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INTRODUCTORY OF RENEWABLE ENERGY SOURCES IN ASEAN COUNTRIES AND GREEN-Y MODEL FOR PREDICTING FIT-IN TARIFF IN MALAYSIA

Hui Hwang Goh, [51]; **Kai Chen Goh** [2], **Wan Nur Zatil Shahida Wan Sukri** [2], **Qing Shi Chua** [1], **Jia Ji Lim**[3]
[1]Department of Electrical Engineering, Faculty of Electrical and Electronic Engineering,
[2]Department of Construction Management, Faculty of Technology Management and Business,
Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia.
[3]International Business School, Universiti Teknologi Malaysia (Skudai Campus), 81310 Skudai, Johor, Malaysia.

Abstract

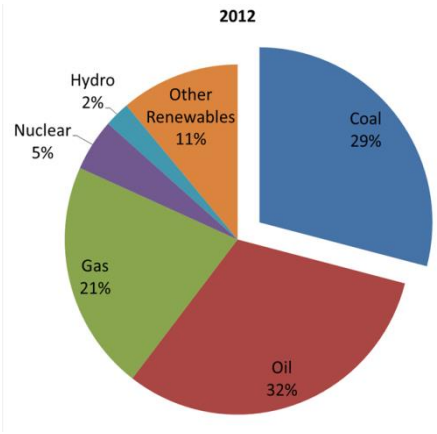
ASEAN is enriched with renewable energy sources (RES) and this is the major advantage as compare to other countries. However, the endowed RES are not being fully utilized because they are mainly relied on non-renewable energy sources (NRES) such as fossil and coal. Even though the cost of acquiring NRES is low nowadays, but the cost will be hiked sooner or later when the currently available NRES are running out. The awareness towards the implementation of the RES has been taken into consideration by the ASEAN due to the conveniences. The principal aim of this paper is to provide an insight to the ASEAN countries in preparing themselves towards the adapting of renewable energy and guidelines for the policies for RES. The developed Green-Y model is used to advise the ASEAN governments to evaluate and predict the economic concept included a feed-in tariff. Forecasted photovoltaic cost analysis results in Malaysia show the increasing of feed-in tariff for every year.

Key words: *ASEAN RES, Photovoltaic Cost Analysis, Renewable Energy, RES Policies, RES Potential*.
JEL code: *O21*

Introduction

ASEAN countries are enriched with many renewable energy sources (RES) such as wind energy, hydropower energy, solar energy, biomass and many more. Most of the countries in ASEAN are utilising fossil and coal as the primary energy resources. According to the statistic of global energy consumption, only 11% of renewable energy resources were used as shown in Fig. 1 in the year 2012. Moreover, about 29%, 32% and 21% of coal, oil and gas subsequently had been utilised (Sieminski, 2014). Most of the countries in Asia are using fossil and coal as main sources to generate electricity instead of using the highly available renewable energy. Therefore, just a small amount of renewable energy resources has been utilised to generate electricity for daily usage in the particular country.

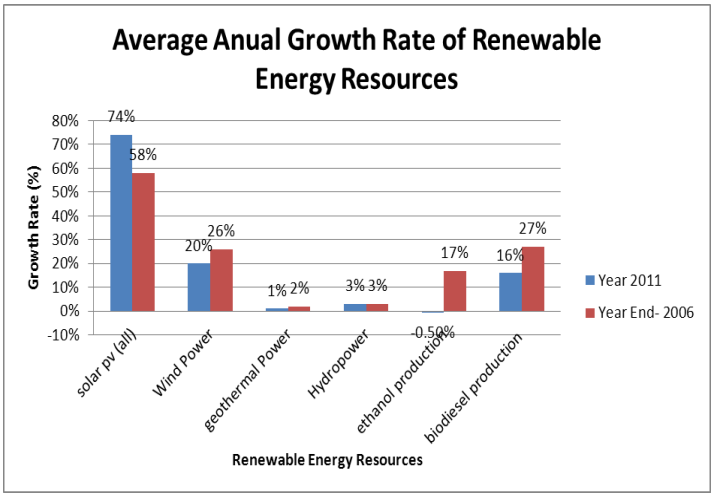
[5] Corresponding author – Goh Hui Hwang, Department of Electrical Engineering, Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia, Tel.: +60167516824, Email addresses: hhgoh@uthm.edu.my, jonathanhhgoh@gmail.com



Source: author's construction based on (Sieminski, 2014)

Fig. 1. **Global energy consumption**

Renewable energy market grew rapidly for several years; photovoltaic energy has the rapid expansion with the fastest growing energy, followed by wind power for about 164 GW, and biodiesel production. Hydropower and geothermal power have the least growth rate. The average annual growth rate of renewable energy resources in ASEAN from 2006 to 2011 is provided in Fig. 2. Approximately half of the available renewable energy resources were supplied to the world in 2011.



