ROLES OF SINGLE BUYER IN SUPPORTING RENEWABLES -THE MALAYSIA'S EXPERIENCE

Nor Ziha Zainol Abidin
Single Buyer Department, Tenaga Nasional Berhad
129, Jalan Bangsar, 59200 Kuala Lumpur, Malaysia, norziha@tnb.com.my
Joon B. Ibrahim
Single Buyer Department, Tenaga Nasional Berhad
129, Jalan Bangsar, 59200 Kuala Lumpur, Malaysia, jooni@tnb.com.my

ABSTRACT

Renewables have become the emerging source of energy. The sustainable and environmental friendly energy is rapidly becoming more pronounced to alleviate the damaging effect of burning hydrocarbon fuels. For some countries, the utilization of renewables also helps to minimize the dependency on imported fuels. For Malaysia, the recent tariff hikes has triggered interest from general public to explore the possibility of generating their own electricity from solar resources.

This paper highlights the roles of Tenaga Nasional Berhad in supporting renewables, particularly Utility-Scale Solar PV, with the focus on the Single Buyer, as the sole power purchasing agency for Malaysia Electric Supply Industry (MESI). A brief review of the status of renewables in Malaysia and government policies that supports the development of renewables is also discussed. The paper next makes comparisons with countries with similar Electricity Supply Industry (ESI) structure. The paper subsequently analyzes how the roles of Malaysia's Single Buyer can be further enhanced to support the country's renewables initiatives.

KEYWORDS: ***renewables, Utility-Scale Solar PV, Single Buyer, MESI, energy policy, energy mix***

1. INTRODUCTION

Renewables have become the emerging source of energy. The sustainable and environmental friendly energy is rapidly becoming more pronounced to alleviate the damaging effect of burning hydrocarbon fuels. For some countries that heavily rely on imported fuels, harnessing the renewables resources helps to minimize the dependency on imported fuels that is susceptible to price volatility. For these reasons, countries worldwide have reformulated their energy policy and diversifying their energy mix to include a significant percentage of renewable energy. Germany for example, is one of the leading countries in renewable energy sector. The country has achieved twenty-five (25) percent share of electricity produced by RE in first half of 2012 and is targeting thirty-five (35) percent of electricity from renewables by 2020 [1] [2]. Malaysia is not an exception. The country is blessed with natural resources including renewables like hydro potential and solar energy. As a testimony to Malaysia's commitment in advocating green energy, the country has rolled out several renewables programs to support its policy. At the same time, as the incumbent utility, Tenaga Nasional Berhad (TNB) has been playing its part in supporting renewables. With the recently announced tariff hikes, TNB is facing a stronger pressure from the general public and authorities to enhance its participation in supporting renewables.

2. OBJECTIVE

This paper attempts to analyze the roles of Single Buyer in supporting the Utility-Scale Solar Photovoltaic (PV) generation. In doing so, the paper examines the potential integration challenges associated with high penetration of Utility-Scale Solar PV that may be encountered by Single Buyer in discharging its duty. The paper finally proposes some recommendations to enhance the role of Single Buyer in anticipating higher penetration of Utility-Scale Solar PV.

3. SCOPE AND LIMITATION

Renewables itself is a broad topic that spans across multiple disciplines. In fact, there are already numerous papers published that discuss renewables in Malaysia in great detail. Hence, this paper focuses only on Utility-Scale Solar PV generation, connected to the Peninsular Malaysia's transmission grid, as the imminent player that will change the landscape of Malaysia's generation sector. Discussion is centered on the impact of the Utility-Scale Solar PV on the functions of Single Buyer particularly and on MESI in general.

4. OVERVIEW OF MALAYSIA'S POWER SECTOR

To better appreciate the subject matter, it is imperative to gain some insight on the Malaysia Electricity Supply Industry (MESI). The industry has undergone a structural reform from a predominantly single player entity into a multiplayer industry [3]. The power sector has been transformed from a vertically-integrated industry into a Managed Market Model (M3). This effort is a testament to the government's continuous effort to deliver reliable and affordable electricity to the consumers.

Under M3, the account of Tenaga Nasional Berhad (TNB) is unbundled into five business entities: TNB Generation, System Operator (SO), Single Buyer (SB), Transmission, and Customer Services [4]. These business entities are regulated under Incentive Based Regulation (IBR) to extract efficiency from this natural monopoly. At this juncture, MESI is currently in a Trial Period for IBR for one year until end of 2014 and the first Regulatory Period will commence subsequently for the period of three years.

The Managed Market Model allows Single Buyer to remain within TNB provided that it is ring-fenced. The ring-fencing requirement is necessary to ensure transparency in its dealing. To fortify the ring fencing arrangement, Suruhanjaya Tenaga (ST) as the regulator has a direct supervision on the operation of SB to ensure compliance to the Single Buyer Rules (SBR) through the Oversight Panel [5].

In the following sections, the roles of Single Buyer are further elaborated particularly in the generation capacity planning and as the exclusive power purchaser.

