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POTENTIAL USE OF SOLAR PHOTOVOLTAIC IN PENINSULAR MALAYSIA

A. Johari, S.H. Samseh, M. Ramli and H. Hashim
Department of Chemical Engineering,Faculty of Chemical Engineering
Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia
Email: sitihafsharsamseh@yahoo.com

ABSTRACT
Energy is important in all aspects of development to support population growth, urbanization, industrialization as well as tourism industry. Energy consumption is also increasing and several alternative green energy sources are seriously taken into consideration to fulfill Malaysia's energy demand. The Malaysian government has looked into the renewable energy (RE) sources such as solar energy to be one of the alternatives to face problems related with the increase in energy demand. However, the heavily subsidized non renewable sources in the country have made the RE sources as an uneconomical option. The aim of this paper is to briefly review the incentives and the RE Act adopted by the Malaysian government to ensure long term reliability and security of energy supply. The feed-in-tariff system, solar radiation intensity in Peninsular Malaysia and the role of renewable energy sources in the Five-Fuel Diversification Strategy energy mix are also highlighted in this paper.

Keywords: Electricity, Renewable energy, Photovoltaic, Feed-in-tariff, solar radiation**.**

1. INTRODUCTION

The consumption of energy in Malaysia rises rapidly, increasing at an average rate of 5% in the 1980s and 12% in 2009 (Loganathan et al. 2010). The maximum electricity demand in Peninsular Malaysia has increased by 1.7%, from 14,007 MW in 2008 to 14,245 MW in the year 2009. In Sabah, the maximum electricity demand has increased by 6.8%, from 673 MW in 2008 to 719 MW in 2009 whilst in Sarawak the maximum electricity demand has increased from 860 MW in 2008 to 996 MW in 2009 (Energy Commission, 2009). In 2009, the total electricity sales was 92,753 GWh, of which the industrial sector remained the largest user of electricity at 43.4% of the total energy sold in 2009 and followed by commercial sector at 33.9%. The residential sector was the third largest user of electricity in Malaysia at 21.1% and only 0.3% of the total electricity sold was consumed by the agriculture sector as shown in Table 1. The growth in electricity demand is heavily influenced by strong demand from the industrial sector, which increases at 5.4% annually (Martunus et al. 2008). Mostly, Malaysia's energy sources for electricity which are based on a "four-fuel mix" strategy come from gas, oil, hydro and coal. By 2010, it was estimated that gas and coal would contribute 92% of the sources of electricity generation whilst hydro and oil would contribute 7% and 1%, respectively (International Energy Agency, 2010). The consumption of fossil fuel in electricity generation contributes to the emission of greenhouse gases especially CO_2. The emission of greenhouse gases causes global warming and climate change.

Table 1 Energy usage by sector in 2009 (Loganathan et al. 2010)

Sector	Sales of Electricity (GWh)	Percentage (%)
Industrial	40,233	43.4
Commercial	31,435	33.9
Residential	19,584	21.1
Agriculture	243	0.3
Public Lighting	1,208	1.3
Total	92,753	100

The increase in fossil fuel prices today and the country's commitment to reduce the carbon emission has supported the interests in expanding the use of renewable energy for energy generation. Under the 8th Malaysia Plan (2001–2005), the government of Malaysia had changed the Four Fuel Policy to the Five Fuel Policy energy mix with the addition of renewable energy as the fifth source of fuel in the year 2000. The government of Malaysia has formulated numerous energy related policies in order to ensure long-term reliability and security of energy supply for sustainable socio-economic development in the country. Various efforts are currently undertaken by the government to encourage the utilization of renewable energy resources such as biomass, biogas, solar, mini-hydro and municipal waste for energy generation. The Ministry of Energy, Water and Communications (MECW) has stated solar energy as one of the most important renewable energy sources in Malaysia. The climatic conditions are favorable for the development of solar energy due to the abundant sunshine. The aim of this paper is to review the renewable energy utilization in Peninsular Malaysia by focusing on the potential of solar energy particularly towards photovoltaic (PV) usage in Malaysia. In addition, the paper is intended to highlight the renewable energy capacity, policies adopted by Malaysia government to encourage the utilization of solar PV, feed-in-tariff of solar PV and solar radiation intensity.

