De-Regulation of Electricity Industry: A Malaysian Perspective

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***Abstract*—The Malaysian electricity industry has gone through an evolution over the years from vertically integrated utility into a single buyer market model currently. Many countries have de-regulated their electricity industry to increase efficiency and to introduce electricity price competitiveness. It is a natural path for any developing country like Malaysia to evolve into a fully functional market with complementary commercial instruments, such as whole-sale, balance, and network access arrangements. However, Malaysia must take the right path in pursuing de-regulation through energy market, thus ensuring a smooth transition from regulated into de-regulated electricity industry. This paper analyzed the energy market operation of three different countries. The analysis was based on the drivers for regulation, how the de-regulation was introduced to the vertically integrated system, the market model and the structure. From the comparative analysis, the hybrid model which combines single buyer model and pool market seems to be the potential approach for Malaysia in its path to de-regulation.**

***Index Terms*—imbalance cost past through, incentive base regulation, power purchase agreement, vertical integrated utility**

I. Introduction

Energy markets have been implemented in many countries and is proven to be successful. Energy markets provide incentives/pressure to reduce the electricity price and increases supply efficiency. In Malaysia, the electricity industry is still in the regulated environment and the government heavily subsidizes the fuel cost through Petronas (Malaysia's national petroleum company). Nevertheless, many improvisations have taken place to improve the industry and to complement the consumers. The Malaysian government and the regulators have made some enhancements with the introduction of Single Buyer (SB) Model and Incentive Base Regulation (IBR) where it ensures electricity tariff stability and promote renewable energy penetration in Malaysia. It also increases the efficiency and reduces the cost of operation and liberates certain portions of the generation. Yet a lot more improvisations can be introduced to further improve the electricity industry. One of the ways is through the introduction of an energy market. The implementation of an energy market leads to healthy competition among the participants not just at the power generation level but also at the power distribution level (wholesale and retail market). Although there will be price fluctuation (system clearing price) due to fuel price volatility and demand, it can always be managed through certain market rules. One of the challenges for the energy market is the integration with Renewable Energy (RE). Malaysian government is intensifying the penetration of renewable energy into the grid system and is expected to achieve 20% of the installed capacity by the year 2025. This will affect the operation of energy market as the high RE penetration increases complexity of grid operation. Hence, the system marginal price will be affected, as the RE will have lower bidding price because of its zero fuel cost. It is also important to find a mechanism that integrates energy market and renewable energy together so that we could have a robust and sustainable electricity industry without neglecting the importance of environment conservation.

The Malaysian government has come up with many initiatives towards the development of Malaysian electricity industry through Malaysia Electricity Supply Industry MESI [1] as in Fig. 1. The aims of MESI is to:

- Enhance governance to ensure the industry's sustainability
- Introduce explicit, transparent tariff pass through mechanism to balance merit risks for the industry player
- Rationalize gas price subsidies and increase fuel supply security
- Create equitable competitive bidding mechanism towards greater efficiency

The outcome of this initiative was ring-fenced Grid System Operator and Single Buyer and the creation of ring-fencing guidelines for both entities. It also paved the way for renegotiation of Power Purchase Agreement (PPA) with the Independent Power Producer (IPP), which translates into better deals for the consumer. Open competitive bidding also creates a level playing field for the power producers. With the introduction of Incentive Based Regulation (IBR) and Fuel Cost Pass Through (ICPT) mechanism, it had increased the efficiency in operation and sustained the electricity tariff without a significant price hike.

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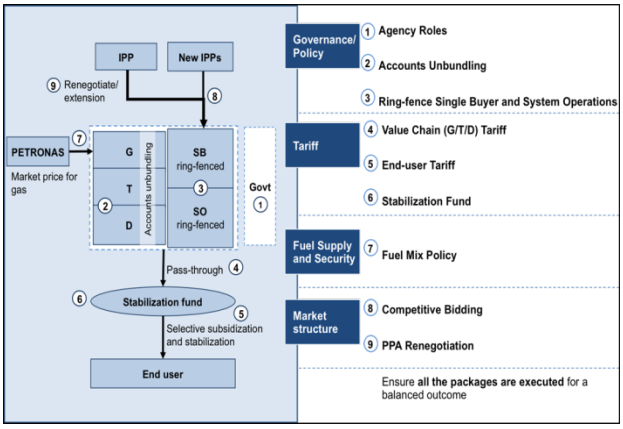

Figure 1. MESI reform structure with ring-fenced single buyer and grid system operator.