Source: author's construction based on (Al Jaber et al., 2012)

Fig. 2. **Average annual growth rate or RES**

Presently, most of the governments are starting to implement more RES to generate electricity as it is more environmental protection, energy access improvement and energy security enhancement (Martinot, 2005). Furthermore, some states in ASEAN started to propose policies' model of generating performance based on the electricity inducement that synthesizes these policies contained in the context of better renewable energy practice framework, policy

instrument and sustainable economic concept. The main objective of this paper is to assist ASEAN, mainly for Malaysia's government in preparing the implementation of renewable energies and to guide a Malaysia policy for RES in the mid to long term. Besides that, this paper also will assess the current best practices, and future cost or RES and corresponding support necessary to initiate stable growth of RES. Moreover, integration of better RES policies with climate and innovation policy as well as liberalized energy market is also part of the objective of this research work. Last but not least, the selected recommendation for the future deployment of RES based on the Green-Y model in order to assist Malaysia in implementing national action plans and to support a long term vision of ASEAN RES.

Literature reviews

Renewable energy resources and policies

Energy and RES policies in ASEAN regions have been growing over the last two decades ago that shared some feed in tariff design features, RES potential and RES utilization. Economics of RE growth increased in energy consumption up to 3.6% per annum since 1995 to 2007 (Suryadi, 2012). This section reviews the involvement of RES in each country's policies and a summary table of the energy consumption and feed in tariff data.

Solar energy resources

Southeast Asia's countries are very popular with the sunny weather that consumes to solar energy resources. Approximately 4 to 7 kWh/m^2 of solar radiation have been produced per day (Essays, 2013). Solar photovoltaic technologies are becoming the alternative resources of generating the electricity in most of the ASEAN countries, especially for water pumping, street light, telecommunication network, and home. Table 1 shows the solar energy resources potential and utilisation of high penetration regions in Philippines, Vietnam, Malaysia, Indonesia and Thailand (Fürsch et al., 2010).

Table 1

Potential and utilisation of solar energy resources

Country	Potential	Utilisation
Vietnam	5 kWh/m^2/day (4-5.9 hours) 2MW	0.6 MW (solar PV)
Philippines	5.1 kWh/m^2/day	1 MW (centralised solar PV)
Indonesia	4.8 kWh/m^2/day	5 MW
Malaysia	4.5 kWh/m^2/day	1.5 MWp (PV stand alone) 450 kWp (grid connected PV)
Thailand	>5000 units (solar PV)	6 MW

Source: author's construction based on (Fürsch et al., 2010)

Biomass energy resources

Biomass derived from the dead plant, agricultural and forestry residues, municipal waste and animal residues. In ASEAN countries, the energy that can be generated is depended on the production structures it as the resources of the residue is varied from country to country. Table 2 shows the biomass energy resources potential and utilization. From Table 2, the potential of

biomass energy resources is high in a certain country such as Indonesia, Thailand and Malaysia. However, the utilization of biomass energy resources is low.

Table 2

Potential and utilization of biomass resources

Country	Potential	Utilization
Philippines	**Commercial Potential** 120 MW	-
Malaysia	**Technical Potential** 2700MW	211 MW
Indonesia	**Technical Potential** 49810 MW	302 MW
Thailand	**Technical Potential** 7000 MW	560 MW
Vietnam	**Technical Potential** 400 MW	50 MW

Source: author's construction based on (Hoogwijk et al., 2003)

Renewable targets and strategies

Every country in ASEAN has their renewable energy target and goal. Setting up their renewable energy policy strategies is one of the keys to achieve the target and goal. For example, all 27 member of European Union (EU) had set their 2020 target to 20% of establishment energy efficiency (Fürsch et al., 2010). ASEAN countries also have prescribed the renewable energy target with respective strategy to promote the renewable energy development. The strategies and target are a long term direction, and it is a correct signal to the world market. The renewable energy strategy and targets of all over Southeast Asia's country are shown in Table 3.

