

Review

A Decade of Transitioning Malaysia toward a High-Solar PV Energy Penetration Nation

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Abstract: In the last 10 years, Malaysia has aggressively moved towards a higher penetration of 20% of renewable energy (RE) in the Malaysian energy mix by 2025. Several incentives and initiatives have taken place with the aim of achieving the goals in terms of installed capacity and catching up with the leading countries in these sectors. Since 2011, Malaysia started the Feed-in-Tariff (FiT) before introducing Net Energy Metering (NEM) in 2017, and recently, another initiative known as NEM 3.0 has been introduced. This paper reviews all policies undertaken by the Malaysian government from 2011 to 2021 in spearheading the country to be on par with others, especially those in the Southeast Asian (SEA) region. The effectiveness of each policy on the growth of photovoltaic PV energy installation is highlighted, and the latest update on the NEM 3.0 policy is also discussed. A comparison of each approach in terms of installed capacity and system connection setup to the grid is also considered for the benefit and sharing of knowledge from one of the fastest-developing countries in the region.

Keywords: solar PV; sustainability; renewable energy policies; feed-in-tariff; net energy metering



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1. Introduction

The focus on the renewable energy sector has increased significantly in the past ten years in Malaysia, even though it is considered an oil and natural gas supplying country [1]. This is due to the increase in electricity demand as the population increases [2]. Malaysia has an average annual solar radiation of 1643 KWh/m², making it perfect for solar PV energy production [3,4].

To ensure energy security, Malaysia implemented five energy policies: an extension of four fuel energy policies and renewable energy as the fifth policy. This plan started with the goal of 5% of the energy mix to mitigate 70 million tons of CO₂ over 20 years, beginning in 2005 [5]. The first renewable energy program began in 2001 and was called the small renewable energy program (SREP) under the special committee's initiative on renewable energy (SCORE). This was built to support the governmental goals and to utilize RE as the fifth fuel in Malaysia. In 2021, it is very close to the deadline of the plan started years ago [6]; it is essential to study and to go through the initiative programs applied and to be executed by the governments and to test its effects on helping to reach the main goal that the Government of Malaysia decided years ago. Malaysia has implemented many policies for renewable energy [7,8]. These policies help to increase the installation of renewable sources, replace traditional sources of energy such as fossil fuel, and catch up with the leading countries in renewable energy such as Germany and China [9–11]. These countries have implemented many policies, including Feed-in Tariffs (FiTs), Renewable

Profile Slandering (RPS), Net Energy Metering (NEM), tax reduction quota requirements and trading systems [2,12]. In Malaysia, most of these policies have been implemented. However, some of these policy quotas have been completed and have ceased to be practiced. On the other hand, new approaches have been implemented to encourage new users and to fulfil the renewable energy capacity goal that Malaysia has set for 2025. It is debatable that some of these policies are not effective and do not influence the user to install PV systems. This is true in some guidelines, and it is explained later in this paper [13]. The National RE Policy and Action Plan (NREPAP) is the basis towards a more aggressive renewable energy deployment in the country. It aims to increase RE contribution in the national power generation mix, enable the growth of the RE industry, guarantee reasonable RE generation costs, preserve the environment, and increase awareness on the role and importance of RE.

Since 2011, Malaysia has started several incentive programs to encourage renewable energy installation, primarily for solar (PV) systems, beginning with the FiTsystem in 2011 [14]. Later, in 2016, Malaysia's quota for FiTs was completed, and the government started a new policy known as Net Energy Metering (NEM) [15,16]. This policy does not include any financial return to the customer. However, they can offset the cost of energy access in the form of electricity from their next monthly bill. The policy saves consumer energy and reduces their electricity bill [7].

This article reviews the latest PV system policies in Malaysia and compares each policy's benefits and effects on the renewable energy sector in Malaysia since the beginning of 2011 until the recent announcement made in 2021. The works highlights the technical requirements and approved size of system for each PV-related policies since 2011 in Malaysia from technical, financial and environmental prospects. The paper explains each policy in chronological order until the recently released policy. The paper also compares Malaysia's PV installation capacity with some neighboring countries. Last but not least, this paper refers to the goals of NREPAP, set to be accomplished by the implemented policies.