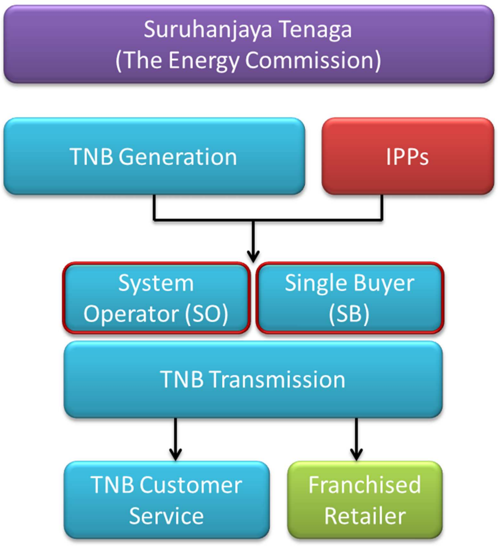

Figure 1: Malaysia ESI Structure

5. ROLE OF SINGLE BUYER IN GENERATION CAPACITY PLANNING

Under the Managed Market Model (M3), there are essentially two distinct entities responsible for procuring new generation capacity, Single Buyer and Suruhanjaya Tenaga. These functionalities are specified in the Single Buyer Rules (SBR), a set of rules that governs the operation of Single Buyer.

Single Buyer is responsible for the electricity demand forecast and the generation capacity planning while Suruhanjaya Tenaga is specifically tasked to acquire the new generation capacity identified earlier by Single Buyer via Competitive Bidding exercise [6]. The proceeding subsections briefly describe the generation procurement process in Malaysia.

5.1. Assessment of Long –Term Supply And Demand

The generation procurement process begins with the long-term electricity demand forecast as it fundamentally provides the information to decide on needs for future generation investment and the associated transmission reinforcements. The key assumptions used in conducting the demand forecast study include the economic and population growth, key industrial and commercial developments, and other important parameters such as the Government policy that could potentially impact the electricity growth in Peninsular Malaysia. The outputs of demand forecast study are The Demand Supply Forecast Reports which Single Buyer submits to Suruhanjaya Tenaga for approval and later serve as inputs to the subsequent process.

Based on the electricity demand projection, the next step is to conduct Generation Capacity Planning Study to decide on the timing and type of generation plants needed to meet the generation shortfall in the future. The reliability index, loss of load probability (LOLP) is used as the main criteria to evaluate the adequacy of generation supply to support the forecasted demand. Other factors, such as the operating reserve requirement, plant and fuel availability, plant retirement and project lead time are also considered as they certainly influence the outcome of the generation planning study.

In planning for the future generation plant up, only the conventional plants are considered as the candidates. The obvious reason is that these types of plants, such as coal, gas thermal and hydro plants are dispatchable and able to provide a dependable capacity. A plant that is dispatchable and dependable means that it is controllable by the System Operator and can be switched on and off, depending on the price, to meet the demand and to maintain the reliability of the network [7].

5.2. Contracting For New Capacity

The Generation Capacity Planning Study, conducted by Single Buyer, identifies any generation shortfall in meeting the future demand. If new generation capacity is required, Suruhanjaya Tenaga will undertake the responsibility to contract for new capacity through an International Competitive Bidding (ICB). The exercise begins with initiation of the tendering process, until the contract is awarded to the winning bid.

EC successfully completed three ICB exercise since its introduction in January 2012. The first ICB, termed Track 1, involved a new capacity of 1,071MW combine cycle plant in Prai at a levelized tariff of 34.7 sen/kWh scheduled to be commissioned in 2016. The second ICB or Track 2 was offered to three bidders for the renewal to operate existing plant with high level of reliability at competitive prices [8]. The third ICB exercise comprised two packages, Track 3A and Track 3B. Track 3A entailed development of a 1,000MW supercritical/ultra-supercritical coal fired power plant on a brownfield site scheduled for commissioning in October 2017. The latter is the development of 2,000MW coal plant on a greenfield site and is scheduled for operation in April 2019 [9].

The ICB exercise has achieved its objective to create a level playing field in the generation sector and eventually fulfill the government's aspiration to deliver a reliable electricity supply to the nation at a competitive rate.

6. SINGLE BUYER AS THE SOLE POWER PURCHASING AGENCY

Single Buyer is the entity sanctioned by Suruhanjaya Tenaga (ST) to be responsible for the management of electricity procurement and related services [5]. To further elaborate, Single Buyer is the entity entrusted to procure electricity from both the IPPs and TNB Generation, dispatch the generators based on a dispatch merit order and consequently produce the dispatch schedule. In performing its function, Single Buyer shall demonstrate transparency and impartiality at all times.

As outlined in the Single Buyer Rules, one of the fundamental roles of Single Buyer is to procure electricity to meet the demand on the least cost basis. To realize this role, Single Buyer shall produce Dispatch Schedules ranging from Day Ahead, Week Ahead to Three Month Ahead Dispatch Schedule. These Dispatch Schedules shall be developed based on a Least Cost Dispatching Scheduling Methodology (LCDSM). The methodology specifies that the Generating Unit with the lowest marginal cost is to be dispatched first followed by the next lowest marginal cost unit until all demand is met. The Dispatch Schedules shall also be designed to ensure the security and reliability of electricity supply which includes adequate provisions for system security, operating reserve, transmission and generation constraints and fuel availability.

The underlying principle of LCDSM is to minimize the generation cost, subject to various constraints. Hence, the strategy is to select the cheapest possible combination of generating units to meet the demand at all times. This method does not discriminate between the types of plants to be dispatched; as long as the plant is cheap, it will be run first. LCDSM is consistent with the Least Cost Operation outlined in the Malaysian Grid Code [10].

