A comparative study on renewable energy policies between Japan and Malaysia

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Abstract. The world relies heavily on fossil fuels for energy generation, thereby leading to global warming and regional climate change. Renewable energy (RE) is one of the realisable solutions to tackle the drastically increasing energy demand. As the global push for RE culminates within the coming years, energy policies will be the key driver in promoting RE deployment. Japan as a developed country aims to achieve a 36–38% share of RE in the energy mix by 2030, whilst Malaysia being a developing country has set a goal of achieving 31% RE mix by 2025. This paper presents a comparative study of RE policies between Japan and Malaysia, with the RE policies of both countries being analysed and presented chronologically. Moreover, the factors that contributed to the effectiveness of the policy and the measures that can be taken to overcome the shortcomings of the policies are elaborated. It is observed that both countries have been actively implementing a series of RE policies since the 21st century, especially Japan after the Fukushima nuclear disaster in 2011. Japan has shown an outstanding achievement where it achieved 20.8% of RE mix in 2020 while Malaysia is still far behind its target at approximately 2% in the same year. Hence, the Malaysian government should follow Japan's footsteps in adopting and enforcing RE policies, and at the same time increase civil awareness regarding RE and stimulate participation from various stakeholders.

Keywords: Renewable energy, Policy, Japan, Malaysia, Climate change.

1. Introduction

Renewable energy (RE) is defined as sustainable energy that will not be depleted over time, and is naturally and perpetually replenished, with some being carbon neutral and emission-free. Solar, wind, hydropower, biomass, biogas and geothermal energy are prominent examples of RE. Non-renewable energy is produced from the combustion of sedimentary commodities such as fossil fuel — coal, petroleum, and natural gas — the norm of the energy sources that the world adopt today.

The latter form of energy is highly detrimental to the environment as most of them are derived from carbonaceous biological remains. Carbon dioxide (CO_2) and other greenhouse gas (GHG)

emissions released will adversely enhance the greenhouse effect, causing global warming and climate change, undesirably hastening the dystopian phase of the Anthropocene era. The Sixth Assessment Report (AR6) recently published by the Intergovernmental Panel on Climate Change (IPCC) Working Group I asserts that climate change is unambiguously anthropogenic, as human-induced global temperature has perceptibly risen by 1.07 °C since the 19th century [1]. It is an unprecedented dilemma that governments must strike a balance between taking immediate action on climate change and at the same time, ending the pandemic by eradicating the COVID-19 virus.

Optimistically, the world energy outlook for the forthcoming decades is to achieve net-zero carbon/GHG emissions, which is pledged by various countries such as the United Kingdom [2], Malaysia [3], China, Japan, and the European Union [4], just to name a few. This can be made possible by unanimity and avid participation of various stakeholders and policymakers, and through legislation of nationwide RE acts and policies. Global engagement in RE is projected to resolve pressing issues such as full electrification of areas that are stricken by poverty or grid connectivity is limited.

The objective of this research is to assess and study the contemporary advancement of RE in Japan and Malaysia, to address the gap in the field of RE as a comparative study. The RE policies in Japan and Malaysia are presented in Section 2 and 3 respectively. Section 4 compares the RE policies between the two countries which includes similarities and dissimilarities, and finally Section 5 concludes this paper.

2. Renewable energy policies and programmes in Japan

2.1. RE policies in Japan

After the two international oil crises and price leaps in 1973 and 1979, Japan enacted several laws and measures to reduce the dependence on imported oils and to develop alternative energy sources. One of the first laws enacted was the 'Oil Emergency Measures' in 1973, whereby administrative guidance was implemented for large companies in manufacturing industries to cut their oil and electricity consumption. Japan then went on to become a founding member of the newly established International Energy Agency (IEA) in 1974, which was founded to help its members respond to major oil supply disruptions. There was also a 'Petroleum Stockpiling Law' in 1975 which intended to stabilise the supply and demand of oil. With the advent of these laws, the Japanese government stepped back from regulating crude oil market prices. The price of electricity had also increased in tandem with the fuel price, and as a result, the energy efficiency in Japan began to improve. Japan had also gradually shifted to using coal and liquefied natural gas (LNG) [5].