2. Global Solar Energy Policies

At the global level, there are several policies that have been implemented to encourage the installation of renewable energy in general and solar energy in particular. An example of these countries that utilize solar policies are: USA, Germany, Spain, Australia, China, France and Malaysia. The implementation of solar energy policies in these countries increased the installation of the solar energy project significantly. The most common policies are: Feed-in Tariff, Portfolio Standard (RPS), pricing laws, tax credits, quota requirements, production incentives, trading systems, and Net Energy Metering (NEM) [17]. These policies have been exchanged and developed to improve the implementation of renewable energy and to reduce the reliance on fossil fuels and encourage new technologies related to green energy. The most successful policy that showed results is FiT for its cash return back. However, this may apply to many countries but not all, due to the fact that these policies are affected by the decision of the policy maker, which is affected by their culture and history of the countries. Therefore, until now, there is no perfect policy that can be used as a model to all countries [18].

3. Energy Policies in Malaysia

Energy policy is the governmental act implemented by the installers of renewable energy sources, distributors and consumers [19–23]. Energy policies help assist the energy mix in Malaysia and address the barriers and market failures associated with the energy rate [6,24,25]. Several policies have been executed by the Malaysian government to guarantee sustainable energy in the future. This sections explains each policy in detail as follows:

3.1. Feed-in Tariff (FiT) Policy in Malaysia

In March 2007, the European Union targeted 20% renewable energy for 2020, emphasizing small-scale units [10,26]. A FiT is a payment system that pays for those who

produce energy in their homes [27–29]. This policy is implemented to accelerate the use of solar energy [30–32]. Malaysia's FiT system provides distribution licenses (DLs) to buy electricity produced from renewable resources (renewable energy) from feed-in users and sets the FiT rate. DLs pay for renewable energy supplied to the electricity grid for a specific duration [33,34]. By ensuring the customer's access to the grid and setting a suitable price per kW of energy produced from the solar system, the FiT policy could guarantee that renewable energy becomes a viable and sound long-term investment for companies, industries and individuals [35,36].

The PV system installer receives compensation for any kWh of renewable energy produced by the installed PV system that they own and export to the grid [33,37].

Although Malaysia has multiple RE resources, such as biomass, biogas, minihydro and solar resources, it is far from reaching its goal. The FiTs were implemented to support RE and to pass the challenges [35,38].

FiT Connection Mechanism to the Grid

- 'LV direct connection' means the connection of a renewable energy installation directly to a low-voltage supply line has to be technically feasible according to prudent utility practices Figure 1.
- 'LV indirect connection' means the connection of a renewable energy installation to a low-voltage supply line indirectly through the internal distribution board of the FiAH where the renewal energy installation is connected to an electrical point within the premises of the FiAH instead of the point of common connection Figure 1.

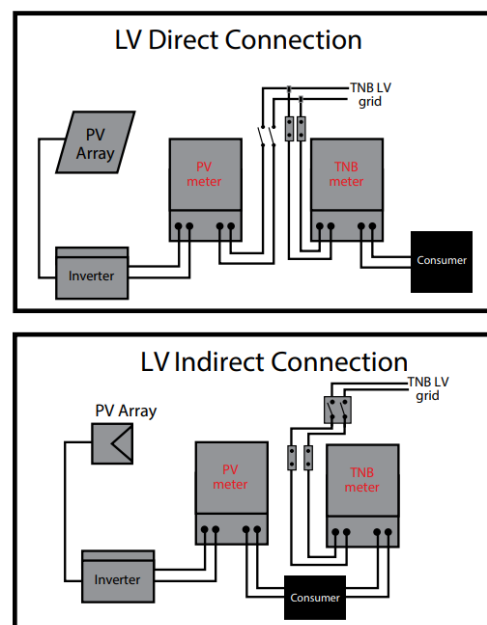


Figure 1. Direct and indirect connection for FiT to the grid.

3.2. Net Energy Metering (NEM)

Net Energy Metering (NEM) is an electricity policy that allows utility customers to offset some or all energy produced by their solar system at the utility rate [39,40]. This scheme was introduced in Malaysia in 2016 after the FiT quota was fulfilled. The main concept is that the PV system's energy is first offset by the consumer, and then any excess is exported to the utility grid. The cost of selling to the grid is MYR 0.31/kWh [41], while the utility electricity rate is over MYR 0.50/kWh to the grid [42,43]. This applies to all sectors as long as they are connected to the utility grid. They use a bidirectional meter that spins in both directions [9]. When the customer exports energy to the utility, the meter spins in a clockwise direction [44,45]. If the user consumes power from the utility, the meter spins in the opposite direction [45]. A photovoltaic system has a panel or an array of solar

modules, a solar inverter, and sometimes a battery and interconnection wiring. In addition, customers must install a bidirectional meter [46].