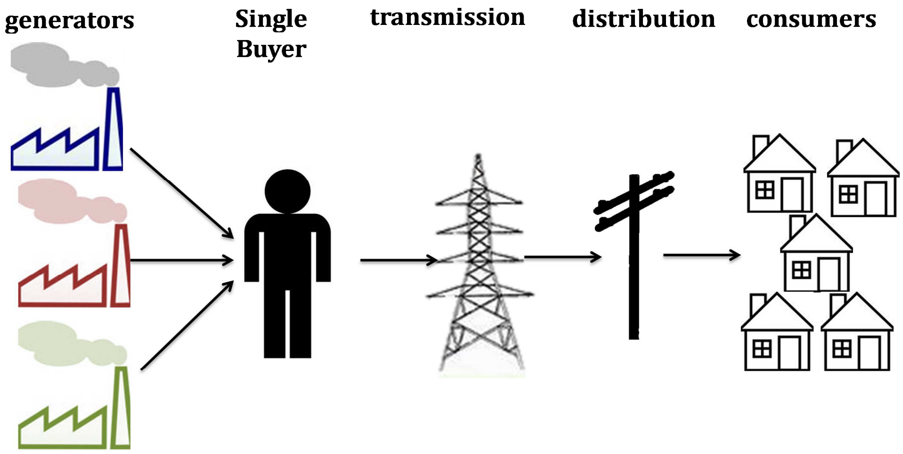

Figure 2: Single Buyer as the power purchasing agency

7. STATUS OF RENEWABLES IN MALAYSIA

7.1. Development of Malaysia's Renewables Acts and Policies

Malaysia is committed to promoting renewables to be part of the electricity generation mix since the 8th Malaysia Plan in 2001. Recognizing renewables as the fifth fuel besides oil, gas, coal and hydro, the country has targeted five percent (5%) of total generation capacity to come from renewables by 2005, thereby reducing 70 million tons of CO_2 emission within 20 years [11] The government's interest to develop solar energy was further manifested in the succeeding 9th Malaysia Plan in 2006, where 300MW of renewables capacity is targeted to be connected to the power utility-grid in Peninsular Malaysia [12]. In 2010, the introduction of National RE Policy and Action Plan (NREPAP) from the 10th Malaysia Plan has further encouraged the development of renewables in the country. In the longer term, NREPAP essentially aimed to achieve thirteen percent (13%) share of renewables capacity by 2030 [13] .

Despite relentless initiatives to promote renewables for power sector, the, the response in terms of renewables development projects is slow [14]. Among the reasons identified for the sluggish response were 1) failure of renewables markets due to the monopsony power of the utility, 2) economical, financial and technological factors that constrains the market performance, 3) absence of proper regulatory framework, and 4) limited oversight to oversee the implementation problems [15]. Consequently, in 2011, the Parliament has passed Renewable Energy Act 2011 and Sustainable Energy Development Authority (SEDA) Act 2011 to spur the growth of renewables in a more aggressive manner. The renewable bill provides for the implementation of Feed-in Tariff (FiT) program, while the latter results in the establishment of SEDA Malaysia to oversee the implementation of FiT mechanism.

Moving forward, the ministry is drafting two more policies, namely the Net Metering (NEM) and Utility-Scale Solar PV Policies, which aim to increase the share of renewables in the electricity generation.

Figure 2: Development of RE Acts and Policies in Malaysia

7.2. RE programs in Malaysia

To drive these policies, Malaysia has rolled out several renewables programs since 2001. This section elaborates some of these programs.

a. SREP- Small Renewable Energy Power Program (SREP) was launched in 2001 as a support mechanism to intensify the use of renewables as the fifth fuel under the five-fuel policy provides for in the 8th Malaysia Plan. Under this program, the small RE power producers (of 10MW and below) are eligible to sell electricity to the utilities, Tenaga Nasional Berhad (TNB) in Peninsular Malaysia and Sabah Electricity Sdn.Bhd (SESB), via the distribution network under 21-year of licensing agreement. The developer of the plant, which covers renewables resources from solar, biomass, biogass, municipal waste, wind and mini-hydropower, could apply to sell the energy to the grid on the basis of "willing seller willing buyer". Concluded in 2010, SREP has only managed to connect 61.2MW to the grid [11].

b. MBPIV- Launched in 2005, the Malaysian Building Integrated Photovoltaic Technology Application Project (MBIPV) was aimed to promote the utilization of PV technology, by harnessing solar energy, to generate electricity for buildings. Initiated by the 9th Malaysia Plan, the project was a collaborative effort between Malaysia and the United Nations Development Program (UNDP) and Global Environmental Facility (GEF). The MBIPV project marked a critical milestone in the implementation of the much later FiT program where it proposed to consider FiT as one of potential renewables policies for Malaysia [16]. The project was successfully concluded in 30th September 2010

c. FiT- Following the enactment of RE Act 2011 and SEDA Act 2011, the Feed-in Tariff (FiT) program was introduced to encourage the public to generate electricity from renewable resources. Under the Malaysia's FiT mechanism, the utilities are obliged to purchase the electricity produced by the FiT Approval Holder at a fixed premium FiT rate [17]. Funding for this project comes from RE fund of which 1.6% additional charge is imposed on the customers' electricity bill. The renewables resources eligible for FiT program are biogas, biomass, small hydropower and Solar PV [18]. The program received an overwhelming response from the public, thanks to the premium FiT rate offered when it was first introduced in December 2011. To date, there is a total of 82,814.45 MWh of renewables generated under FiT program in 2014, resulting in CO_2 avoidance of 403,655.02 tons [19] [20] .