2. RENEWABLE ENERGY

In the 8th Malaysia Plan, the Malaysian government includes renewable energy as the fifth energy source with the aim to generate 5% of the country's electricity from renewable sources. It is estimated that by utilizing only 5% of renewable energy in the energy mix, the country could save RM 5 billion over a period of 5 years (Abdul and Lee, 2004). Efforts in promoting the utilization of renewable energy resources are actively being made by Malaysian government due to a number of benefits. One of the benefits in the utilization of renewable energy resources is the sustainability of energy supply in a long term. Other benefit of promoting the utilization of renewable energy is the reduction of the greenhouse gases emission that has negative impacts on the environment from the consumption of fossil fuels. In Malaysia, coal consumption for electricity generation grows at the rate of 9.7% per year since 2002. The increase in coal utilization usually tallies fairly well with the increase in CO_2 emission. Figure 1 shows the consumption of coal from 2005 to 2020 which increases from 12.4 to 36 million tons.

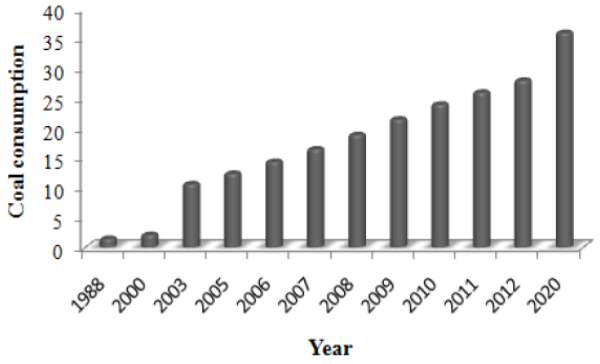

Figure 1 Coal consumption for electricity generation in Malaysia, million tons (Martunus et al. 2008)

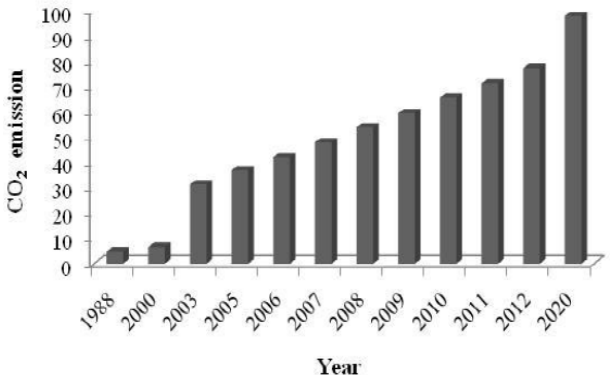

Figure 2 CO_2 Emissions from Coal Fired Plant in Malaysia, million tons (Martunus et al. 2008)

The increase in coal consumption has contributed to the changes in CO_2 emissions pattern in Malaysia. Martunus et al. (2008) estimated that CO_2 emissions from coal fired power plants in Malaysia will grow 4.1% per year to reach 98 million tons by 2020 as shown in Figure 2. The emission is continuously increasing with the construction of new coal fired power plants and the increase on the capacity of existing coal fired power plants. It is estimated that the country could avoid 42 million tons of CO_2 in 2020 and 145 million tons of CO_2 in 2030 if the cumulative renewable energy is to be increased from 2,080 MW to 4,000 MW respectively. Table 2 shows the projection of cumulative renewable energy capacity for Malaysia.

Solar energy is considered as one of the promising sources of renewable energy as Malaysia receives abundant sunlight throughout the year. In addition to that, it is also considered as a clean energy source that does not emit CO_2 in the process of electricity generation. Malaysian government realizes that the solar energy has the ability to ensure energy security and mitigate climate change. The government has currently carried out various efforts to develop and promote the utilization of solar energy resources by formulating policies and programs on solar energy.