Table 3

Renewable Energy Strategy and Target

Indonesia National Energy Policy (2004) • 5% the power capacity should be based on RE in 2020
Malaysia Small Renewable Energy Power Programmes • 5% (500MW) grid connected electricity to be generated from renewable energies by the end of 2005 Biomass-based for Power Generation and Cogeneration in the Malaysia Palm Oil Industry • The strategy involve the implementation of barrier removal activities (2002-2004) and the implementation of innovative loan/grant mechanism (2005-2008)
Philippines Renewable Energy Framework (2003) • Increase RE-based power capacity by 100% 2013 (from 2003), increase non-power contribution of RE to energy mix by 10 MMBFOE in the next 10 years Regulation governing RE Development • Geothermal • Mini-hydro

• Ocean, Solar and Wind
Thailand Strategic Plan for Renewable Energy Development : new option for Thailand • Increase the share or renewable energy to 8% of commercial primary energy consumption in 2011 • Renewable portfolio standard (RPS). 4% of new power plant must be generated by renewable energy in 2011 • Inactive measures being developed
Vietnam National Energy Policy (September 2004 Draft) • To provide electricity in 2020: 3% share in primary commercial energy; 5-6% in electricity generation Rural Electrification Policy • To provide electricity services in the rural areas, either grid-based or off-grid, to imp rove the living conditions of the rural population and ability to earn household income as well as to reduce poverty in the rural areas Renewable Energy Action Plan • To support an acceleration of renewable electricity production, to meet the needs of isolated households and communities that cannot receive electricity services from the national grid, and to supplement grid supply cost effectively in remote areas • Phase 1 targets the addition of 25-51 MW of renewable energy capacity; Phase 2 aims to achieve between 175-251 MW additional renewable energy capacity

Source: author's construction based on (Pacudan, 2005)

In order to achieve the renewable energy developmental goals, the specific renewable energy policy framework has been established in each of the ASEAN countries. Every framework of ASEAN shows the current government concern, renewable energy development status, development concern and etc. The policies promoting renewable energy development are shown in Table 4.

Table 4

Policies Promoting Renewable Energy Development

Indonesia National Energy Policy (2004) • Guarantee sustainable energy supply to support national development Green Energy Policy (2004) • Provide sufficient supply to satisfy needs of the community • Secure sufficient supply for future generation
Malaysia Five-Fuel Diversification Policy (2000) • Renewable Energy as the fifth fuel • Ensure reliability and security of supply • Balance energy supply mix • Protect the environment
Philippines Renewable Energy Policy Framework (2003)

• Reduce the country's dependence on imported energy • Broaden resource base • Save foreign exchange and reduce emissions
Singapore National Energy Efficiency Committee (2001) Address the increasing energy consumption • Promote energy conservation; use of cleaner energy sources and renewable energy; promote test-bedding of pioneering energy technologies and commercialisation of energy technologies
Thailand Strategic Plan for Renewable Energy Development (2003) • Seek alternative to fossil fuels • Reduce import and save foreign exchange • Reduce environmental impacts • Optimise the value of domestic energy resources
Vietnam Rural Electrification Policy (2001) • Provide electricity services in the rural areas, either grid-based or off-grid, to improve the living conditions of the rural population and ability to earn household income as well as to reduce poverty in the rural areas

Source: author's construction based on (Finon, 2006)

Feed in Tariff

Feed in tariff (FiT) is a major instrument for promoting the generation of electricity from RES for many decades in Europe countries. FiT also called as a regulatory, which is a minimum guaranteed price per kWh of electric utility that has to put to the private sector, independent producer of renewable electricity. The concept of FiT is the total amounts of electricity per kWh received by the independent producer of renewable electricity including the production subsidies add to the market price of electricity but it's excluding the tax rebate because the government pays it.