In 1980, the Law Concerning the Promotion of the Development and Introduction of Alternative Energy was enacted, in which the New Energy Development Organisation (NEDO) was established. NEDO's main purpose was to deal with the large-scale technical development of coal, geothermal, solar, and other alternative energies. NEDO would act as the R&D hub of new energy sources by handling the financing and aid for development projects.

Later in April 1997, the Law Concerning the Promotion of the Use of New Energy came into force, aimed at promoting non-fossil energy sources that were previously not widespread due to economical constraints. These were such as biomass, temperature gradient, geothermal power (binary power generation), wind, hydroelectric (below 1 MW), solar thermal and photovoltaic (PV) generation.

In 2000, the Japanese government began to adopt an electric power market model that had plans to be liberalised on a step-by-step basis to promote fair competition and transparency within the electricity market. Under the Amendment of the Electricity Utility Industry Law, suppliers (more commonly new entrants to the electricity market) were allowed to use the power transmission lines that were owned by power utilities under 'wheeling rules' for a fixed rate. Before this amendment was proposed and put into effect, all customers in the regulated market received electricity supplied by the ten privately-owned regional electric power companies. The liberalisation allowed the power producers and suppliers (PPS) to sell their electricity to extra-high voltage users who had electricity

demands above 2 MW. The scope of liberalisation was further expanded in April 2005, covering users with an electricity demand of over 50 kW. This was then followed by the April 2013 Electricity System Reform. Under such liberalisation, electrical utilities could retain control over the transmission and distribution lines (power grid) but will cease to have full control at the end of 2020 [6].

The Basic Energy Plan (BEP) was first formulated and established in 2003 after the Basic Act on Energy Policy was adopted in 2002. Goal and targets related to energy security and efficiency, self-sustainability, and environmental concerns were announced within the BEP. The BEP is revised every 2 to 3 years depending on the current state of energy in Japan. The 2010 BEP was noted to have established ambitious targets for Japan and detailed the measures to be taken to achieve the targets set. It was noted that a comprehensive FiT system could increase Japan's production by 40 to 50 billion kWh or more in the next decade, due to the potential of RE expansion marketed by the growth of installed generating capacity from wind and solar energies [7]. The ambition of the targets set for Japan in 2030 was also regarded to be very challenging to achieve, to the extent that there was a potential of provoking negative reactions among the affected parties if there was a tremendous gap between the actual results and targeted values. The BEP was then upgraded to the Strategic Energy Plan (SEP) in 2014, essentially comprising a more detailed realisation of the 2015 Long-Term Supply and Demand Outlook. In terms of RE promotion, the government had plans to introduce smaller-scaled RE within residential homes and local communities, with the hope of revitalising regions where electricity is less readily available than in the urbanised regions of Japan [8].

The Green Growth Strategy through Achieving Carbon Neutrality in 2050 is chiefly an industrial policy that targets sustainable growth and innovation by incorporating necessary policies, hence aiming to update policy measures as well as goals to be achieved [9]. On the RE side, the government plans to maximise introduction, reduce costs and secure suitable locations to support RE development. The strategy also noted that the increase in energy demands would also lead to the potential growth of energy-saving industries such as the reformation of manufacturing processes and the electrification of transport, businesses, and homes. To help achieve the goals stated in the strategy, a JPY 2 trillion fund was allocated in support of the development and demonstration of the technology, where taxes and regulations would be reformed to optimise the process [9].

As plotted in figure 1, Japan had an energy mix of 31.3% natural gas, 29.1% coal, 17.3% RE, 9.0% hydro, 8.8% oil, and 4.6% nuclear in 2020. The RE composition in its own percentage is 41.0% solar PV, 38.1% hydro (including large hydro), 15.5% biomass, 4.2% wind and 1.2% geothermal [10]. Japan has its newest RE goal of reaching 36–38% by 2030 [11].