Since the introduction of Imbalance Cost Pass Through (ICPT) mechanism, the consumer enjoyed rebates as much as RM 6.3 Billion in total since 2014 [2]. The surplus is possible through the efficiency and low fuel cost. However, as 70% of the tariff is fuel cost, and the main fuel source for generation in the grid system is coal and gas, the consumer price is still vulnerable to fuel price volatility. This has caused the government to spend RM 929.37 million in fuel subsidy (the first half of 2018) in order to maintain the tariff. The increment of fuel cost has led to the government increasing tariff for industry consumers as much as 1.35 cent/kWh starting from 1 July 2018.

The introduction of MESI has led to some positive impacts to the industry but it is not enough to sustain the tariff, as the efficiency of operation is insufficient to protect from the exposure of fuel price volatility. Hence, Malaysia is considering the idea of embracing renewable energy as the next source of generation, and liberation of the electricity industry from single buyer model into energy market. Thus, MESI 2.0 was introduced with the core idea of "Reimagining MESI".

The 4-core objective of MESI2.0 is in the following areas:

- Efficiency
- Customer Experience
- Green/Sustainability
- Security

Through these core objectives, the Malaysian government is trying to achieve a highly efficient electricity industry and customer empowerment. It will also allow the government to transfer the risk of fuel price management to the participants and market force to decide. Through these initiatives, we could see the birth of energy market, open fuel resourcing, enhanced IBR and better consumer experience by giving flexibility to the consumer. These initiatives will shift the focus to renewable energy as the next resource for generation. To implement these initiatives, comprehensive studies need to be in place to see the impact to the consumer and industry. The biggest blocker would be the novation of PPA, as this will cost the government a huge amount of money and it has to be agreed by the power plant owner and their lender (financial institution).

In this paper, the potential energy market model for Malaysia's electricity industry will be explained. There is no one size that fits all for energy market as each country is unique. Three countries namely, Singapore, Australia and Canada will be reviewed, and their approach considered for Malaysia. These countries were selected because they have similar characteristics as Malaysia.

II. Types of Energy Market Model

Malaysia started off as a vertically integrated utility and is currently adapting single buyer model as shown in Fig. 2 and Fig. 3 [3]. This is one of the outcomes of MESI as discussed earlier. The generation sector was opened up for other generators, but this was done prior to the introduction of Single Buyer Model. The single buyer model had introduced more transparency in the operation, as the IPPs had previously argued that the selection of generator in the operation was biased towards TNB (Tenaga Nasional Berhad) power plant although it was planned as per least cost dispatch according to the merit order list. The ring-fencing guidelines and web base operation data publication had changed the perception of the stakeholders to a certain degree. The Grid System Operator (GSO) and Single Buyer (SB) are governed by a committee comprising of various stakeholders, known as Oversight Committee (OSC) to ensure transparency. The single buyer model is just a step before deregulation.

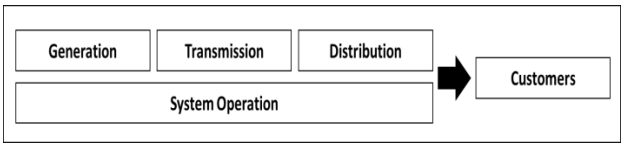

Figure 2. Vertically integrated utility model.

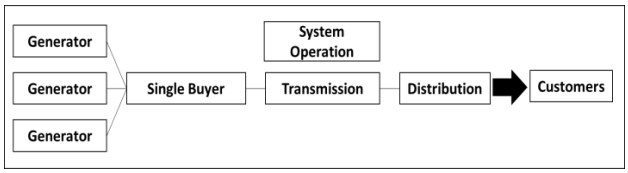

Figure 3. Single buyer model in Tenaga Nasional Berhad.

Energy market can be divided into two main components which are market participants and market facilitators [4]. The market participants comprise of generators, consumer and retailers. Meanwhile, the facilitators would be the market operator, system operator and grid owner. The commodities traded in an energy market are energy, capacity, and ancillary services. In the wholesale market, the common model is a power pool wholesale market. In this model, all the generators must sell the energy to the pool and the retailers must buy power from the pool to meet their demand. This model is quite similar to the single buyer model.

