FINANCIAL ASSESSMENT OF SOLAR PV SYSTEM IN RESIDENTIAL SECTOR OF MALAYSIA

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This project is dedicated to my parents who have never failed to give me financial and moral support, for giving all my needs during the time I developed my project and for teaching me that even the largest task can be accomplished if it is done one step at a time and also to my sisters and my brother who is always alive in my memory.

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ABSTRACT

Energy usage and its respective become a controversial issue in the modern world. Energy is considered as one of the indispensable factors for continuous development and economic growth. One of the main sources of energy is fossil fuels which is limited; therefore, it is necessary to use another sources for energy such as renewable energy. One of the most useful source of renewable energy is solar energy. The energy generated from solar is clean and natural without contaminating noise, harmful emission and waste products. Malaysia is situated at the equatorial region with a high amount of solar radiation. It has a promising potential to establish large scale solar power installations. Among the wide range types of different buildings, residential buildings are considered as one of the biggest energy consuming sector in the world. The aim of this study is to investigate the financial potential of solar PV systems in residential buildings in Malaysia. To achieve the aim of study, at the first step number and capacity of each component of suitable PV system was estimated. Then with using retail price information of each component that gathered from local manufacturers or exporters in Malaysia, the cost of each component of solar PV system and the price of whole system was estimated. Then the annualized life cycle costs of the system were calculated. At the Last stage of the study, the payback period of initial investment, net present value (NPV), and Internal rate of return (IRR) of the project were determined.

ABSTRAK

Penggunaan tenaga pada masa kini kian menjadi salah satu isu kontroversi dalam dunia moden kini. Hal ini adalah kerana, tenaga yang telah dianggap sebagai salah satu faktor yang amat diperlukan pada pertumbuhan ekonomi dan pembangunan untuk kadar masa yang berterusan. Salah satu sumber utama tenaga adalah seperti bahan api fosil yang terhad; dan sebab itu, ia adalah amat diperlukan untuk menggunakan sumber-sumber seperti yang lain untuk dijadikan tenaga seperti tenaga yang boleh diperbaharui. Salah satu sumber tenaga yang diperlukan dan boleh diperbaharui adalah seperti tenaga suria. Ia merupakan tenaga yang dijana daripada solar malahan ia juga bersih dan semulajadi tanpa mencemarkan bunyi bising, pelepasan yang berbahaya dan bahan buangan. Kedudukan Malaysia yang terletak di rantau khatulistiwa yang mempunyai jumlah sinaran suria yang tinggi juga memyebabkan potensi yang baik untuk mewujudkan pemasangan kuasa solar secara besar-besaran. Bangunan kediaman dianggap sebagai salah satu pengguna tenaga terbesar dalam kategori bangunan. Kajian ini adalah bertujuan untuk menyiasat potensi kewangan sistem PV solar di bangunan-bangunan kediaman di Malaysia. Untuk mencapai tujuan kajian tersebut, anggaran pada setiap komponen PV telah dilakukan untuk mencapai keupayaan yang bersesuaian. Dengan menggunakan maklumat harga jualan bagi setiap komponen yang telah dikumpul daripada pengilang-pengilang tempatan mahupun pengeksport di Malaysia, kos bagi setiap komponen sistem PV solar dan harga keseluruhan sistem juga telah dapat dianggarkan. Seterusnya, kos kitaran hayat bagi sistem PV dikira. Pada peringkat akhir kajian, tempoh pembayaran balik bagi pelaburan awal, nilai bersih dan kadar pulangan projek dalaman juga telah ditentukan.

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INTRODUCTION

1.1 Introduction

Green energy is the energy that is produced in a manner that has less of a negative impact to the environment than other energy sources like fossil fuels, which are often produced with harmful side effects. Such types of energy that often come to mind are solar, wind, geothermal and hydro energy. There are several more, even including nuclear energy, that issometimes considered a green energy source because of its lower waste output relative to energy sources such as coal or oil (Fayaza et al., 2011).Renewable energy plays an important role in the supply of energy. The demand for fossil fuels will be reduced when more renewable energy sources are used, the. Therefore, this study has been conducted in order not only to enhance the development of renewable energy in Malaysia but to focus on solar energy and it is uses (Fayaz et al., 2011).