To achieve 20% of the national renewable energy mix goal, NEM is a great fit that complements the other schemes applied by the Malaysian government, which help lessen the reliance on fossil fuel.

NEM has many benefits for the utility grid. It reduces the pressure on the grid to import and store all energy from consumers [47]. While in FiT, all produced energy is sent to the grid, which increases the amount of injected power to the grid, and in some sector, the grid must expand in order to connect more consumers. Thus, there is no need for extensions of distrusting networks from the grid since the consumer uses the energy produced by the PV system and then sends it to the utility grid, which is the excess energy [48]. With more consumers installing a PV system, the grid does not have problems such as high demand as the population increases. This advantage applies to all NEM policies introduced later on.

3.3. Net Energy Metering 2.0 (NEM 2.0)

After the first NEM was implemented, little installation was achieved. This inspired the NEM 2.0 to be introduced in July 2018. This new NEM policy applies accurate net energy metering [1,40]. The first NEM did not help in the return of investment results. However, NEM 2.0 allows consumers to offset energy exported to the grid on a one-on-one basis. This means that PV installers can offset every 1 kWh of electricity with 1 kWh of electricity from the grid in their next electricity bill [49,50]. The previous NEM had some displaced cost. The allocated quota for NEM 2.0 was 500 MW, which was fulfilled in 2020 [16]. It was divided into domestic and nondomestic sectors: residential, commercial, industrial and agricultural [51].

The policy is implemented by the Ministry of Energy and Natural Resources (KeTSA) and regulated by the Energy Commission (EC) with the Sustainable Energy Development Authority (SEDA) of Malaysia as the implementing agency [52].

The PV system's allowed maximum capacity from the consumer is 12 kWac for a single-phase system or 72 kWac for a three-phase system [53].

3.4. Net Energy Metering 3.0 (NEM 3.0)

NEM 3.0 is the same concept as NEM 2.0. The energy produced from the solar PV installation is consumed first, and any excess is exported to TNB at a one-to-one cost. It was introduced by KeTSA on 29 December 2020 to provide more opportunities for electricity consumers to install solar PV systems on the roofs of their premises to save on their electricity bill. NEM 3.0 will be effective from 2021 to 2023 with the total quota allocation of 500 MW. NEM 3.0 is the latest policy announced by the Malaysian government during the COVID-19 pandemic [54,55]. It was discussed in more details with the government's applied programs and the quotation and regulation of each program [56,57].

The NEM 3.0 consists of three programs which are assigned to a specific market sector. The first program is NEM Rakyat, which covers the residential segment. A 100 MW capacity is allocated to this program, effective on 1 February 2021 [58]. The program applies the one-to-one NEM 3.0 policy for 10 years [59]. The allowed maximum PV installation capacity for the domestic consumer are 4 and 10 kW for single-phase and three-phase NEM consumers, respectively. The second program, called NEM GoMEn, covers the government ministries and entities and has 100 MW allocated for solar power implementation. The program also applies a one-to-one offset for 10 years. The maximum allowed PV installation capacity is 1000 kW per single account with a maximum of 75% from the maximum demand (MD), i.e., the average of the recorded MD of the past one year or the declared MD for consumers with less than a one-year record. This is applicable for medium-voltage consumers and for low-voltage consumers not exceeding 60% of the fuse rating (for direct meters) or 60% of the current transformer (CT) rating of the metering current transformers [21,25,60].

3.5. NEM Connection Mechanism to the Grid

3.5.1. Direct Feed-Connection

The connection point between the consumer and the utility grid is considered a direct connection when it is created, as exhibited in Figure 2a where two meters are connected to the grid [43], with one meter measuring the consumed energy from the grid by the user and the second one measuring the exported electricity produced by the PV solar system installed by the user. This connection method was adopted by the first policy FiT due to the policy regulation that requires the users to send all produced energy to the grid and to use the grid's power [35].