The power pool can operate in two ways which are [5]:

- **One Sided Pool:** The generators offer price quantity pairs for the generating units for a specific time interval and the market operator forecast the demand and dispatch the units to meet the demand

- **Two-Sided Pool**: The market operator dispatches based on requirement of demand curve created by the price quantity bids, made by buyer and seller. Finally, the unit commitment schedule is determined by the operator.

Some wholesale markets have evolved into having retail market to allow customers to be involve in the power bidding process. However, these are only for large power consumers (for example, in Singapore). Fig. 4 shows the model for a wholesale market and Fig. 5 shows the model for wholesale and retail market.

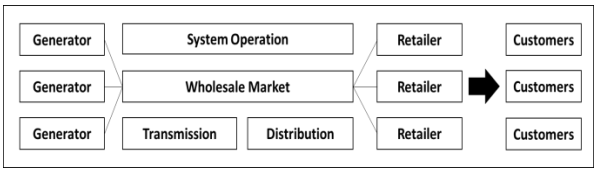

Figure 4. Wholesale market model

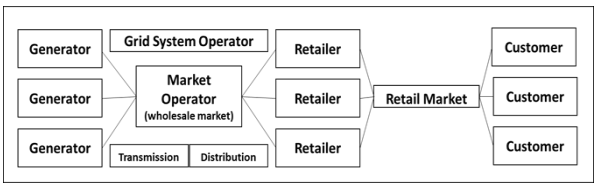

Figure 5. Wholesale market model with retail market model.

The other type of wholesale market is wholesale market with bilateral trade [6]. The concept is very similar to the wholesale market. What differs is that retailers and consumers could have direct trading with the generator without involving the market. This allows them to hedge the price to reduce the impact of price volatility.

The retailers, large power consumer and the generators have their own conditions and price set in the contract. The planned delivery and consumption will be notified to system operator to allow them to plan dispatch arrangements. The system operator ensures energy balance in the real time through the balancing market if there is any changes or abnormality in the real time dispatch. Fig. 6 show the wholesale market with bilateral contracts.

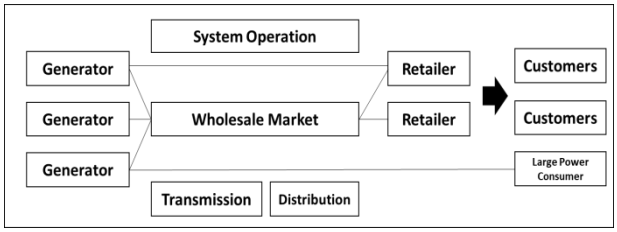

Figure 6. Wholesale market with bilateral trade.

Within this wholesale market model, the 3 main facilitators are the market operator, system operator and transmission operator (often also the grid owner). There are different combinations that have been used in many jurisdictions around the world in order to achieve desired target and output, as shown in Fig. 7. However, in most of the market models, they follow either combined system operator and market operator or separate market operator and system operator (Fig. 7, case 3 and 4). In both cases, the grid owner exists as a separate entity.

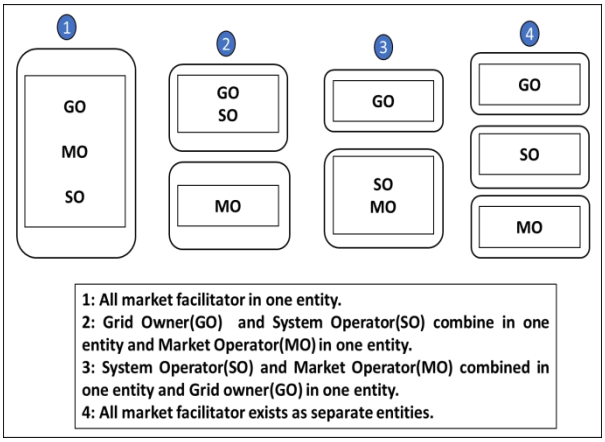

Figure 7. The different type market facilitators interaction in energy market.