Table 2 Projection of cumulative renewable energy capacity for Malaysia, Megawatt (Weinee, 2010)

Year	Biomass	Biogas	Mini-Hydro	Solar PV	Solid Waste	Total
2020	800	240	490	190	360	2,080
2030	1,340	410	490	1,370	390	4,000
2050	1,340	410	490	18,700	430	21,370

3. POLICY AND INCENTIVES TO ENHANCE SOLAR ENERGY IMPLEMENTATION IN MALAYSIA

The abundance of sunlight makes solar photovoltaic (PV) a very viable form in generating electricity. In the 9th Malaysian Plan, under the Renewable Energy (RE) Policy, Malaysian government announced the Malaysia Building Integrated Photovoltaic (MBIPV) Project which aimed at promoting the use of solar electricity in electricity generation. The Building Integrated Photovoltaic (BIPV) Project was officially launched on July 2005 with the cost of RM 25 million. The project was completed in 2010.

The project was initiated by the Malaysian government with the support from the United Nations for Development Programme (UNDP) and Global Environment Facility (GEF). Under this project, the PV system is connected to the utility's local grid in which the excess electricity produced during the day is exported to Tenaga Nasional Berhad (TNB). The electricity is imported from TNB if additional consumption is needed. This concept is known as net metering. On the other hand, under the MBIPV project, several financial incentives were offered to the public to install the PV system into their premises. The category and purposes of MBIPV incentive schemes are listed in Table 3.

Table 3 MBIPV incentives schemes (Haris, 2010)

MBIPV Category	Purpose of BIPV Category	MBIPV Incentives
BIPV Showcase - Target: 100 kWp	To create BIPV success stories and quality example for public or industry references	100% technical and financial incentives (limited to BIPV system), and promotional support
BIPV Demostration - Target: 200 kWp	To stimulate the local building industry (private and government sectors)	100% technical support and limited financial support for BIPV system (1st 100kWp: 28%, 2nd 100kWp: 25%), and promotional support.
Suria 1000 - Target: 1,200 kWp	To catalyse BIPV market by targeting general public to install BIPV at their premises (homes or building) and property developers	Financial incentives from 75% (1st call) reducing to 40% (8th call) over a four-year period, based on a bidding concept and maximum 35% for property developers.

In 2010, all the MBIPV incentives had been taken and are no longer available. Effective 13th January 2010, the MBIPV project reports directly to the Ministry of Energy, Green Technology and Water (KeTTHA). As such, MBIPV Project is no longer associated with Pusat Tenaga Malaysia (PTM), which is now known as GreenTech Malaysia. On 4 April 2011, the parliament had passed the Renewable Energy (RE) Act 2010 bill which aimed at developing renewable energy in a more aggressive manner. When tabling the bill in December 2010, the Malaysian government aimed to have 2,080 MW of renewable energy capacity by 2020 (Bernama, 2011). The Act allows individuals to sell electricity produced from renewable sources like solar PV at a higher rate than traditional power producers to TNB. This incentive is expected to boost renewable energy industries and its current electricity generation share in the country from under 1% to 11% by 2020 (Ling, 2011). Under the RE Act 2010, a small-scale solar photovoltaic producer, meaning a household, can potentially earn up to RM1.75 per kWh of electricity produced by selling the power to TNB (Yee, 2011). Under the bill, the Malaysia government also proposed to implement the feed-in tariff system for the country, covering technologies including solar photovoltaics.