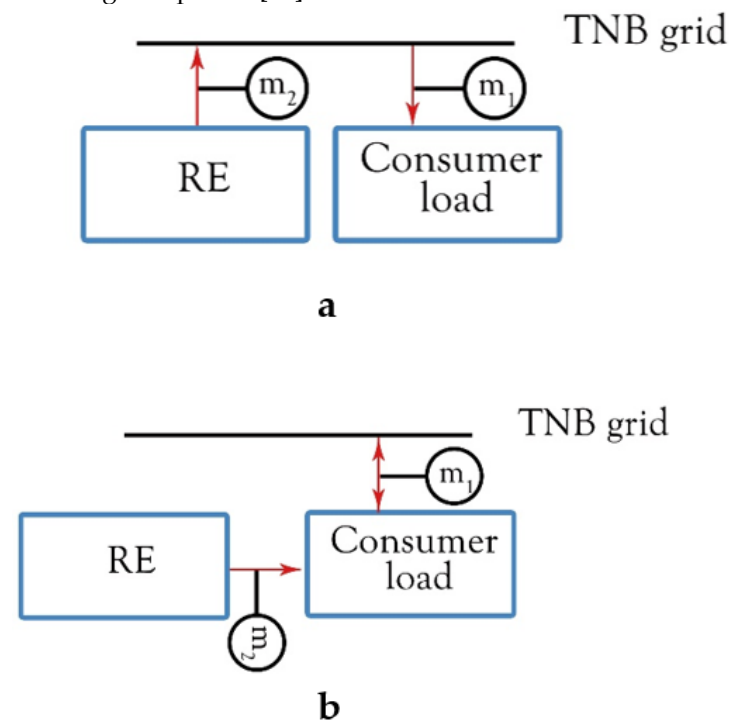


Figure 2. (a) Direct feed-connection point at the distribution licensee's grid (connection to the distributor licensee's grid). (b) Indirect feed-connection point of consumption (connection to the TNB grid) [21].

3.5.2. Indirect Solar PV

Indirect solar PV power generation is implemented for two types of connections, namely Type A for low-voltage customers and type B for medium-voltage consumers [61,62]. The acceptable installation method is where the PV panels are mounted on the building's rooftop within the same premise for both programs, as shown in Figure 2b.

NEM 3.0 applies to the different feeding connection scenarios; the first of which is the typical and traditional scenario of a grid on the PV system [18,63]. The second is indirect solar PV power generation. The connections in each scenario are clarified in the figures below.

The third program covers the commercial and industrial sectors; this program, called NEM Net Offset Virtual Aggregation (NEM NOVA), allows excess electricity to be sold to the grid at market price. Through virtual aggregation, the program allows the installers from these sectors to offset their electricity bill for up to three bill accounts under the same name through virtual aggregation. The allocated quota for this program is 300 MW [21]. All three programs were announced in 2021. This will help Malaysia achieve its goal of 20% renewable energy installed capacity by 2025 [21].

3.6. Large-Scale Solar (LSS)

The LSS program is a utility-scale program [64–67]. It can be applied through a competitive bidding process. The lowest price receives the allowed quota. Malaysia awarded 500 MW for the third time for LSS [68].

For large-scale solar plants, it aims to apply bids to drive down the levelized cost of energy (LCOE) [67,68]. LSS and the energy commission is the implementing agency for this scheme. The lowest bidding price wins the installation quota. At one interconnection point, LSS must have a 30 MWac capacity to be connected to the transmission network.

The scheme uses a reverse auction system to award bidders based on the lowest bid for offtake rates. LSS 3 received a 50% reduction compared with offtake bids received in LSS 2. Debt financing is a standard financing method in this program. There is only a single off-taker, Tenaga Nasional Berhad (TNB), and this cost is directly passed on to electricity consumers. The rate of the electricity produced by the PV farm includes but is not limited to Engineering Procurement and Construction (EPC), land cost, project development cost, financing cost, O&M cost and interconnection cost [68].

3.7. Self-Consumption (SELCO)

This scheme is called self-consumption (SELCO), which started in 2017 as a second option for the NEM scheme. This is true for consumers who install PV systems and use the generated electricity for their own consumption [69–71], where any excess is not allowed to be exported to the utility grid [72]. There is no capacity limit for SELCO, which gives customers the freedom to install as much as they need for their PV system [73–76]. However, any system that exceeds a 72 kW size must obtain a private generating license as mandated by the Energy Supply Act [76].

3.8. Peer-to-Peer (P2P)

Peer-to-peer (P2P) electricity trading is a business model designed on an interconnected platform. This platform is a virtual marketplace for electricity where a consumer can purchase it directly from the producer with no need for a middle party to handle the transaction [77–80]. P2P electricity business trading is also known as the “Airbnb” of energy, since both concepts are based on the platforms that allow local peers to sell their product [81–83].

The buyer handles the electricity sold in this platform, and the seller becomes a member of the forum by default. Members are charged a monthly subscription fee, such as in any open markets where the electricity producer seeks the highest possible price while managing the lowest cost for producing the electricity [83–86]. In addition, the buyer seeks the lowest price that meets their preference and quality type [87,88]. When the producer of the electricity that sells on the platform has a price that matches the buyer’s requirements and who consumes the electricity, a trade occurs [85]. This is totally different from the traditional way of buying electricity, where the consumer has no option but to buy from the utility grid at a fixed price tariff set by the grid [81,89].