III. Overview of Singapore Energy Market

The electricity market is operated through a wholesale electricity market by the Energy Market Company (EMC) with spot bidding every 30 minutes. SP Power Assets operate the transmission and distribution network. The retail market was introduced recently and is available only for consumer that consume above 2000 kWh and SP Services Ltd will supply to those who do not fall in this category [7]. The electricity market is regulated by Energy Market Authority (EMA), which ensures reliable energy market. Power System Operator (PSO), a subdivision of EMA ensures safe and secured operation of electricity supply. EMA also issues electricity license for the market participants. The principal legislation that governs the energy market is Electricity Act (Chapter 89A), Singapore Wholesale Market Rules and Code of Practice. EMA is conferred power by the Energy Market Authority of Singapore Act (Chapter 92B); each of these entities has agreement with one another to govern their behaviors.

The electricity reform of Singapore envisaged the introduction of an electricity market that is sustainable and driven by the influence of market forces with minimal intervention by the regulators or other government entities. The phases of reform are divided into three. The first phase corporatizes the Public Utility Board (PUB) where the electricity and gas undertakings of PUB are transferred to Temasek Holdings, while PUB is reconstituted to regulate the electricity and gas industries. Temasek Holdings creates Singapore Power as holding company for generation company (Power Senoko), transmission company (Power Seraya) and electricity supply and utilities service company (SP Services Ltd). Another new generator company, Tuas Power was set up as an independent company under Temasek Holdings to further unbundle the generation sector.

In the second phase, the Singapore Electricity Pool was introduced in September 1998. It operates a day

ahead of wholesale electricity market, which allows trading between the generators and SP Services Ltd operating in a competitive environment on a least cost manner. The intention of pool market is to introduce the attributes of a modern market without full complications to give exposure to participating companies. In this phase, Power Grid is responsible as grid owner, pool administrator and system operator.

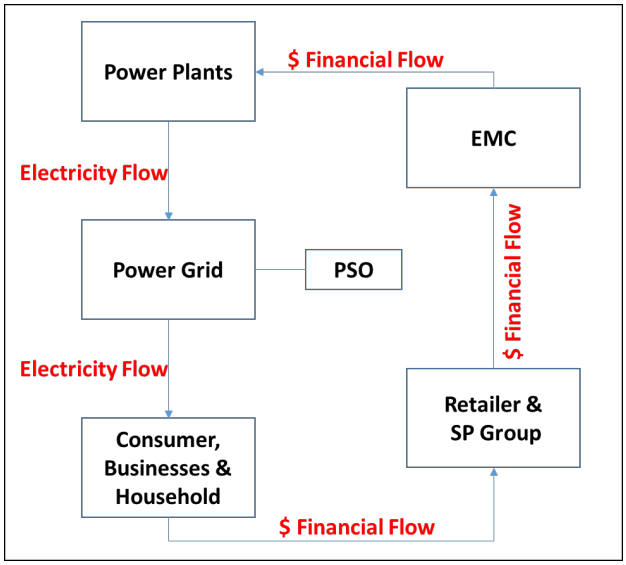

Figure 8. Singapore wholesale electricity market flow.

In September 1999, under the third stage of reform, Singaporean government carried a comprehensive study on its electricity industry and came up with wholesale market structure and regulatory framework to support a competitive electricity industry. In year 2000, the Singaporean government further enhanced the roles of system operator and market operator, separation of ownership level, establishment of real time wholesale market, and liberalization of retail market. In 2001, PUB was restructured into a water authority under the Ministry of Environment and a new statutory body which is EMA was established to regulate electricity and gas market. EMA is under the purview of Ministry of Trade and Industries of Singapore. Meanwhile, the retail market was to be liberalized in stages [8]. In 2008, Temasek Holdings diversified the ownership of three generation companies it owns; Power Seraya, Power Senoko and Tuas Power.

The energy market, which was introduced, comprises of two markets that are the "real time market" and "procurement market". Energy Market Company (EMC) administers the operation of the energy market. Every half an hour, the market-clearing engine ("MCE") will determine the market-clearing price based on the supply and demand requirements. Participating generators will submit their bids to system. The electricity market uses nodal pricing as its energy pricing where generator will be paid at nodal price at their point of injection. While generators are paid their nodal price, the energy buyers are paid at uniform overall average price to avoid the disadvantage due to different location. This uniform pricing is known as Uniform Singapore Energy Price (USEP). The dispatching process is a process of matching the demand and generation. The demand forecast will be provided by Power System Operator (PSO) to EMC and EMC through market clearing engine (MCE) will produce the unit commitment schedule, which PSO will use it for generator dispatch. To safeguard the electricity pricing from market power, EMC has imposed a vesting contract to the three large generators in the system, where they are required to sell a specified amount of electricity at a specified price, which in return will reduce the incentive for these players to exercise their market power. The vesting price is based on long-term marginal cost. EMA will ensure the vesting parameters reflected in the contract is reasonable and it will be reviewed every 2 years. Fig. 8 clearly shows the relationship between each players in the market and also the financial and electricity flow. National Energy Market of Singapore (NEMS) also allows market participants to have bilateral contracts to manage their exposure to price volatility. However, this contract needs to be done outside of the energy market.