4. FEED-IN-TARIFF (FIT)

On 28th April 2011, the Malaysian parliament had passed the legislation to create a system of feed-in tariff for the nation. Malaysia is the fourth Asian nation to implement a feed-in tariff system, following Japan, Taiwan and Thailand. The program was scheduled to be implemented by the third quarter of 2011, and contains targets for specific technologies by year, including PV projects that are smaller than 1 MW in size (Malaysia Building Integrated Photovoltaic, 2011). Tariff levels are set between RM1.23 cents per kWh for PV plants smaller than 4 kW to RM0.85 cents per kWh for system 10-30 MW in size. Bonuses are included for rooftop PV, BIPV, locally produced modules and inverters. Annual targets for solar photovoltaics start at 29 MW in 2011 and reach 580 MW in 2030. All solar PV producers are guaranteed an income for up to 21 years from the date of signing the agreement. Table 4 lists the feed-in-tariffs rates for solar PV.

Table 4 The feed-in-tariff rates for solar PV (Haris, 2010)

Capacity of Renewable Energy Installation	Feed-In-Tariff Rate (RM-sen/kWh)	Effective Period	Initial Annual Degression Rate
< 4 kW	1.23	21 years	8%
> 4 kW < 24 kW	1.20	21 years	8%
> 24 kW < 72 kW	1.18	21 years	8%
> 72 kW < 1,000 MW	1.14	21 years	8%
> 1 MW < 10 MW	0.95	21 years	8%
> 10 MW < 30 MW	0.85	21 years	8%
Bonus for rooftop	+0.26	21 years	8%
Bonus for BIPV	+0.25	21 years	8%
Bonus for local modules	+0.03	21 years	8%
Bonus for local inverters	+0.01	21 years	8%

+ Additional in FIT rate

5. SOLAR RADIATION

In Malaysia, the climatic conditions are favourable for the development of solar energy as Malaysia lies directly on the equatorial zone. The average daily solar radiation in Malaysia of 4,500 kWh/m^2 and the sunshine duration of about 12 hours per day indicate the potential use of solar energy to generate electricity. In Peninsular Malaysia, the Klang Valley (Kuala Lumpur, Petaling Jaya) has the lowest solar radiation value, whereas areas around Penang (Georgetown,

north-west coast) have the highest values measured. An installation of solar PV in Malaysia would produce energy of about 900 to 1400 kWh/kWp per year depending on the locations (United Nations Development Programme, 2005). The areas located at the northern and middle part of the Peninsula would yield higher performance. An installation in Kuala Lumpur would yield around 1000 - 1500 kWh/kWp per year (Ismail, 2010). Figure 3 shows the solar radiation value in Peninsular Malaysia.

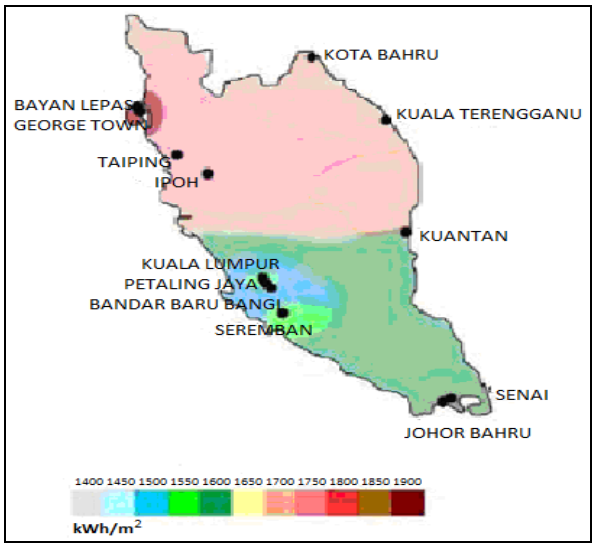

Figure 3 Solar radiation values in Peninsular Malaysia (United Nations Development Programme, 2005)

6. CONCLUSION

The Malaysian energy sector is still heavily dependent on non-renewable fuels 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 RE approach through solar energy plays a meaningful role as a country's fifth fuel. The Malaysian government has taken various efforts to encourage individuals and companies to invest in solar PV project by adopting the Renewable Energy Act. Under the RE Act, the government has created a feed-in-tariff system as one of the most cost effective mechanisms to promote RE applications. In Malaysia, the favourable climatic condition makes solar photovoltaics to be in a very viable form to generate electricity and the applications are also very versatile. In Malaysia, the reason why RE approach is important in the future is due to its abilities in ensuring energy security and sustainability.