In Malaysia, under the NEM policy, the producer of electricity can sell the excess energy to the grid in return for a reduction in their electricity bill in the next month (carries forward). For every kWh of electricity sold, one kWh is returned. Under the NEM, there is no financial return, in contrast to the FiTs, where electricity is sold to the grid with a financial return to the electricity producer. In the P2P platform, the excess energy produced from the PV system can be sold to another consumer at a price smaller than the utility grid price [90]. This means that the prosumer (who generates as well as consumes) can sell the excess electricity produced to another consumer who is willing to pay [91]. In this way, the prosumers obtain a financial return [92,93]. The prosumers sell their solar electricity at a competitive rate compared to that of the retailer’s tariff. This provides the consumer with an option of where to choose to buy electricity. This fulfils a completion for the electricity market price [89].

A pilot trial has been designed in Malaysia to test the feasibility of solar energy trading in the Malaysian energy market by allowing consumers to choose whether they wish to purchase clean, renewable energy or power from fossil fuels [94]. Being the implementing agency, SEDA has accepted the responsibility to undertake P2P strategies to be explored under the Renewable Energy Transition Roadmap (RETR) 2035 to augment the solar PV rooftop market [94].

The pilot program was run for eight months in Malaysia. It is essential to have a clear awareness and explanation for the prosumer and consumer about the concept. Solar PV is a new technology that can be confusing for people to understand the policy concepts of the trading behind it. This requires educational programs that can encourage homeowners to join the platform and to install PV systems. It is also essential to identify the technical requirements for a successful smooth platform. [94]

This project can be beneficial for both the PV installer and the utility grid. Prosumers can reduce the cost of electricity while enjoying clean energy by participating in P2P sharing. Furthermore, the prosumer can obtain a financial return on the excess PV energy produced. Previously, under FiT, only prosumers with renewable sources could enjoy the economic and environmental benefits of solar energy trading, as depicted in Figure 3 [95,96].

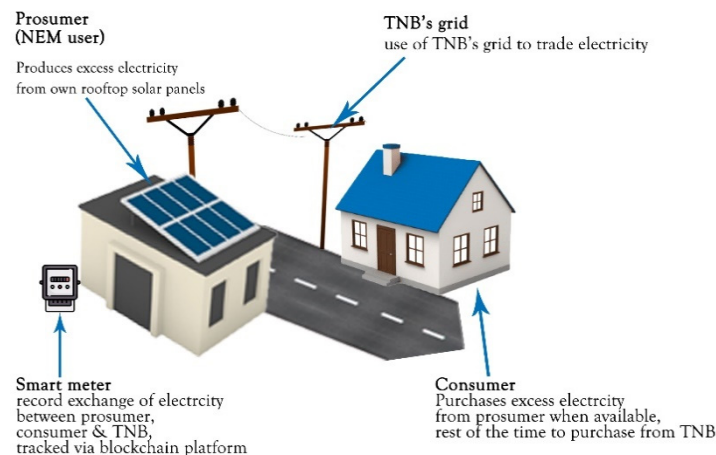


Figure 3. P2P scheme connection [21].

P2P can also benefit the grid by reducing the high-demand pressure on electricity. The increased demand increases with population growth, which requires the grid to expand its distribution network, which costs more than the P2P platform [95,96].

4. Results and Comparison of Solar Energy Policies in Malaysia

Solar PV requires minimum construction and maintenance. The policies applied by the governments have helped to decrease the price of the panels sold on the market. The main goal that inspired these policies is to achieve a 20% Renewable Energy (RE) Capacity Mix by 2025, based on the pledge made in 2019. The preliminary Renewable Energy Transition Roadmap (RETR 2035) established by SEDA has predicted that by 2025, more than half (56%) of the 20% RE target capacity will be contributed by solar PV due to the declining price of solar PV in Malaysia and the high average solar irradiance, which makes this goal possible [7,8].

As highlighted earlier, the first policy that supported the renewable energy in Malaysia was FiT in 2011. However, FiT is no longer offered a new allocation of quotas for solar PV despite that it was a successful program that ended in 2016 and replaced with NEM. The program had so many advantages due to the incentives offered by the Malaysian Government. Because of the excess of electricity being exported to the grid for cash back, this program has attracted many users to install solar PV and invest in the projects. Table 1 tabulates the summary of the PV policies in Malaysia from 2016 until present, where NEM is the active policy for the grid using PV systems. The government started this program

due to the increase in solar PV projects which would require the grid expansion. According to a case study conducted by Razali [16], which compared the NEM and NEM 2.0, it can be concluded that the financial aspect of NEM 2.0 is more cost saving for large-scale solar. Whilst for a small scale such as a home, both policies are not profitable [16].