The Malaysian energy sector is still heavily dependent on non-renewable fuel such as fossil fuels and natural gas as a source of energy. With uncertainties in prices, depletion and environmental issues surrounding the non renewable energy resources, the renewable energy approach through solar energy plays a meaningful role as a country's fifth fuel. For this, the Malaysian government has taken various

efforts to encourage individuals and companies to invest in solar PV projects (Johari et al; 2011).

Solar energy reside in one of the most important places among a range of substitute energy sources. An accurate knowledge of solar radiation availability at a particular geographical location is very important for the development of solar energy systems and for the evaluation of their efficiencies and productivity. The familiarity of solar radiation data is a requirement for the modeling and design of all photovoltaic systems (Jakhrani, et al., 2010).

1.2 Background of study

During the past decade, the world had realized that fossil fuels such as petroleum, natural gas, and coal, are causing tremendous damage to the earth. The emission of carbon dioxide and carbon monoxide by burning these fossil fuels will cause many environmental problems such as global warning, green house gases, and depletion of the ozone layer. One of the most severe environmental phenomenon is global warming that will caused melting of iceberg in north and south poles of the earth and resulted in increasing of sea level. With the increasing of sea level, the sea water will flood coastal cities and island countries. The United Nations-sponsored Intergovernmental Panel on Climate Change (IPCC) reported in 2001 that the average temperature is likely to increase by between 1.4°C and 5.8°C by the year 2100 (IPCC, 2001). An investigation on global warming in Malaysia carried out by Universiti Teknologi Malaysia (UTM) shows a similar result with the report of IPCC 2001. The mean annual temperature in Malaysia for the past fifty years (1951 – 2001) shows a significant increase, ranging from 0.99°C to 3.44°C which is fall into the range set by IPCC (Ahmad, 2005).

Figure 1.3, shows world population prospects from 1950 to 2050 done by United Nation Population Division in 2009. World population reached about 6.8 billion, up about 83 million from 2008. It is estimated the world population will reach 8 billion and 9.4 billion in 2025 and 2050 respectively (Nation, 2009). With this huge increase of world population, the demands for conventional fuels are also increase tremendously. Many Oil and Gas companies are exploiting conventional fuels rapidly to fulfill market demand. Some companies are force to go for deep sea exploration to search for fossil fuels but the cost of exploration is very high and the result is not guarantee. After spending high cost for drilling an oil rig, the amount of oil can be extracted is not guarantee and the cost of exploration may even higher than the revenue from selling this oil. With this rapid exploration, conventional fossil fuels are no longer enough to support human daily activities. Therefore, alternative fuel must be developed to replace or substitute conventional fuels before the fuels come to the end.