There are many variables that vary the cost of FiT and its difference with every country that implements FiT. The FiT cost is depended on the renewable energy technology used, variable time, season of feeding renewable energy, national characteristic, potential cost, cost of RES (Finon, 2006). Feed in tariff policy was implemented more than 40 countries worldwide, but the most successful renewable energy market is in Germany and Spain. The FiT was experiences in European countries begin to demonstrate the proper FiT because it more costs effectiveness. Feed in tariff supply policy is focusing on the development of RES generation. The feed in tariffs have two designs which are fixed price and premium price, the premium price also called as 'spot market gap'(Held et al., 2006). However, some ASEAN member implemented FiT as it is the best economic concept for renewable energy cost. In this further project, there will be a model that can calculate and forecast the FiT and others' economic concept of renewable energy. The model is called Green-Y model.

Methodology

The material in this project is designed and simulates the solar PV and Biomass by using preliminary Green-Y model by excels software. The green-y then calculates the feed-in tariff of solar power and biomass system. The total cost includes the investment cost, fuel cost, operation and maintenance's cost and total installed cost. The feed-in tariff is found from the variety of equation, which includes the total cost, annual digression, and period of the RES. The analysis is based on the FiT in Malaysia.

Green-Y model

The appropriate relevant parameters are one of the important keys to calculate the cost generation. The most important parameters when determining the generation cost are (De Silva, 2012).

- Investment and operational costs
- Full load hours
- Fuel price (biomass)
- Discount rate
- Expected return on equity
- Electricity price

The Green-Y model basically calculates by the amount of net present value (NPV) as shown in Equation 1 and Equation 2 together analysis over the payback period in Equation 3.

$$NPV = \sum_{t=2030}^{t_0=2010} \frac{\left(\frac{income}{year}\right) - \left(\frac{\cos tO\&M}{year}\right)}{(1+r)^{t-t0}} - Investment\cos t \quad (1)$$

$$NPV = -S + \sum_{J=1}^{N} \frac{(Q_j)}{(1+i)^J} \quad (2)$$

$$NPV = -S + \frac{Q_1}{(1+I)} + \frac{Q_2}{(1+I)^2} + \ldots + \frac{Q_N}{(1+I)^N} \quad (3)$$

Where:
I = Discount rate = interest rate + inflation rate
N = Lifespan of renewable energy in year
J = Specific year for calculation

Photovoltaic cost analysis in Malaysia

In order to determine the FiT cost, the generation cost per technology must be known then the FiT can be fixed accordingly. Therefore, the NPV has to assume to be zero or no net present value. All the parameters need to calculate personally before put into the Green-Y equation. The full load is estimated to be 10 hours / day and approximately 3760 hours/year. While, the cost for O&M is the cost of operation and maintenance and it is estimated with Rm

2400/kW/Year. Besides that, the investment cost or the project cost is approximately Rm 104000/kW and the interest rate; r is about 6% or equivalent to 0.06. The total duration of the entire estimation takes about 21 years starting from 2010 with the annual digression about 8% (2010 to 2013) and 10% (2013 to 2030). Table 5 shows the parameters that need to be considered for conducting economic analysis on a photovoltaic system.

Table 5

Important parameters for the photovoltaic system

Parameters	Values
Capacity (kW)	4
Full load hours/year	3760
Investment cost (Rm/kW)	104000
Operation and maintenance cost (Rm/kW/year)	2400
Interest rate, r (%)	6
Duration of support, t (years)	21
Feed-in tariff (Rm/kWh)	?
Annual Digression %	8 (2010 to 2013) 10 (2013 to 2030)

Source: Authors' construction

Research results and discussion

The example of FiT calculation for year 2010 is enclosed in the following. However, the FiT for the year 2011 to year 2030 can be calculated subsequently by following the example as stated.

$$NPV = 0$$

$$\frac{income}{year} = Capacity * Full\_load * FiT^{*} = 4 * 3760 * FiT = 15040FiT$$

$$\frac{CostO\&M}{Year} = 2400\left(\frac{Rm}{kW.Year}\right)$$

$$0 = \sum_{t=2030}^{t_0=2010} \frac{(15040 * FiT) - (2400)}{(1+0.06)^{2010-2010}} - 104000$$

$$\frac{FiT}{AnnualDigression(8\%)} = 7.0745$$

$$FiT = 8\% * 7.0745$$

$$FiT = 0.56596\ Rm/kWh$$

According to the graph provided in Fig. 3, the FiT for photovoltaic is increasing by years. The FiT initially is low as the value of 0.599 Rm/kWh and it started to increase by years up to 2.367 Rm/kWh in 2030. The proportional increment showed that the capital FiT for photovoltaic system is successful and reliable.