Table 1. Summary of solar PV policies in Malaysia from 2011 until 2021.

Policy Name	Definition	Timeline	Advantages	Drawback	References
FIT	Feed-in Tariff policy is the form of selling electricity produced by the user to the grid. Two meters are installed. One to count electricity used by the user and the second meter to measure the kWh produced by the user and sent to the grid sold at a fixed price to the grid. The concept of FiTs is that the output from the PV system produced by the user is sold to the grid with a tariff price set by the utility grid	2011–2016	<ul style="list-style-type: none"> - Reduction of CO₂ emissions - Encourages investment in photovoltaic solar energy, - Helps solar energy to compete with other trad - Creates new jobs 	More pressure on the grid, since the customer send all the PV produced energy to the grid.	[33,37]
NEM	NEM allows the consumer to generate solar power and use it, and the excess energy is exported to the grid and is offset later on with a rate of 0.31 from the next electricity bill.	2016–2018	<ul style="list-style-type: none"> - Reduction of CO₂ emissions - Less pressure on the grid since the customers first use the PV energy, and then the excess energy is sent to the grid. - Creates new jobs 		[44,45]
NEM2.0	The policy allows the consumer who generate PV energy to export the excess energy to the gride and every kWh is offset with another kWh from the next electricity bill.	2019–2020	<ul style="list-style-type: none"> - Every kWh exported to the grid is compensated from next electricity bill with the value of kWh. - Creates new jobs 	There is no financial benefit; the project saves money but does not allow to earn cash.	[16,53]
NEM3.0	Same concept as NEM 2.0, with the exception that it allows indirect connection for commercial building. In addition, the rate for the exported kWh is less than the price of kWh for commercial building.	2021–2023	<ul style="list-style-type: none"> - Reduction of CO₂ emissions - It allows indirect connection to the grid. - Creates new jobs 	<p>Limited capacity, and older customer who already joined the grid under NEM previously could not join.</p> <ul style="list-style-type: none"> - The price of exported electricity for commercial building for every kWh is less than the rate of kWh sold by the grid. 	[25,60]
LSS	Is a bidding program where the lowest bidder gets the quotation.	2016–2021	<ul style="list-style-type: none"> - Reduction of CO₂ emissions - Great return of investment - Tax break - Saves space if used for other project such as fish farm - Creates new jobs 	<ul style="list-style-type: none"> - It requires big space; it is wasted, if not used for other projects. - Very high cost 	[81–83]
P2P	In P2P, it is electricity that is sold to and from a locally distributed energy generator that sells their electricity at reasonable rates that the consumer is willing to pay in exchange for their electricity	2020	<ul style="list-style-type: none"> - Reduction of CO₂ emissions - A great way to encourage the installation of solar energy and gain profit. - Increases the national and regional independence of electricity 	It is still not practiced and lack of good data from different locations.	[81,89]

All these policies have created approximately 50,000 jobs in Malaysia in the green field of construction, operation and maintenance of solar photovoltaic plants. Government policies affect how jobs are generated throughout the renewable energy supply chain. FiTs were critical to creating many jobs in today's marketplace. Malaysia, including other countries in Asia, plays a significant role in the production of solar panels [97].

IRENA reported in 2018 that 3.6 million jobs come from global solar employment, with almost 3 million from Asia. According to the report, Malaysia is one of the top 10 nations employing in the solar power industry.

Figure 4 shows the installed capacity of FiT and NEM, which was introduced in 2011 and 2016, respectively. Because the NEM had no financial return, it affected the return of investment for the PV system.