IV. Overview of Australia Energy Market

Australian energy market is geographically divided. There are three energy markets in Australia, which are Western Australia (WEM), National Electricity Market (NEM) and Interim Northern Territory Electricity Market (I-NTEM). Principally, all these markets work as independent market operators and independent system operators that facilitate the whole arrangement of electricity between generators and retailers. In this case, we will focus solely on NEM, as it is the most relevant in this research.

NEM is legalized through National Electricity Law 1996, which sets out National Electricity Law and National Electricity Rules [9]. Both legislations focus on the roles and functions of various institutions in Australian Energy Market, which lead to the birth of NEM. The Australian Energy Market Operator (AEMO) is responsible to manage NEM. The Ministerial Council of Energy is the policy and governance body for Australian Energy Market. Meanwhile, the Australian Energy Regulator enforces the rule and regulations, which are stipulated and made available to market participants. In the early 1990's, Australian electricity industry went through a comprehensive restructuring from wholly state owned vertical integrated utility into a full pledge energy market with competing generation and retail utilities while maintaining the natural monopoly function of transmission and distribution.

NEM comprises jurisdictions namely, Queensland, South Australia, Tasmania, Victoria, and New South Wales. The market model for NEM follows the concept of a "pool" where the exchange between the power producer and consumer is facilitated through a mechanism where the output from the generators is instantaneously matched with consumers' demand in real time through centrally dispatch process. Generators offer bid to supply the market every five (5) minutes daily [10].

With all the bids, AEMO decides which generators to be deployed using marginal price and least cost principle. Energy retailers play a role as market intermediaries by purchasing power from NEM and selling it back to consumers with the inclusion of transmission and distribution cost. Currently, there are about 10 million residential, commercial and industry energy users.

The NEM's transmission network carries power from generators to large consumer and distributor. Usually, the transmission and distribution service provider also own the transmission and distribution network. In NEM, Electra Net and ETSA utilities operate and manage the transmission and distribution network.

AEMO performs the following two functions in NEM:

1) Power system operator

Prepares, maintains and publishes plan for the development of the national transmission grid in accordance to National Electricity Rules and operates the grid system to ensure safe and reliable operation

2) Market operator

Operates and manages the wholesale market exchange including managing the market participants under NEM

In addition to these functions, AEMO also carries out an advisory role in relation to power system operation, performance of connections between transmission and distribution. The composition of AEMO is a 60:40 ratios between government and private members of electricity industry. AEMO is a corporate entity with limited guarantee established in pursuant to Australia's Corporation Act 2001 where it is a self-funded where the participants pay the fees. However, AEMO is bounded by the following parameters:

- It must be for non-profit
- Does not amount to taxation
- Consistent with National Electricity Rules

V. Overview of Canada (Ontario) Energy Market

The electricity market in Ontario operates in a hybrid composition where both wholesale market and single buyer co-exist together. IESO (Independent Electricity System Operator) is the entity that manages the grid operation and the energy market. It is an independent not-for-profit Crown Corporation.