8. INTEGRATION CHALLENGES WITH UTILITY-SCALE SOLAR PV IN MALAYSIA

Malaysia's potential in solar generation is substantial [21]. The country's solar insolation per year ranges from 1400 to 1900kWh/m2/year, and averaging about 1643kwh/m2/year with more than 10 sun hours per day [22][23][24].

So far, Malaysia's experiences are mainly with the small-scale Solar PV generation that connects directly to the distribution network. The effect of Distributed Generations (DG) is manifested through reduction in the overall demand as they offset the load served by the utility. With low penetration level, these decentralized generations pose minimal threat or challenges to the operation of the grid.

However, similar claim cannot be said when dealing with Utility-Scale Solar PV. Unlike the conventional plant, the variability and intermittency of Solar PV generation brings new challenges in power system operation [25]. This section discusses the prevailing concerns surrounding Utility-Scale Solar PV and the expected integration challenges particularly when the penetration level becomes significantly high.

8.1. Malaysia's First Utility-Scale Solar PV Generation

Despite many accomplished and ongoing small –scale renewable projects, Malaysia's experience in Utility-Scale renewables is still at the infancy stage. The country has recently seen its first Utility-Scale Solar PV generation with the signing of the Power Purchase Agreement (PPA) between TNB as the offtaker and the developer, 1MDB Sdn. Bhd. (1MDB) to design, build, own, operate and maintain a 50MWac Solar PV generating facility [26]. The plant, which is scheduled for commissioned in 2016, will be injected to the 132kV transmission network.

Being the pilot project for a Utility-Scale Solar PV generation, the project forms part of initiatives to support the national agenda for the development of renewable energy in Malaysia.

8.2. Impact Of Utility-Scale Solar PV On The Grid Operation

Solar PV is an intermittent source of energy. The electricity produced by this technology varies throughout the day and highly dependent on uncontrollable natural factor such as cloud cover, haze and other weather conditions. Consequently, Solar PV plants cannot be readily controlled by the System Operator in the similar manner with the conventional plants. This characteristic has made Solar PV neither dispatchable nor dependable. Rather, to maintain supply-demand balance, the conventional plant has to be maneuvered more so as to response to the variability of Solar PV [27].

In the early days, where the focus of Solar PV output was entirely on the energy production, the functions of the grid-connected inverter were rather fundamental. Other than its main function to convert the variable direct current (DC) output of Solar PV into the grid-frequency alternating current (AC), the grid-connected inverter is also designed with maximum power point tracking (MPPT) for maximum solar power harvesting.

Today, align with the rapid growth of the solar industry, the grid system experiences higher penetration of solar PV generation, posing a new level of challenge to the grid operator to manage the increasing number of this type of variable generation. With this consideration, today's generations of inverters are also expected to provide ancillary services to support grid stability. Some of the key grid interaction controls and capabilities that Solar PV inverters must provide include power factor and reactive power support, high frequency MW response and fault ride through capability.

However, the supplementary yet imperative functionalities of the Solar PV inverter to ensure a stable grid operation may significantly add up to the cost of solar energy production.

8.3. Impact Of Utility-Scale Solar PV On The Merit Order Dispatch

Section six of this paper deliberates on the Least Cost Dispatching Scheduling Methodology (LCDSM) adopted by Single Buyer in producing the Dispatch Schedules. In Single Buyer Rules (SBR), any plant defined as a Generating Unit is subjected to LCDSM. By SBR definition, a Generating Unit is any plant capable of producing electricity with a minimum nameplate rating of 30MW and connected to the Grid System in Peninsular Malaysia, including a CCGT. By this virtue, a Utility-Scale Solar PV plant must be treated as a Generating Unit and thereby subjected to LCDSM. But what if the generation cost of Utility-Scale Solar PV is not cheap? If the price of a Utility-Scale Solar PV is higher than the system marginal cost, the plant may not be dispatched at all. In the case of a solar PPA that only pays for energy charge, the plant may not be able to recover its cost since it does not receive capacity payment, but relies only on the energy payment. If it is not dispatched, then it will not generate income. Looking at the present situation, Solar PV in Malaysia has not reached grid parity; therefore, this risk is very real.

In another possible scenario, consider a Utility-Scale Solar PV plant as a ‘must-run’ unit in which the plant must be dispatched whenever solar generation is available. In this scenario, having a Utility-Scale Solar PV may pose economic and technical challenges. Being a ‘must-run’, the plant is guaranteed to be dispatched despite being the most expensive plant. As a consequent, the LCDSM dispatch will be distorted, resulting in less optimal overall generation cost.

The first Utility-Scale Solar PV of 50MWac may have little impact on LCDSM dispatch since it only represents a small fragment of the maximum demand. The variability of Solar PV can be compensated by the allocated spinning reserve. However, when the penetration level becomes significantly high, it will be technically more challenging to manage the fluctuation created by the variable generation. The existing spinning reserve will no longer be able to cater for sudden drop in generation. This situation calls more back-up generation to cover for larger variation, hence resulting in higher generation cost.

