Wind Energy Association (2009), high availability is crucial for the economics of any wind farm. However, this situation is primarily depending on system reliability and adequate maintenance capability on the OSWT farm. The key advantage of an OSWT technology is minimal maintenance is required and maximum access of feasibility. Further from here, three research questions are formatted.

a) What are the factors that would contribute in the possible adoption of OSWT in Malaysia?

b) What are the strategies of Tenaga National Berhad (TNB) and The Ministry of Energy, Green Technology and Water (KeTTHA) to adopt the OSWT?

c) How far the proposed model could contribute empirically to Tenaga National Berhad (TNB) and The Ministry of Energy, Green Technology and Water (KeTTHA) for the adoption of OSWT in Labuan Island, Sabah?