The main legislation in Ontario is the Electricity Act [11]. The market rules govern the wholesale market and grid. Initially, until 2002, the electricity industry operated as a vertical integrated utility with 300 municipally owned distribution utilities. In 2002, the vertically integrated utility split into three companies namely, a system operator, generation company and transmission & distribution company. However, this move has not resulted in positive impact and has caused the electricity price to soar. Thus, the government reviewed this structure and in 2015, they merged the IESO with the wholesale market through amendments to Electricity Act. This step is meant to consolidate real time operation with long-term planning, procurement and conservation efforts. With the hybrid model, the new IESO, the generators submit bids (the amount of energy and price) and on the other side large consumer and retailer submit bids on the amount of electricity they consumed and at a particular price. IESO accepts the lowest bid until it meets the demand. Then IESO dispatches the generator distributor received at their accepted offer. The market operates in 5-minute period. The average of market clearing price for 1 hour will set the Hourly Ontario Energy Price (HOEP). This price will be charged to the participants of the market. The main reason Ontario is categorized as single buyer is that IESO procures all the power from transmission to distribution onwards and no bilateral contracts are allowed between the generator and customer. However, HOEP will not be the settlement value for the generators [11]. The contracts between IESO and generators are based on maximum net revenue requirement. This means generators receive minimum monthly revenue regardless of the amount and value of the energy produced. This is to ensure sufficient and reliable generating capacity for the power sector. The retail customers do not participate in the energy market. Most of the residential and business consumers employ time of use rates. These rates are determined by the OEB (Ontario Energy Board) and revised twice a year. The consumer also could have a direct contract with the retailers OEB does not regulate this contract. Fig. 9 clearly show the relationship between each players in the IESO electricity market.

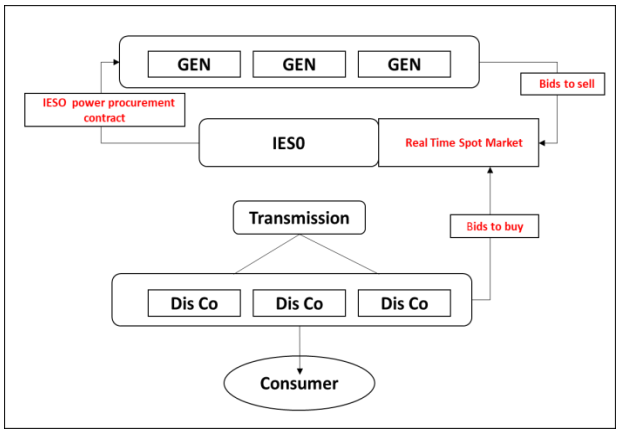

Figure 9. IESO electricity market model.

VI. Discussion

In this paper, we have highlighted three types of energy market, which are in the form of combined market operator and system operator (Australia), a separate market operator and system operator (Singapore), and a hybrid single buyer, market operator and system operator (Canada). Each of these models gives different type of advantages and disadvantages.

In the first two models (Australia and Singapore), the market force will decide the price of electricity (lasses-faire concept) based on supply and demand requirement. Hence, there is an intervention from the regulator to ensure fairness and security of supply. What differs is whether the system operator or market operator operate in a single entity or two different entities. Working in a single entity (Australia) could consolidate the resources

and expertise. It reduces the cost of operation. However, there might be lack of check and balance as both system operator and market operator are in the same entity. Singapore has a separate entity model where PSO and EMC are independent of each other. Each entity will ensure the check and balance. A market still can work in single entity mode, but it has to ensure a comprehensive market rule and regulation for supply security and to safeguard the participants. From the perspective of the hybrid model (Canada), there is integration of single buyer model into the market model. This is to ensure the price stability and guarantee return for the generators. These will facilitate the energy market and the same time will ensure sustainability. This model is suitable for countries that have many long-term PPA agreements as the cost of nullifying the contracts will cost billion to the government and it is legally complicated. The government needs political strength and financial backing in order to do this.

Many countries are experiencing de-regulation of electricity supply industry [12]. The two major push factors to this de-regulation are economy and politics. The cost of supplying electricity is rising due to the volatility of fuel cost and other factors like environmental issues, land purchasing etc. Fig. 10 and Fig. 11 show the volatility of the fuel price in Malaysia. The fuel mix in Malaysian grid is dominated by coal and natural gas [13], [14].

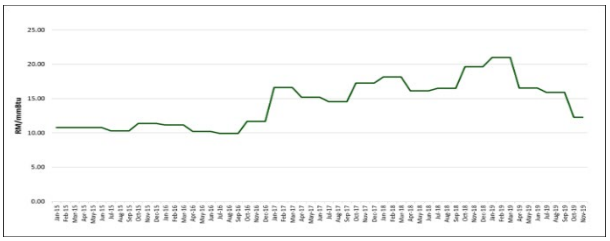

Figure 10. ACP coal price trend.