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REFERENCES

Abdul, R.M. and Lee, K.T. 2004. Energy policy for sustainable development in Malaysia, In: The Joint International Conference on Sustainable Energy and Environment (SEE), Hua Hin, Thailand, 1-3 December.

Ahmed, A.Z. 2008. Integrating sustainable energy in buildings: a case study in Malaysia, In: FAU Conference, Copenhagen, Denmark, 14-15 May.

Bernama, Renewable energy bill passed, MBIPV project, http://www.mbipv.net.my/news1/2011/April/Renewable%20Energy%20Bill%20Passed%204th%20April%202011.pdf, 01/05/2011.

Energy Commission. 2009. Electricity Supply Industry in Malaysia, Performance and Statistical Information 2009. Putrajaya: Malaysia.

Haris, A. H. Ir. 2010. Renewable energy and feed-in-tariff, RE/MBIPV, In: National Project Team.

International Energy Agency. 2010. Energy Balances in Non-OECD Countries, In: Global Commodities Forum, Paris.

Ismail. 2010. An overview of the renewable energy and energy efficiency blueprint for Iskandar Malaysia, In: Minggu Sains dan ICT Negeri Johor at Iskandar Regional Development Authority, 21-27 June.

KeTTHA. 2011. (Ministry of Energy, Green Technology and Water, Malaysia), MBIPV project, http://www.mbipv.net.my/default.asp 23/02/2011.

Ling, G.P. 2011. Going solar and renewable, MBIPV project, http://www.mbipv.net.my/news1/2011/April/Going%20solar%20and%20renewable%2018th%20April%202011.pdf, 01/05/2011.

Lim C.H., Elias S. and Philip J. 2006. Renewable Energy Policy and Initiatives in Malaysia, Alam Cipta International Journal on Sustainable Tropical Design Research and Practice I (I): 33-40.

Loganathan, N. and Thirunaukarasu, S. 2010. Dynamic Cointegration Link between Energy Consumption and Economic Performance: Empirical Evidence from Malaysia, International Journal of Trade, Economics and Finance I (III): 261-267.

Malaysia Building Integrated Photovoltaic. 2011. Malaysian parliament approves feed-in-tariffs, MBIPVproject, http://www.mbipv.net.my/news1/2011/April/Malaysian%20Parliament%20Approves%20FeedIn%20Tariffs%2029th%20April%202011.pdf,01/05/2011.

Martunus, Othman, M.R., Zakaria, R. and Fernando, W.J.N. 2008. CO_2 Emission and Carbon Capture for Coal Fired Power Plants in Malaysia and Indonesia, In: International Conference on Environment 2008.

MMD (Malaysian Meteorological Department). 2010. Petaling Jaya: Selangor.

Muis, Z.A, Hashim, H., Manan, Z.A., Taha, F.M. and Douglas, P.L. 2010. Optimal Planning of Renewable Energy-Integrated Electricity Generation Schemes with CO_2 Reduction Target, Renewable Energy.

Saidur, R., Hasanuzzaman, M., Sattar, M.A., Masjuki, H.H., Irfan A.M. and Mohiuddin, A.K.M. 2007. An Analysis of Energy Use, Energy Intensity and Emissions at the Industrial Sector of Malaysia, International Journal of Mechanical and Materials Engineering 2: 84-92.

United Nations Development Programme. 2005. Overview of policy instruments for the promotion of renewable energy and energy efficiency in Malaysia, In: Background Report.

Weinee, C. 2010. Solar photovoltaic: plug into the sun, MBIPV project, In: Malaysia Energy Guide.

Yee, L. H., Higher income for home solar energy, MBIPV project, http://www.mbipv.net.my/news1/2011/April/Higher%20income%20for%20home%20solar%20energy%209th%20April%202011.pdf, 01/05/2011.