World Academy of Science, Engineering and Technology
International Journal of Educational and Pedagogical Sciences
Vol:9, No:2, 2015

Green-Y Model for Preliminary Sustainable Economical Concept of Renewable Energy Sources Deployment in ASEAN Countries

H. H. Goh, K. C. Goh, W. N. Z. S. Wan Sukri, Q. S. Chua, S. W. Lee, B. C. Kok

***Abstract*—**Endowed of renewable energy sources (RES) are the advantages of ASEAN, but they are using a low amount of RES only to generate electricity because their primary energy sources are fossil and coal. The cost of purchasing fossil and coal is cheaper now, but it might be expensive soon, as it will be depleted sooner and after. ASEAN showed that the RES are convenient to be implemented. Some country in ASEAN has huge renewable energy sources potential and use. The primary aim of this project is to assist ASEAN countries in preparing the renewable energy and to guide the policies for RES in the more upright direction. The Green-Y model will help ASEAN government to study and forecast the economic concept, including feed-in tariff.

***Keywords*—**ASEAN RES, Renewable Energy, RES Policies, RES Potential, RES Utilization.

I. 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 nations in Asia are using fossil and coal as their main roots to generate electricity instead of using renewable energy. They are precisely utilizing a modest quantity of renewable energy resources to get electricity. Currently, most of the governments are implementing more RES to generate electricity as it is environmental protection, energy access improvement and energy security enhancement.

Some nations in ASEAN are proposing policies' model of generating performance based electricity inducement that synthesizes these policies contained by the context of better renewable energy practice framework, policy instrument and sustainable economic concept. The primary aim of this paper is to assist ASEAN, mainly for Malaysia's government in developing the implementation of renewable energies and to guide a Malaysia policy for RES in the mid to long condition. 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, the integration of best RES policies with climate and innovation policy as well as the liberalized energy market is likewise part of the objective in this research study. 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 underpin a long term vision of ASEAN RES policy.

H.H.Goh, Q.S.Chua, S.W.Lee and B.C.Kok are with the Department of Electrical Power Engineering, Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia (corresponding author phone: +60(167416824); e-mail: hhgoh@uthm.edu.my).

K.C.Goh and W.N.Z. Shahida are with the Department of Construction Managment, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia.

II. Renewable Energy Resources and Policies

Renewable energy and RES policies in ASEAN regions have been developing over the last two decades ago that shared some feed-in tariff design features, RES potential and RES utilization. Economics of RE growth has increased in energy consumption up to 3.6% per annum since 1995 to 2007 [1]. This segment reviews the involvements of RES in each country's policies and a summary table of the energy consumption and feed in tariff data.

A. Wind Energy Resources

Wind power is one of the most established among others' RES as its capacity increases up to two times every 3 years and the technology cost of constructing wind turbine decline. The wind capacity cost for onshore is US$850-950/kW and capacity cost for offshore is US$1,100-1,200/kW [2]. Table I showed the wind resources potential and utilization among of ASEAN countries such as Vietnam, Philippines, Thailand, and Indonesia. All these countries indicate the huge measure of potential in wind energy and relatively small in utilization.

TABLE I
Potential and Utilization of Wind Energy Resources [3]

Country	Potential	Utilization
Vietnam	**Theoretical Potential** 103 GW 8.7 GW 452 MW	-
Philippines	**Theoretical Potential** 76,600 MW **Technical Potential** 7,404 MW	1.18 MW
Thailand	**Theoretical Potential** 3 GW 52 MW	0.7 MW
Indonesia	**Technical Potential** 1,600 MW **Theoretical Potential** Significant	0.5 MW

B. Solar Energy Resources

Southeast Asia's countries are really popular with the sunny weather and solar energy resources. Approximately 4-7

kWh/m^2 daily of solar radiation have been produced [4]. Most of the ASEAN nations are using solar photovoltaic technologies as alternative resources of generating electricity, particularly for water pumping, street lighting, telecommunication network, and dwelling. Table II indicates the solar energy resources potential and use of high penetration regions in the Philippines, Vietnam, Malaysia, Indonesia and Thailand. [5].