8.4. Impact of Utility-Scale Solar PV on the Malaysian Grid Code (MGC)

The Malaysian Grid Code (MGC) is a document that outlines the development, maintenance and operation of the Peninsular Malaysia’s Grid System. The MGC defines the principles governing the relationship between parties to the MGC, namely the Grid System Operator (GSO), Suruhanjaya Tenaga (ST), Grid Owner (GO), Single Buyer (SB) and all Users of the Grid System in Peninsular Malaysia [28]. The Grid System is defined as the TNB’s transmission network with voltage level of 66kV and above. The SBR applies in conjunction with the MGC. Nonetheless, should there be any inconsistencies between the two documents; MGC takes precedence over SBR.

The Utility-Scale Solar PV will be connected to the Grid System. As the management of the Grid System is bounded by the MGC, the document’s lacks of treatment on renewables is foreseen to pose operational challenges. This section deliberates the issues.

In the MGC a Centrally Dispatched Generating Unit (CDGU) is defined as a Generating Unit that is centrally dispatched by GSO. The definition of CDGU is important as it characterizes the expected performance of a plant with respect to maintaining the integrity of the grid.

Generating Unit categorized as CGDU is expected to perform certain functions, among others, to provide spinning reserve. The spinning reserves can be delivered via responses such as primary response and secondary response. Moreover, a CDGU shall also be black start capable- a procedure necessary to recover from a total or partial blackout. A CDGU shall also be dispatched according to the least cost operation.

Clause CC6.4.1.1 of the MGC sets forth exceptions to the rule. The clause states that a Generating Unit with capacity of 50MW and less, hydro units and renewable energy plants that is not designed for frequency and voltage control are exempted from performance requirement usually expected from a CDGU. These exemptions have several implications on the treatment of Solar PV plant.

To begin with, any Solar PV plant with a capacity of 50MW and less is not expected to perform like a CDGU. This statement is also putting an exemption on Solar PV plant not designed for frequency and voltage control capability. However, the new generation of Solar PV inverters can fulfill similar technical requirements as the conventional plant. Therefore, to make exceptions for renewables plants will be at a cost to the operation of the grid system, especially when the penetration level becomes growingly significant. This is because other conventional plants have to provide for ancillary services Solar PV cannot deliver.

Based on these arguments, it is necessary to enhance the MGC to accommodate the growing percentage of renewables, particularly Utility-Scale Solar PV, in the generation portfolio and the due treatment for this type of plant to maintain a reliable grid operation.

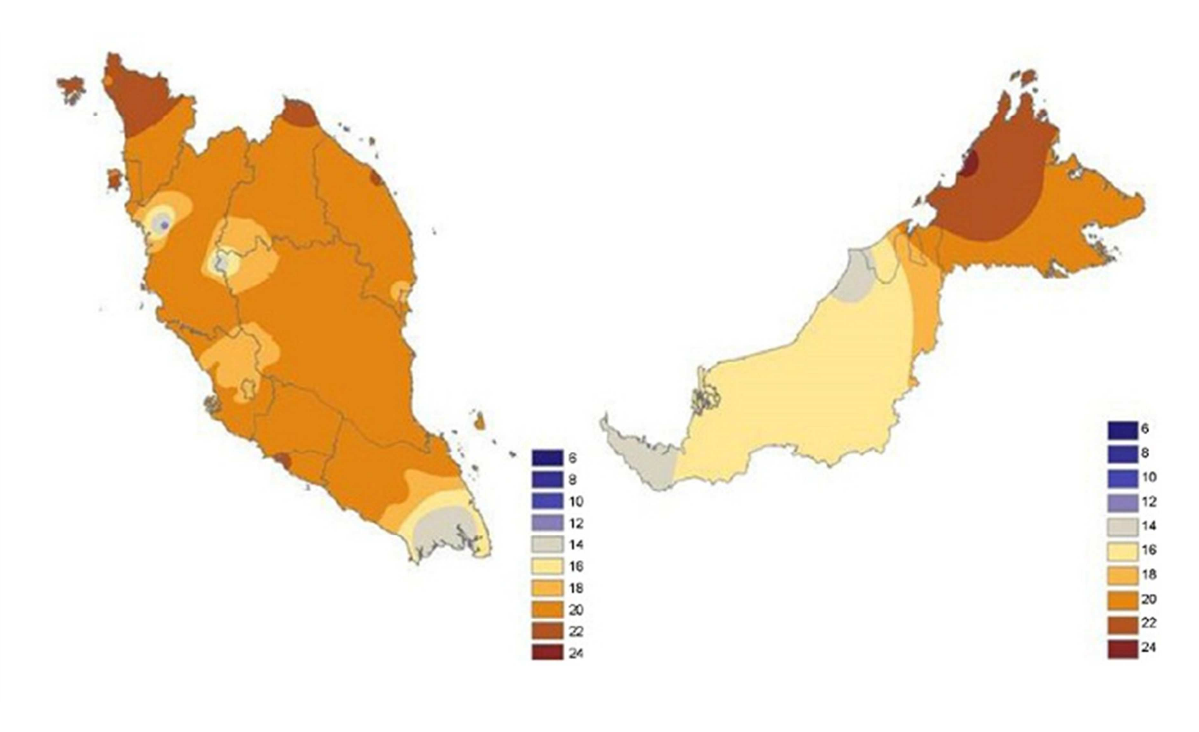

*Figure **3:** Annual average solar radiation (MJ/m2/day)*

9. COMPARISONS WITH OTHER COUNTRIES WITH SIMILAR ESI STRUCTURE

To benchmark Malaysia's renewables development particularly a Utility-Scale Solar PV, it will be prudent to look at how other countries are treating their power generation from renewables. In this paper, the authors attempt to look at Jordan and Thailand as the ESI structure of these countries is similar to Peninsular Malaysia.