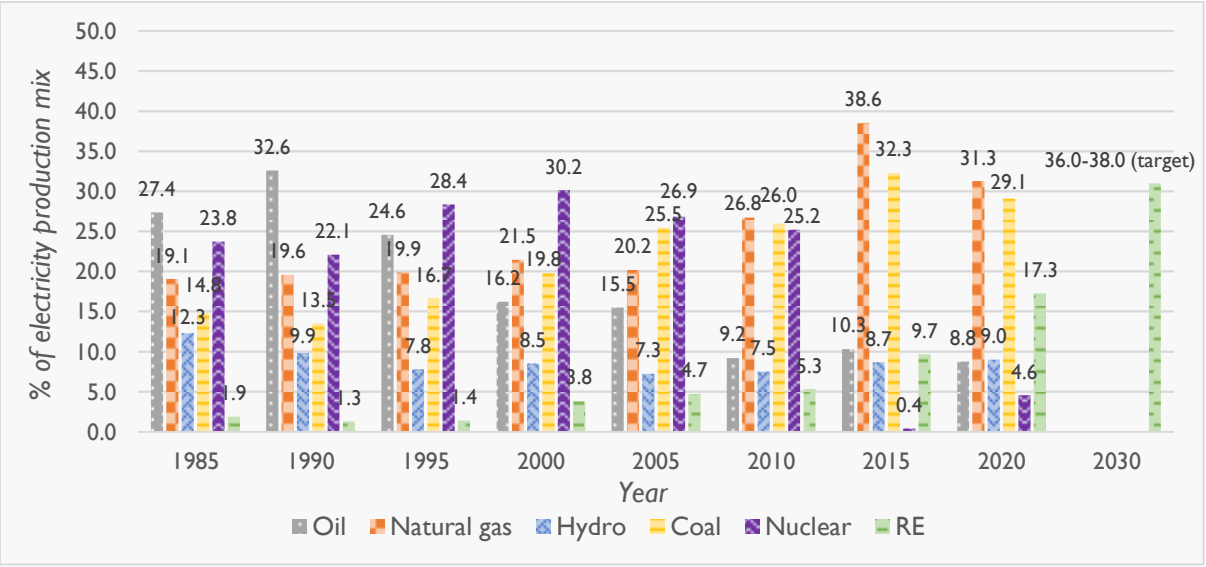

Figure 1. Percentage of electricity production mix in Japan from 1985 to 2030 (target) [11][12].

2.2. RE programmes in Japan

2.2.1. Sunshine Project. The Japanese government launched the Sunshine Project in 1974 in response to the first international oil crisis. The project was a national research and development (R&D) programme that aimed to produce alternative energies to fossil fuels by the next century. The Ministry of International Trade and Industry (MITI) took charge of the programme between its launch in 1974 to its expansion in 1981 with an initial budget of JPY 2.5 billion. When the second oil crisis hit in 1979, the government was further inclined to invest in the development of alternative energies, increasing the funding and targets [13]. The programme was mostly directed towards the expansion of domestic energy sources in the long term. In addition to the Sunshine Project, the Moonlight programme was launched in 1978 to develop new energy efficiency technologies that could help with the reduction of energy consumption [14]. These two programs were integrated into the New Sunshine Program in 1993 that lasted until 2002. This program was managed by NEDO, which covers most of the RE projects launched.

2.2.2. Renewable Portfolio Standard (RPS). The Japan introduced the RPS in 2003 under the Act on Special Measures Concerning the Use of New Energy by Electricity Companies. The RPS legally required each of the electrical power companies to generate or purchase a designated volume of "new energy" or its equivalent as a percentage of electricity being sold [15]. The implemented quota could be met using three methods: self-generation, purchasing from new energy providers or obtaining New Energy Certificates (NEC) from the certificate market [16]. An NEC equates to 1 MWh of electricity generated and supplied by an accredited facility [17]. The actual obligatory amount to be met by electric utilities was continuously reduced for them to meet the goals.