TABLE II
POTENTIAL AND UTILIZATION OF SOLAR ENERGY RESOURCES [3]

Country	Potential	Utilization
Vietnam	5 kWh/m^2/day 2MW	0.6 MW
Philippines	5.1 kWh/m^2/day	1 MW
Thailand	> 5,000 units of solar PV	6 MW
Indonesia	4.8 kWh/m^2/day	5 MW
Malaysia	4.5 kWh/m^2/day	1.5 MWp 450 kWp

C. Hydropower Resources

The hydropower resource is one of the most worldwide RES that have been carried out in virtually every province, including Southeast Asia. Hydroelectric power (large to micro) is available in most of the ASEAN countries as shown in Table III. Even though there is a great deal of micro hydro resources in most of the countries, its utilization energy is comparatively depressed [5].

TABLE III
POTENTIAL AND UTILIZATION OF WIND HYDROPOWER RESOURCES [5]

Country	Potential	Utilization
Vietnam	**Theoretical Potential** 800 – 1400 MW 90 – 150 MW 400 – 600 MW	110 – 155 MW 20 MW 60 MW 30 – 75 MW
Philippines	**Theoretical Potential** 11,223 MW 1,847 MW 27 MW	2,867 MW
Thailand	**Theoretical Potential** 700 MW	139 MW
Indonesia	**Theoretical Potential** 75,000 MW 459 MW	4,200 MW 64 MW
Malaysia	**Technical Potential** 29,000 MW	2,026 MW 40 MW

TABLE IV
POTENTIAL AND UTILIZATION OF BIOMASS RESOURCES [5]

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

D. Biomass Energy Resources

Biomass derived from the dead plant, agricultural and forestry residues, municipal waste and animal residues. The energy that can be generated in ASEAN depending on the production structures itself as the resources of the residue is varied from country to country. Table IV shows the biomass energy resources potential and utilization in ASEAN.

From Table IV, the potential of biomass energy resources is high in a certain country such as Indonesia, Thailand and Malaysia. However, the use of biomass energy resources is low.

E. Geothermal Energy Resources

Geothermal energy is the energy that comes naturally from the earth, heat from the core of the earth. Currently, ASEAN has total capacity 2519.5 MW geothermal electricity, which totals 1922 MW from Philippines and 587.5 from Indonesia [6]. The geothermal energy resource potential of the Philippines and Indonesia also shows the highest score among others as shown in the Table V. The monetary value of generating power from the geothermal resource is approximate US$0. 025 per kWh and the monetary value of generating steam is US$0. 035/ton.

TABLE V
POTENTIAL AND UTILIZATION OF BIOMASS RESOURCES [5]

Country	Potential	Utilization
Vietnam	**Theoretical Potential** 200 – 340 MW	-
Philippines	2600 MW	1931 MW
Thailand	-	1 MW
Indonesia	**Theoretical Potential** 27,000 MW	802 MW

III. RENEWABLE ENERGY TARGET AND STRATEGIES

Every country in ASEAN has their renewable energy target and goal. Putting up their renewable energy policy strategies is one of the keys to achieve the target and destination. For instance, all 27 members of the European Union (EU) set their 2020 target to 20% of establishment energy efficiency [7]. ASEAN countries also have prescribed the renewable energy target with several strategies to advance the renewable energy development. The schemes and target are a long term direction, and it is a correct signal to the world marketplace. Table VI shows the renewable energy strategy and targets in Southeast Asia's countries. In parliamentary law to achieve the renewable energy developmental goals, the specific renewable energy policy framework has been set up in each of the ASEAN countries. Every framework of ASEAN shows the current government concern, renewable energy development status, development concern and etc. Table VII shows the policies promoting renewable energy development.