9.1. Jordan

The Jordanian ESI structure is somewhat similar to Malaysia ESI. National Electric Power Company (NEPCO) is a state-owned transmission company responsible for owning and managing the transmission network, power control, power purchase and sale and power exchange with bordering countries. The regulation of electricity industry is overseen by the Jordanian Electricity Regulatory Commission (ERC) [29] [30].

Effort to promote power generation from renewables in Jordan began as early as 1988 with its first wind power pilot project in Al-Ibrahemiya. The recent past has seen rigorous effort by the government in terms of regulatory, financial and technical supports, alongside international agencies and foreign benefactor, to harness the renewables potential in power generation. Since the country is highly dependent on oil imports, hence, subject to oil price volatility, renewables is seen as the cheapest option to provide electricity to its people, given the fact that the potential is enormous and yet to be tapped [31].

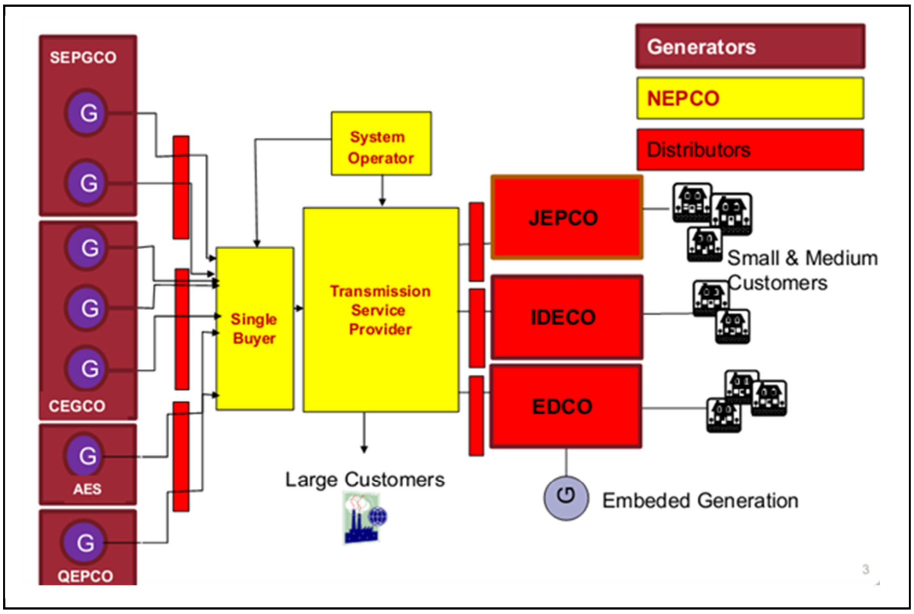

Figure 4: Structure of Jordanian Electricity Sector (2013)

At present, Jordan is targeting to have 10% of its energy mix from renewables by 2020 [32]. To realize this aspiration, the country is planning to have large scale power projects consisting of up to 1000MW of wind energy, 600MW of solar energy and 50MW of waste-to energy by 2020.

As a support mechanism, the government has introduced several schemes for renewables connection to the grid. For small-scale power projects of 5MW or less, the connection scheme is Energy Net-Metering where the customers can sell his excess of renewables generation to the network at predetermined prices depending on type of RE resources. For large scale projects with capacity of more than 5MW, the interested party may submit direct proposals or via competitive tenders. For both scheme, additional incentives are given if the installations originate from a fully Jordanian origin Renewable Energy Facility. Other renewables schemes in place are Electric Power Wheeling Applications (EPWA) and Self-Generation Applications (SGA). EPWA is a scheme in which a customer uses the transmission and/or distribution lines and its associated facilities to deliver electricity generation from its Renewable Energy System (RES) to another location for its own self-consumption. SGA, as the name suggests, is an option offered to smaller consumers of less than 5MW generation annually.

9.2. Thailand

Thailand ESI structure adopts a semi-unbundled structure termed "Enhanced Single Buyer Model". Electricity Generating Authority of Thailand (EGAT) is a state-owned with fifty percent (50%) share in generation and fully owns and operates the transmission network. The distribution systems are operated by the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Industry (PEA). The regulation of this sector is mandated to the Energy Regulatory Commission (ERC) [33].

Apart from complementing fossil fuel to create a sustainable energy development, renewables initiatives in Thailand is seen as the country's commitment to alleviate the adverse impact of climate change [33]. The 15-Year Renewable Energy Development Plan (REDP 2008-2022) laid down clear policies and responsive plans that focus on increasing domestic alternative energy use to replace the fossil fuel imports. The REDP is targeting renewables to make up twenty percent (20%) share of final energy consumption in 2020. The REDP was later superseded by Alternative Energy Development Plan (AEDP 2012-2021) which is seen as more ambitious with its higher targets of renewables.

One of Thailand's successful mechanism to attain its renewable target is through the implementation of its Feed-in Tariff (FiT) or popularly known as the adder program. Implemented in the early 2007, the program provides incentives to private investors by a guaranteed purchase of renewables by the local utility at generous rates. The overwhelming response on the adder program, predominantly from solar application, has that resulted in a 'speculated MW' rather than realizable projects. This has led the government to review its policy that impacted the whole renewables industry.