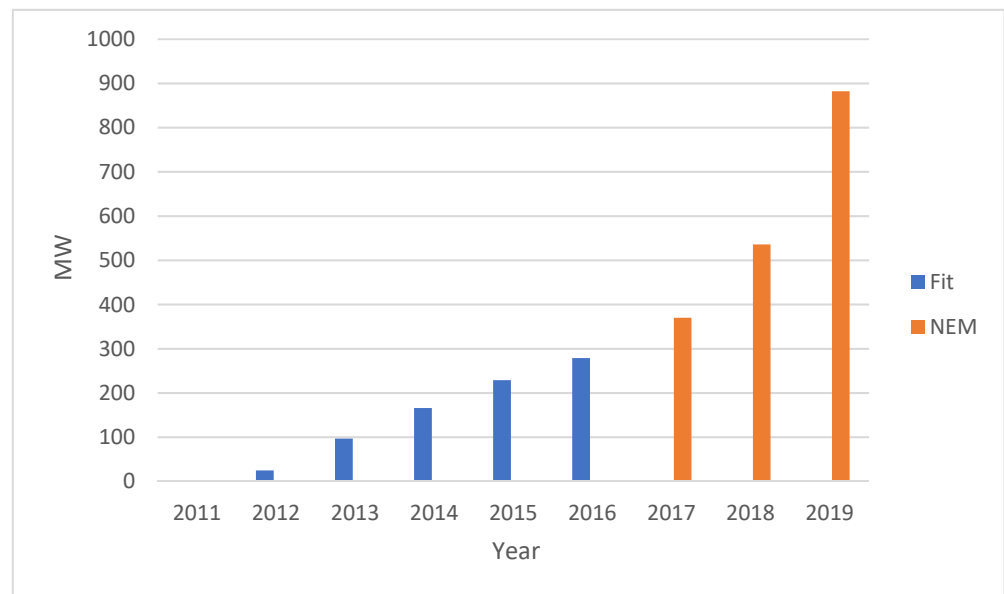


Figure 4. Installed capacity (MW) of commissioned PV solar installations in Malaysia.

The clean energy produced by solar PV installed in Malaysia was 440 GWh in 2018 as shown in Figure 5. Although this sounds like a success, compared with leading countries in solar energy in Asia, Malaysia is far behind. The installed capacity of PV is very low when comparing with China and Japan. For example, in 2019, China installed 205,493 MW, whilst Japan has established a PV capacity of 61,840 MW Table 2. With the installed capacity of 882 MW, it is nowhere near what China and Japan accomplished ten years ago in 2010. Table 1 tabulates the installed capacities for some of the countries in the region [35,81].

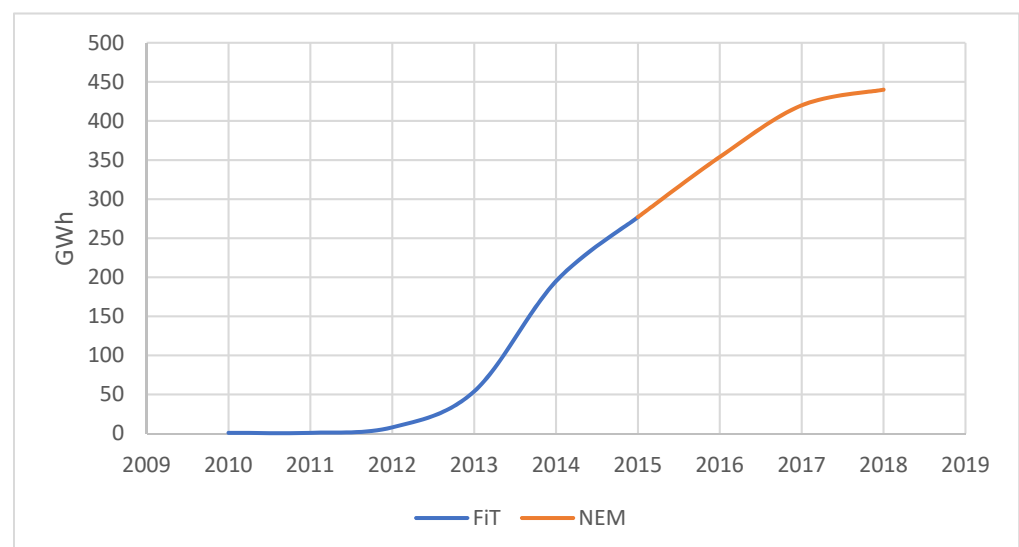


Figure 5. Energy produced from PV in GWh from 2010 to 2018 [98].

In 2019, a pilot project was conducted in selected countries around the world, including Malaysia. The project was called a peer-to-peer energy trading and was completed in 2020. It was conducted to test the market flexibility to join a platform that sells electricity from producers to users directly. The study had approximately eight customers that participated [95,96]. As part of the strategy to scale up the solar PV rooftop market, a peer-to-peer energy trading pilot study was tested under a regulatory sandbox in 2019 and was recently completed in 2020 [95,96].

Table 2. Solar energy installed capacity in MW [81].