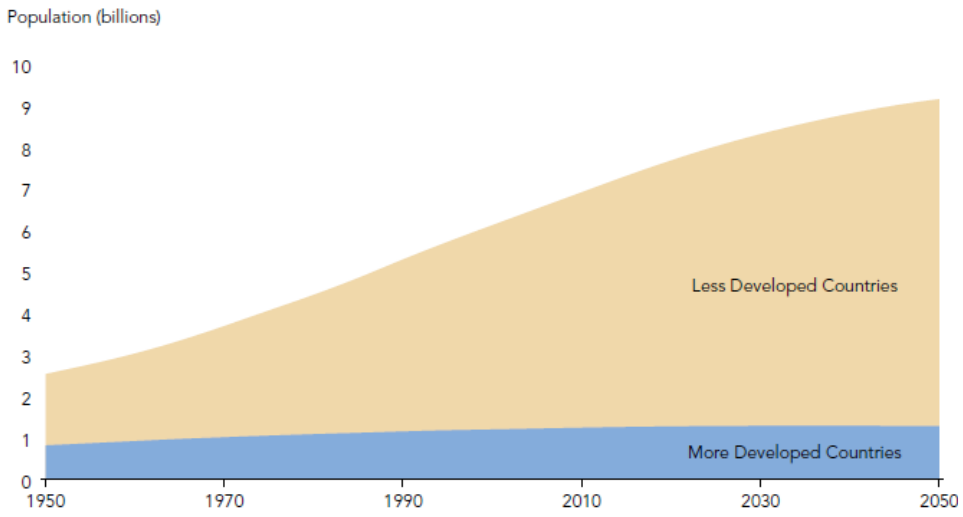

Figure 1.1: World Population Prospects from 1950 to 2050

These results proven that Malaysia is no longer isolated from the consequences of global warming. Global warming is not only environmental phenomenon for developed countries but also a significant problem for developing countries. Proactive measures and long term planning must be take to overcome this problem. One of the effective steps to reduce dependency on conventional fossil fuel

will be using renewable energy, in particular photovoltaic (PV) technology. PV technology is one of the very effective solution to generate electricity available today (Maricar, et al., 2003) and this technology will not emit any green house gases while generating the electricity.

The electricity consumption in Malaysia is becoming of an interest nowadays given the fact that the Malaysia's electricity consumption per capita is the second highest among the five ASEAN founding nation. As electricity consumption per capita grows rapidly since 1971, one may deduce that this may be one of the important factors that lead to a growth of a nation. Although many studies have been done to look at this issue, most of them are produced in developed countries. Study on electricity consumption in Malaysia, yet, is relatively few, and limited to Yoo (2006) and Chen et al. (2007) with recent contribution by Tang (2008a; 2008b) and Chandran et al. (2009). However, these studies are only limited to analyzing the relationship between two variables - except for Tang (2009) which has developed a multivariate approach on electricity consumption framework - namely electricity consumptions and economic growth in short- and long-term. The analysis, nevertheless, ignores other important variables that determine the electricity demand function, which is considered as the main component in consuming electricity in Malaysia. Besides that, the studies are limited to analyzing the aggregate consumption function instead of disaggregated data of other sectors in the economy namely, residential, industrial and commercial.

Table 1.1: Electricity per Capita Consumption in ASEAN (kWh per capita)

Country	1980	1990	2000	2006
Malaysia	670.25	1,178.07	2,742.89	3,387.60
Singapore	2,718.31	4,859.86	7,575.41	8,520.02
Indonesia	44.37	161.37	400.36	529.72
Thailand	291.26	708.13	1,462.14	1,984.33
Philippines	367.96	352.73	501.29	572.28

Malaysia as a tropical country has a steady solar radiation which is not seasonal in nature has a good potential for PV systems. However the applications of PV systems are still very low comparing to some developed countries like Germany, Spain, United States, and Japan. Table 1.2 shows the cumulative of total renewable energy in Malaysia. For 2010, Malaysia is target for renewable energy of 350MW but Malaysia only able to achieve 53MW at the end of 2009 which is still far away from the targeted amount.

Table 1.2: Cumulative Total Renewable Energy in Malaysia

Year	Cumulative Total Renewable Energy (MW)	Country Electricity Mix (%)
2010 (target)	350	1.18
2009 (achieved)	53	0.18

Table 1.2 and 1.3 show the cumulative total renewable energy and PV contribution to national energy mix in Malaysia. At 2010, PV only contributed 0.013% which is less than 1% to the national energy mix in Malaysia. Government of Malaysia is aiming for 1.5% for 2015 that will be contributed by PV generation. In 2009, total installed capacity for PV is 7.3GW in the world. European countries contributed the most with the amount of 77%, Germany, Italy and Czech Republic are the biggest contributors with 68%. Therefore, this study aims to investigate low popularization of the PV systems and identify the capital cost and maintenance costs for PV system. Then, payback period and net present value (NPV) will be determined for PV system in Malaysia by using the current feed in tariff proposed by BIPV project group.

Table 1.3: PV Contribution to National Energy Mix in Malaysia

Year	PV Contribution to National Energy Mix (%)
2010 (achieved)	0.013
2015 (target)	1.500

1.3 Problem Statement

Energy is vital in society to ensure the quality of life and to strengthen all other elements in the economy. Most of the countries that continue to experience rapid urbanization and population growth today are in the developing world. The energy consumption in these countries has shown tremendous increase over the last few decades. For instance, the nationwide final energy demand in Malaysia has increased fivefold over the last three decades, while the total population has doubled from 10.4 million in 1970 to 22.2 million in 2000.