IV. FEED IN TARIFF OF RENEWABLE ENERGY RESOURCES IN ASEAN

Feed in tariff is a policy of renewable energy technology mechanism design to quicken investment in the figure of total price per energy unit (e.g. kWh). The objectives of the feed-in tariff are for compromising co-based profitable for renewable energy producers, long term contract of investment renewable energy, and providing cost certainty [9]. Feed-in tariff system usually is combined with priority access to the electricity

power system and a definite purchase of RES; these will pay additional security of investor [7]. Every government of ASEAN has the right to decide their FiT of renewable energy. Some ASEAN countries, they don't implement FiT, as they claim it will give burden to their people. Nevertheless, some ASEAN members implemented FiT as it is the best economic concept of renewable energy cost. Table VIII shows the Feed in tariff of renewable energy 2013 in ASEAN countries.

TABLE VI
RENEWABLE ENERGY STRATEGY AND TARGET [8]

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 10MMBFOE 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

In further project, there will be a good example that can count and forecast the FiT and others' economical concept of renewable energy. The model is called Green-Y model.

TABLE VII
POLICIES PROMOTING RENEWABLE ENERGY DEVELOPMENT [8]

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 commercialization 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

TABLE VIII
FEED-IN TARIFF OF RENEWABLE ENERGY IN ASEAN [10]

Countries	Feed-in Tariff (at June 2013) (USD/kWh)			
	Hydropower	**Wind**	**Solar**	**Biomass**
Indonesia	0.07	-	-	0.09 to 0.01
Malaysia	0.00	-	0.100 to 1.08	1.26
Philippines	0.13	0.20	0.220	0.15
Thailand	0.03 to 0.05	0.11 to 0.14	0.21	0.01 to 0.02
Vietnam	-	0.078	-	-

V. CONCLUSION

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 prepare the model for the economic concept of renewable energy that spread over all economic analysis of generating electricity from RES. ASEAN countries have shared some feed in tariff, RES potential and RES utilization. Some countries in ASEAN implement FiT but some they don't implement FiT as it's depend on their policies. The Green - Y model will be implemented in order to examine the economic concept and forecast the feed-in tariff of RES.

ACKNOWLEDGMENT

The authors would like to thank the Ministry of Education, Malaysia (MOE), Ministry of Science, Technology and Innovation, Malaysia (MOSTI), and the Office for Research, Innovation, Commercialization, Consultancy Management (ORICC), Universiti Tun Hussein Onn Malaysia (UTHM) for financially supporting this research under the Fundamental Research Grant Scheme (FRGS) Vot. No.1417 and Science Fund grant No.S023.

REFERENCES

[1] Beni Suryadi (2012): will ASEAN realize its 2015 renewable energy goals. – Available at http://theenergycollective.com/benisuryadi/95741/asean-races-152015-smes
[2] IEA (2003): Energy in Southeast Asia: Available at http://www.iea.org/Textbase/npsum/WEO2013SUM.pdf (IEA1)
[3] Nguyen, M., H. (2009) Status of Renewable Energy in the AASEAN Region. ASEAN Centre for Energy Power Point (2009); 12-13 Available at http://www.globalmobiletech.com/en/html/Files/091118_ASEAN_policies.pdf
[4] UK Essays (2003): http: A solar plant to promote eco-tourism essay-update 2014. Available at //www.ukessays.com/essays/tourism/ a-solar-plant-to-promote-eco-tourism-tourism-essay.php
[5] N.W.A. Lidula, N. Mithulananthan, W. Ongsakul, C. Widjaya, R. Henson (2007). ASEAN towards clean and sustainable energy: potentials, utilization and barriers. Renewable energy journal 2006; 10.1016/j.renene.2006.07.007.
[6] Vincent T. Radja (1990). The ASEAN geothermal outlook and future prospects of development and utilization. Available at: http://geothermalinmalaysia.files.wordpress.com/2013/11/the-asean-geothermal-outlook-and-future-prospects.pdf
[7] Fursch. M, Golling. C, Nicolosi. M, Wissen. R, Lindenberger. D (2010).European RES-E Policy Analysis. Journal of institute of energy economics at the University of Cologne.
[8] Romeo Pacudan (2005) : Renewable energy policies in ASEAN thesis.
[9] Fulton. M. Bruce M.K., Mellquist N., Soong E., Baker J., Cotter L. (2009). Feed-in Tariff. Report of paying for renewable energy: TLC at the right price.
[10] Renewable Energy in the Asia Pasific, January 2014. A Legal Overview.