On the large scale solar development, Thailand will be having a 52MW Utility-Scale solar plant, the largest so far in the country. The plant, which is scheduled for operation by end of 2014, employs thin-film solar module.

Table 1: A comparison of Thailand's renewable energy targets and 2011 status

No	Type of RE	15 Year Target (until 2022), MW	Actual On-grid Capacity (SPP*+ VSPP**) as of Dec 2011
1	Solar	500	110.97
2	Wind	800	0.38
3	Hydro	324	13.28
4	Biomass	3700	724.72
5	Biogas	120	98.69
6	MSW	160	37.33
7	Hydrogen	3.5	0

10. CONCLUSION

Beginning 2001, Malaysia has formulated numerous policies to support the generation of power from renewables. Since then, several programs have been launched to drive the growth of renewable generation. However, despite these vigorous efforts, the country has yet to achieve its aspired target. Factors such as lack of financial incentives and strong regulatory framework had hampered the development of renewables. Only in 2011, with the passing of Renewable Energy Act 2011, spurred the growth of renewables in a more aggressive manner. The bill provides for the implementation of Feed-in Tariff (FiT) mechanism that obligates the utility to purchase the power from renewable resources at premium rates. So far, judging from the overwhelming response from the public to this date, the FiT program is considered the most successful renewables initiative.

The tariff revision in early 2014, due to fuel subsidy rationalization as well as the price increase in the fossil fuel, has further sparked interest from the public on renewable generation. Suddenly, individuals and enterprising businesses are looking for alternatives to produce their own electricity to cushion the impact of the tariff hikes. As the tariff revision is inevitable to move the country towards industry competitiveness, the Malaysian Government is also rigorously promoting Energy Efficiency and the use of renewables for the electricity generation.

Tenaga Nasional Berhad, specifically Single Buyer as the exclusive electricity purchasing agency, is also impacted. Industry players are now looking for opportunities to generate power from the Utility-Scale Solar PV. This also stems from the success of FiT program which gives a lucrative return to the FiT participants. However, high penetration of Utility-Scale Solar PV is likely to pose a challenge to the operation of Single Buyer. Since Solar PV has not reached grid parity, Single Buyer is bound to buy the power generated from Utility-Scale Solar PV at higher price and this contradicts with the principle of Least Cost Dispatching Scheduling Methodology.

High penetration of Utility-Scale Solar PV is also foreseen as a challenge to maintain a stable operation of the grid. Grid operators now have to deal with the inherent variability and intermittency of Solar PV. Moreover, the current Malaysian Grid Code (MGC)'s lack of treatment of Utility-Scale Solar PV will later cause a bigger problem to the operation of the grid.

Benchmarking with other jurisdictions, it is observed that a strong government incentive is the key to drive the development of RE. In terms of large-scale grid-connected RE, an attractive PPA is the way to entice investors to participate in power production from renewables.

Moving forward, it is necessary to enhance Single Buyer Rules and the Malaysian Grid Code in anticipation of higher penetration of grid-connected renewables in Malaysia. This recommendation is critical to ensure continuous support on renewables from Single Buyer, particularly the Utility-Scale Solar PV, as well as to ensure efficient and fair treatment to the Single-Buyer Market Participants in view of higher penetration of Utility-Scale Solar PV.

REFERENCES

[1] "Crossing the 20 Percent Mark: Green Energy Use Jumps in Germany - SPIEGEL ONLINE". Spiegel.de. 2011-08-30. Retrieved 2013-09-06

[2] TIMETOACT Software & Consulting GmbH (2012-07-26). "Erneuerbare Energien liefern mehr als ein Viertel des Stroms | BDEW | Bundesverband der Energie- und Wasserwirtschaft". Bdew.de. Retrieved 2013-09-06.

[3] Noor Zafina Mohd Zamin, Nor Ziha Zainol Abidin, and Joon B. Ibrahim, "Single Buyer-A Step Forward in Malaysian Electricity Supply Industry Reform," in *Proc. IEEE Region 10 Conference (TENCON) Spring 2013*, Sydney, 17 – 19 April 2013, pp. 396 – 402

[4] Suruhanjaya Tenaga, Electricity Tariff Implementation Guidelines, January 2012

[5] "Single Buyer Rules", MyPower Corporation, ver. 13, August 2012, unpublished

[6] Aizuddin Mohd Sopian, Joon B. Ibrahim, and Nor Ziha Zainol Abidin, "International Competitive Bidding For New Generation Capacity: The Malaysia's Experience," in Proc. *IEEE Region 10 Conference (TENCON) Spring 2013*, Sydney, 17 – 19 April 2013, pp. 396 – 402

[7] Paul L. Joskow, "Comparing the Costs of Intermittent and Dispatchable Electricity Generating Technologies", American Economic Review: Papers & Proceedings 2011, 100:3, 238-24, 2011

[8] Suruhanjaya Tenaga Website (2014), "Results of International Competitive Bidding for new capacity in Prai and restricted tender for renewal of operating licenses of first generation IPP and TNB plants" Press Release. [Online] Available: http://www.st.gov.my/images/article/multimedia/Competitive_Bidding_Results_-_Media_Release_BI3.pdf . Accessed on 23rd April 2014

[9] Suruhanjaya Tenaga Website (2014), "Announcement: Coal fired power plant open bidding" [Online] Available: http://st.gov.my/index.php/component/content/article/17-english/238-announcement.html Accessed on 23rd April 2014

[10] Suruhanjaya Tenaga, "The Malaysian Grid Code, Version 1/2010", 2nd August 2010, SDC1.4.4 pp 330-334

[11] Ministry of Energy, Green Technology and Water Official Website (2014), "Statement by Minister of Energy, Green Technology and Water Datuk Seri Panglima Dr. Maximus Ongkili on the Feed-in Tariff Quota On April 1, 2014". Media Release. [Online] Available :http://www.kettha.gov.my/portal/index.php?r=kandungan/mediak&menu1_id=5&menu2_id=16#.U19d7VKwqP8 Accessed on 29th April 2014

[12] Badriyah Abdul Malek, Kementerian Tenaga, Teknologi Hijau dan Air,"National Renewable Energy Policy and Action Plan", 9th August 2010.