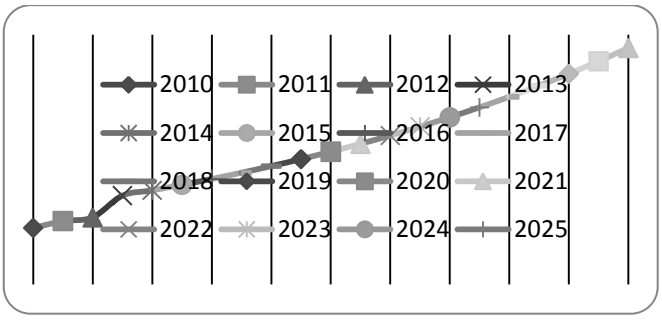


Fig. 3. **The predicted FiT values for year 2010 to 2030**
Source: Authors' construction

Therefore, ASEAN countries including Malaysia are expected to play an important role in the global energy market for the upcoming years. Primarily, the consumption energy demands in ASEAN will be expanded to 76% between 2007 and 2030 with the annual growth rate of 2.5%. This is the highest statistical analysis as compared to the rest of the world (Birol, 2010).

Conclusions

Most of the ASEAN countries have undertaken the step toward sustainability, saving energy resources for the next generation. ASEAN countries start to emphasize in implementing the policies and start to develop the model for the economic concept of renewable energy that covered all economic analysis of generating electricity from RES. ASEAN countries, especially Malaysia has shared some feed in tariff, RES potential and RES utilization. Some countries in ASEAN to implement FiT but some they do not implement FiT as it is depending on their policies. Green-Y model shows the simple and reliable calculation of FiT for the photovoltaic application in Malaysia.

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References

AL JABER, S. A., AMIN, A. Z., CLINI, C., DIXON, R., ECKHART, M., EL-ASHRY, M., PRADHAN, S. G. B., HADDOUCHE, A., HALES, D. & HAMILTON, K. 2012. Renewables 2012 Global Status Report. *In:* SECRETARIAT, P. R. (ed.).

BIROL, F. 2010. World energy outlook 2010. *International Energy Agency*.
DE SILVA, T. S. P. 2012. Develop strategies to increase the Non Conventional Renewable Energy power generation in Sri Lanka above 10% level by the year 2015.
ESSAYS, U. 2013. *A Solar Plant To Promote Eco Tourism Tourism Essay* [Online]. Available: http://www.ukessays.com/essays/tourism/a-solar-plant-to-promote-eco-tourism-tourism-essay.php.
FINON, D. 2006. The social efficiency of instruments for the promotion of renewable energies in the liberalised power industry. *Annals of Public and Cooperative Economics*, 77**,** 309-343.
FÜRSCH, M., GOLLING, C., NICOLOSI, M., WISSEN, R. & LINDENBERGER, D. 2010. European RES-E Policy Analysis-A model based analysis of RES-E deployment and its impact on the conventional power market. *Institute of Energy Economics at the University of Cologne (EWI). Cologne, Germany*.
HELD, A., RAGWITZ, M. & HAAS, R. 2006. On the success of policy strategies for the promotion of electricity from renewable energy sources in the EU. *Energy & Environment*, 17**,** 849-868.
HOOGWIJK, M., FAAIJ, A., VAN DEN BROEK, R., BERNDES, G., GIELEN, D. & TURKENBURG, W. 2003. Exploration of the ranges of the global potential of biomass for energy. *Biomass and bioenergy*, 25**,** 119-133.
MARTINOT, E. 2005. *Renewables 2005: Global status report*, Worldwatch Institute Washington, DC.
PACUDAN, R. 2005. Information for the Commercialisation of Renewables in ASEAN (ICRA).
SIEMINSKI, A. 2014. International Energy Outlook. *Energy Information Administration (EIA)*.
SURYADI, B. 2012. Will ASEAN realize its 2015 renewable energy goals. *The energy collective*.