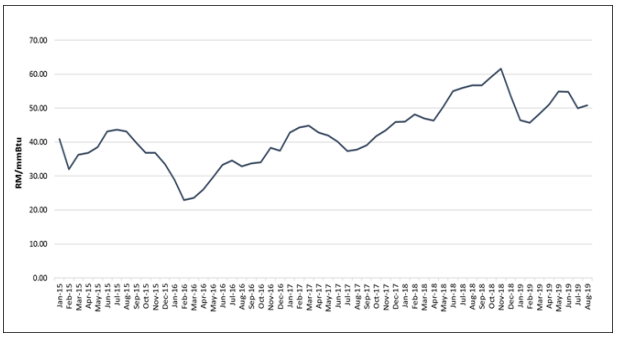

Figure 11. Gas price trend.

Volatile fuel prices make it very difficult to maintain a stable tariff. Looking at the trend of both gas and coal, these prices are increasing, which will impact on tariffs. The Malaysian government has done a tremendous job by maintaining the electricity tariff in the country, but fuel price increases add to the subsidy cost for the government. Table I shows that the Malaysian electricity tariff is one of the lowest in the south east asia region [15]. IBR and ICPT have managed to assist in stabilising price, but more needs to be done. The de-regulation is one of the methods to overcome this problem. This is because in the energy market, the price of electricity is determined by the market forces. In the initial stage of deregulation, the price of electricity seems to decrease but later on, the prices increase as the market forces play its role and the external factor impacts the price. The government still could ensure price stability and support the lower income group through regulation, rebates and incentive schemes but it is only viable if the rebate target group is small.

TABLE I. ELECTRICITY TARIFF IN ASEAN

Type of user	Indo'sia	M'sia	Thai	S'pore	P'pines	Vietnam
Domestic	11	10	12.41	19.97	18.67	10.59
Med-Commercial	11	13.58	11	14.3	12.23	13.44
Large Commercial	8.36	9.6	11	14.02	11.98	12.36
Medium Industry	8.36	8.2	8.36	13.05	11.69	7.81
Large Industry	7.47	7.76	8.36	12.72	11.63	7.41

We previously highlighted three types of energy market, which are in the form of combined market operator and system operator (Australia), a separate market operator and system operator (Singapore), and a hybrid single buyer, market operator and system operator (Canada). Each of these models gives different type of advantages and disadvantages. On reflection, given the context of Malaysia, we recommend the hybrid (Canada model). This is because the hybrid model is good for electricity price stability whilst ensuring grid system stability. Most of the power plant with PPA in Malaysia will be finishing their tenure soon and there are not so many new power plant with PPA coming into the grid, so there would be less need for complex negotiation in this matter if a hybrid energy market system was to be introduced. The hybrid system gives flexibility to the market players, and at the same time it ensures market sustainability without affecting the consumer. This will allow the electricity industry to grow and government (regulator) need to facilitate this. The regulator will need to design a comprehensive and extensive market rules and regulations to ensure this happens. Another factor is the consumers' perceptions; the consumers should be educated on the energy market and its benefits. This is because the consumers also play a vital role in ensuring the success of energy market. The key factors to success of de-regulation is market model, rules & regulation, each entity understands its role and function, good government support, consumer support & participation and the market participants.

VII. CONCLUSIONS

There are many steps involved in de-regulation of energy market. It has to be done in a precise manner to

ensure minimal disruption to the electricity supply, and minimal impact to the economy. De-regulation gives impact to both power system operation and electricity consumers. In the Malaysian context, after being heavily subsidized by the government for the electricity tariff and operated in vertical utility organization (TNB), de-regulation will be a step forward as it relieves the government from the financial burden, and it allows market force to play a role in a more independent manner. The Malaysian government could still continue to give subsidy to the lower income group by implementing selective rebates. This reduces the impact of electricity price volatility for the lower income group.

Based on this research, there is no one size fits all energy market model for Malaysia. Each country is unique, and energy market constraints and enablers are also different. In the Malaysian perspective, it is better to follow single entity with hybrid model like IESO (Canada) as this gives flexibility to the market players, is good for price stability, and will allow the industry to grow.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Mahesvaran perform the analysis on the energy market model from 3 different countries and wrote the paper. Vigna Kumaran, Furong Li and Sara Walker verified the analysis and improvise result.

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