[13] Kementerian Tenaga, Teknologi Hijau dan Air, "National Renewable Energy Policy and Action Plan", April 2010. *Table (ii) RE Policy Planned Outcome*, Page V

[14] Renewable Energy. World. Com, "http://www.renewableenergyworld.com/rea/news/print/article/2011/09/malaysia-explores-its-renewables-options" Accessed on 29th April 2014

[15] Ir. Ahmad Hadri Haris, Ministry of Energy, Green Technology and Water, MBIPV Project Website, " Renewable Energy Bill and SEDA Bill", 16th March 2011, [Online] Available http://www.mbipv.net.my/dload/presentation-RE%20Bill-16Mar2011.pdf Accessed on 2nd May 2014

[16] SEDA Website (2014),: "History of FiT in Malaysia", [Online] Available: http://www.seda.gov.my/?omaneg=00010100000001010101000100001000000000000000000000&s=255 Accessed on 2nd May 2014

[17] SEDA Website (2014),: "Overview of FiT system in Malaysia", [Online] Available: http://www.seda.gov.my/?omaneg=00010100000001010101000100001000000000000000000000000&s=6 Accessed on 3rd May 2014

[18] SEDA Website (2014),: "What are the Renewable Resources", [Online] Available: http://www.seda.gov.my/?omaneg=00010100000001010101000100001000000000000000000000000&s=21 Accessed on 3rd May 2014

[19] SEDA Website (2014),: "RE Generation", [Online] Available: http://www.seda.gov.my/?omaneg=00010100000001010101000100001000000000000000000000000&s=161 Accessed on 5th May 2014

[20] SEDA Website (2014),: "CO2 Avoidance", [Online] Available: http://www.seda.gov.my/?omaneg=00010100000001010101000100001000000000000000000000000&s=540 Accessed on 5th May 2014

[21] S.Mekhilef, A. Safari, W.E.S. Mustaffa, R. Saidur, R.Omar, M.A.A. Younis, "Solar Energy in Malaysia: Current state and prospect"

[22] Ahmad S, Kadir MZAA, Shafie S. Current perspective of the renewable energy development in Malaysia. Renewable and Sustainable Energy Reviews 2011;15(2):897–904

[23] Haris AH. MBIPV Project: Catalyzing Local PV Market. Kuala Lumpur, Malaysia: Finance & Investment Forum on PV Technology; 2008.

[24] Amin N, Lung CW, Sopian K. A practical field study of various solar cells on their performance in Malaysia. Renewable Energy 2009;34(8):1939–46

[25] Dr. Hugh Outhred & Dr. Maria Retnanestri, Ipen Pty. Ltd., "Solar Energy & Photovoltaic Power", October 2013, Bangkok & Singapore

[26] Tenaga Nasional Berhad Website (2014), "TNB Signs PPA With 1MDB Solar Sdn. Bhd." Press Statement. [Online] Available: http://wwwbe.tnb.com.my/tnb/application/uploads/uploaded/PR_TNB_signs_PPA_with_1MDB_Solar_Sdn_Bhd.pdf Access on 23rd April 2014

[27] J.Bebic, GE Global Research. Niskayuna New York, "Power System Planning: Emerging Practices for Evaluating The Impact of High-Penetration Photovoltaics", National Renewable Energy Laboratory, Subcontract Report NREL/SR-581-42297, February 2008

[28] Suruhanjaya Tenaga, The Malaysian Grid Code, Version 1/2010, 2nd August 2010, GD2 Terms and Definition, page 39

[29] National Electric Power Company, [Online] Available: http://www.nepco.com.jo/en/company_brief_en.aspx. Accessed on 30th June 2014

[30] Jordanian Electricity Regulatory Commission, [Online] Available: http://erc.gov.jo/English/Pages/RenewableEnergy.aspx Accessed on 30th June 2014

[31] Albawaba Business, Jordan's future lies in renewable energy, [Online] Available: http://www.albawaba.com/business/jordan-renewable-energy-549840 Accessed on 1st July 2014

[32] EcoMENA, Renewable Energy in Jordan, [Online] Available:http://www.ecomena.org/renewable-energy-in-jordan/ Accessed on 1st July 2014

[33] Thailand's Renewable Energy Policy: FiTs and Opportunities for International Support by Dr. Sopituda Tongsopit and Dr. Chris Greacen, 31st May 2012.

[34] Thailand in the 2010's, Thailand's Renewable Energy and its Energy Future: Opportunity & Challenges, Final Draft, As of 16th September 2009, [Online] Available: http://nstda.or.th/pub/2012/20120523-renewable-energy-strategy-2008-2022.pdf Accessed on 2nd July 2014