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
China	1022	3108	6719	17,759	28,399	43,549	77,809	130,822	175,237	205,493
Japan	3599	4890	6430	12,107	19,334	28,615	38,438	44,226	55,500	61,840
India	65	566	982	1499	3673	5593	9879	18,152	27,355	35,060
Indonesia	15	17	26	38	42	51	58	60	62	198
Malaysia	1	1	25	97	166	229	279	370	536	882
Korea Rep	650	730	1024	155	2481	3615	4502	5835	7130	10,505

Further development of fossil resources (such as coal, gas and oil) for electric-power production in Malaysia would affect GHG emissions and would delay Malaysia from achieving its target of reducing carbon emissions to the environment. To accelerate the process of achieving their target, the Malaysian government must review its power sector expansion plan to focus on RE resources and to reduce oil and gas utilization [10].

5. Discussion

In the previous results and comparison, it can be seen that most of these policies share positive effects such as: the reduction of toxic gasses mainly CO₂, the use of empty lands that are not suitable for plantation, and reducing the pressure on the distribution network in the grid and increasing the national and regional independence of electricity. When comparing these policies with the completed installations, it can be seen that FiT is the most successful policy due to its cash profit and incentive to the customer. The first introduction of NEM policy was not a good hit due to its non-cash profit and the fact that the project takes much longer return of investment (ROI) as compared to the FiT. The second NEM had an improvement where the cost of every exported 1 kWh equals 1 kWh, which comes from the one-to-one energy off-set. This may help the consumers to save on electricity, but they would not earn money out of the projects. It is also not advisable for small consumers to implement NEM. The third NEM introduced in 2020 has a new slandered connection that allows the commercial consumers to do hyper projects where they can depend on solar energy by connecting to the grid and at the same time connect to the battery storage. Most of the quota offered for installations pertinent to these policies were taken out.

Considering the government pledge for 31% of having the renewable energy supply by 2025, a quick benchmarking with other countries could be a good idea in drafting more attractive policies and incentives towards boosting more solar PV installations that can benefit both the vendor/installer and the customer. Undoubtedly, many actions and initiatives have been implemented for the last decade or so on the RE policies, but a direct impact, profitable and cost saving might be something that is required such as the tax exemption for PV system owner and higher capacity of installations, which currently stands at 75% from the MD.

Policies of solar energy in Malaysia still have some limitations such as lack of consistency in policy framework and regional policy innovation, inadequate investment in the technical research of renewable energy and lack of financial investment system. A strong financial support system such as loan facilities and taxes that makes solar power attractive [97]. Although Malaysia is one of the top 10 countries that produce solar panels, the PV market in Malaysia is still small and thus results in a small number of implementation as compared to other countries. Considering the global pace and demand for solar PV installation and market size, respectively, Malaysia must increase the goal and challenge itself to compete with other countries in solar energy such as by increasing the quota size [98] and providing some attractive incentives, as highlighted above.

6. Conclusions

This paper has provided a chronological review of Malaysia's effort to become one of the countries with high solar PV energy penetration. A series of policies were developed with many initiatives introduced. Great efforts from the relevant Ministries and Regulator

have exhibited the seriousness of the government to convert to a clean and green resource for electricity production. The long-term vision for the Malaysian nation is to use solar energy as a replacement for fossil fuel, where it can be safely said that the programs implemented have helped to attain energy independence and to promote efficient utilization. They have also helped to minimize the impact on the environment and to enhance national economic development through technological utilization, which has resulted in improving the quality of life. In addition, the LCOE of solar power is gradually declining to become competitive with the tariffs for grid electricity. This is due to the execution of the LSS 3's bidding program.

Despite the opportunities that these policies are allocating today in Malaysia, the establishment of PV energy sharing in today's energy market depends on the decision of the regulatory board, which determines the percentage of renewable energy in the energy mix. Thus, it is in the government's power to regulate and design taxes and fees that help solar energy integration in the energy market, to support efficient utilization of solar energy and to lessen environmental degradation. However, as the government attempts to balance the environmental needs of green sources of energy and to strengthen the economy that supports people utilizing new energy sources, this could threaten investments in traditional sources.

It can be concluded that between all the previously implemented policies, FiT has proven to be the most effective due to the fact that it is the most profitable. In order for Malaysia to expand the implementation of solar energy, it must improve the policies applied to the users and provide financial support, especially for the rooftop consumers, without excluding attractive incentives for commercial-size solar PV plants. These policies can expand the PV market in Malaysia to a significant degree.

In addition, policy makers and regulators are encouraged to weigh the cost and benefits of each policy on a national state and the value of distributed solar to the grid and stakeholders.

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