2.2.3. Feed-in-Tariff (FiT) System. The FiT system was first introduced to Japan in July 2012 to replace the RPS system. The FiT scheme is a purchase system whereby power companies are required to purchase electricity generated from RE sources at a certain price for a certain period. The portion of the cost that electric companies use to purchase RE is borne by their users, forming a levy to support the introduction of RE that would otherwise be expensive for individuals [18]. The levy would act to recover the high construction costs of RE power generation facilities. The scheme also allowed surplus electricity generated from residential PV to be purchased by electric companies at a fixed price for ten years.

The initial FiT rate was set at 40 yen/kWh for plants with a capacity greater than 10 kW. The tariff would be updated on an annual basis to reflect the changes in construction costs or to account for increased competition for new PPS. Contracts signed prior to each update would remain invariant until the expiry of the contract. The tariff has been observed to be on a declining trend, indicating the effectiveness of FiT.

3. Renewable energy policies and programmes in Malaysia

3.1. RE policies in Malaysia

Dating back to the 1980s, oil was a dominant source of energy in Malaysia, although it has remarkably diminished over the years which is conspicuous in figure 2. This is because of the introduction of the Four-Fuel Diversification Policy in 1981 to diversify the country's energy source and prevent overdependence on oil, after the oil crises as previously mentioned in the last section. The prevalent electricity production mix in Malaysia as of 2019 is mainly comprised of coal (41.1%), natural gas (39.6%), and hydropower (16.4%), with a small proportion for oil (1.5%) and RE (1.4%) [19].

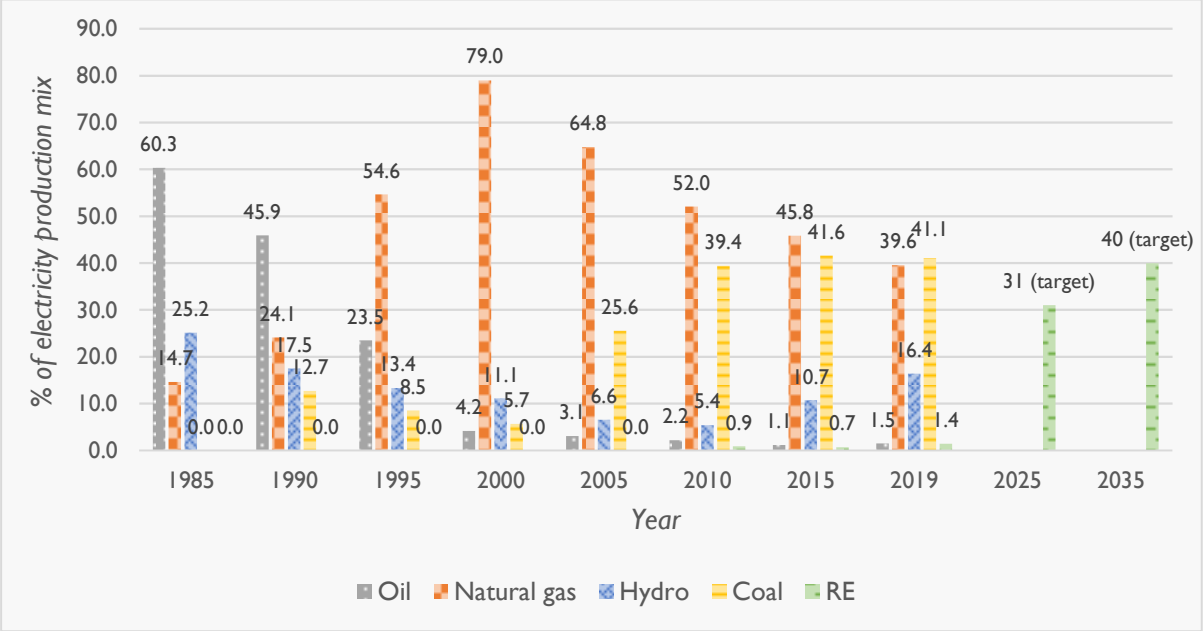

Figure 2. Percentage of electricity production mix in Malaysia from 1985 to 2035 (target) [19][20].