The demand for energy is expected to continue to increase worldwide over the coming years (International Energy Outlook, 2005) in the industrialized countries and particularly in the developing countries, where rapid economic growths are expected. The energy demand for Malaysia increased rapidly at almost 20% annually within 3 years (from 1999 to 2002). The energy demand increase to 18,000MW by the year 2010 (Thaddeus, 2012). Utility providers in Malaysia are using mixed generation to provide the power needed by the country. The generation fuel mix in Malaysia in 2011 is 62.6% gas, 20.9% coal, 9.5% hydro and 7% from other forms of fuels. (Harian, 2012).

The rate of utilization of renewable energy technologies such as solar, wind and biomass are being used by many developed countries to generate their electricity. The world renewable share of electricity generation in 2007 is 18% and would continue to increase to about 23% in the year 2035 (Dincer, 2011). In Malaysia, the electricity is being generated from coal and natural gas as the main energy source, by Tenaga Nasional Berhad (TNB) in Peninsular together with a few independent power producers, by Sabah Electricity Sdn. Bhd. (SESB) in Sabah and by Sarawak Electricity Supply Corporation (SESCO) in Sarawak (Bazmi and Zahedi, 2011).

The electricity generated from solar energy is clean and natural without contaminating noise, harmful emission and waste products. CO2 emission reduction due to photovoltaic (PV) systems per kWh electricity is equivalent to only approximately 0.5688 kg. If this reduction (compared to petroleum) in CO2 emission is taken into account in the calculation of the cost of electricity generation. PV generation method is still new in Malaysia but it has a very high potential due to favorable geographical location in relation to solar irradiance index (Siti Indati et al, 2010).

Malaysia is situated at the equatorial region with an average solar radiation of 400–600 MJ/m2 per month. It has a promising potential to establish large scale solar power installations (Mekhilef, 2011). The Malaysian government is keen to develop solar energy as one of the significant sources of energy in the country. According to the 9th Malaysia Plan (9MP), a large allocation had been dedicated for implementation of solar PV systems.

One of the places for energy consumption are residential buildings. According to the national census, about 85% of the existing housing stocks in urban areas are brick or brick and plank houses. These brick modern houses basically require electrical devices to cope with the local tropical climate unlike the traditional wooden houses. In fact, the results of national census showed that the total number of households with air-conditioning in Malaysia has dramatically increased from 13,000 in 1970 (0.8%) to 229,000 in 1990 (6.5%) and 775,000 in 2000 (16.2%). Thus, it is particularly important to understand the detailed energy consumption structure in such modern houses in the tropics, focusing especially on air-conditioning usage.

According to high rate solar radiation in Malaysia, and the Malaysian government programs to develop solar energy in the country and high usage of electrical consumption in residential building, it would be necessary to use solar energy in residential sector of Malaysia. In recent years, many investigations did abut

aspects of using solar PV system in Malaysia. Yet there is a gap in financial information about using solar PV system in residential Sector of Malaysia.

1.4 Aim and Objectives of the Study

The aim of this study is to investigate the financial aspects of using solar PV systems in residential buildings in Malaysia. To achieve this aim, the following objectives have determined:

- To determine a suitable PV system for residential building of Malaysia.
- To calculate amount of initial investment for the adequate PV system for residential sector of Malaysia.
- To estimate the life cycle cost of appropriate solar PV system for Malaysia.
- To evaluate payback period of elementary investment, net present value (NPV), and internal rate of return (IRR) of designed PV solar system for residential sections of Malaysia.

1.5 Scope of Study

The scopes of data collection for this study focus on the following aspects:

- The selected case is considered in Johor Bahru due to availability of needed information.
- This study just focuses on the financial aspects of using solar PV system which are suitable for residential building. It is mentioned that the study will not focus on technical information about solar PV system.

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