The Four-Fuel Diversification Policy was then superseded by the Five-Fuel Diversification Policy (2001) during the 8th Malaysia Plan (2001–2005). The renewable resources (biomass, biogas, municipal waste, solar, small hydropower etc.) are collectively the fifth 'fuel', to further ensure energy security [21]. The Small Renewable Energy Power (SREP) Programme was implemented from 2001 to 2010 to promote small-scale renewable electricity, as it allowed renewable projects with up to 10 MW capacity to sell their electricity output to Tenaga Nasional Berhad (TNB) or Sabah Electricity Sendirian Berhad (SESB), under 21-year licence agreements. An initial target was set at 500 MW (5% mix by 2005) for grid-connected power generations from RE sources [22].

However, the SREP only achieved 12 MW (2.4% of target) by the end of 2005. In the 9th Malaysia Plan (2006–2010), this 500 MW target was revised and decreased to 350 MW and the programme was extended for five more years to 2010. Albeit as of 2010 only 61.7 MW (17.6% of new target) of capacity had been set up. The failure of SREP was most likely due to limitation of capacity, policy gaps and conflicts, few pre-feasibility studies, and tactical opposition from TNB, amongst other reasons [22]. The SREP underachievement was not a fiasco at all, in fact it was a cornerstone for its successive RE policies/programmes. Most of the SREP RE sources belong to the biomass category, for instance, palm waste, wood waste, rice husk, and municipal solid waste [23].

The National Renewable Energy Policy and Action Plan (NREPAP) was published by the Ministry of Energy, Green Technology and Water (MEGTW) in 2009 to overcome the main barriers to RE deployment in Malaysia. The plan also intended to promote and diversify the energy mix through the utilisation of indigenous RE resources to achieve electrical supply security and sustainable socioeconomic development [23]. It also addressed the past RE market failure and the incoherence of RE policies. The RE generation targets proposed by NREPAP during that time was from 1% in 2011 to 9% in 2020 and 24% by 2050; and the sustainability target was to avoid 30 million tonnes of CO_2e [24]. NREPAP also introduced a FiT system, which was then realised in 2011 by the enactment of the Renewable Energy Act 2011. Consequently, the Sustainable Energy Development Authority (SEDA) was established through the SEDA Act 2011.

Recently, Malaysia's Energy Transition Plan was announced in 2021. The RE installed capacity targets are 31% by 2025 and 40% by 2035, whereas CO_2e intensity reduction targets are 45% by 2030 and 60% by 2035. This plan also introduces battery energy storage systems (BESS) with a capacity totalling 500 MW [20].

3.2. RE programmes in Malaysia

3.2.1. Feed-in-Tariff (FiT). The FiT system in Malaysia was initiated in 2011, but was later abolished in 2016, and the 1.6% Renewable Energy Fund (aka KWTBB) levy that every electricity consumer (domestic customers with 300 kWh or above consumption) had been obliged to pay in their bills every month was to be blamed. The purpose of the fund had been to promote the growth of electricity generation from renewable sources [25]. Nevertheless, the 1.6% KWTBB is still being imposed in the domestic electricity bills nowadays.

Power producers with RE installations having a capacity of less than or equal to 30 MW were eligible to apply to be feed-in approval holders (FIAHs). FIAH enters a RE power purchase agreement (REPPA) with distribution licensees (DLs). DL (i.e., TNB which is the sole utility company in Peninsular Malaysia) was obliged to purchase electricity generated via renewable resources from FIAHs for a specified duration under an annually degressed tariff rate. The degression has been effective from 1st January 2013. Gradual degression is implemented to encourage early RE investment and to achieve grid parity [26]. The RE will eventually be fed into the utility grid.

Solar PV (59%) is the most dominant FiT installation, followed by biogas (17%), biomass (13%) and small hydropower (11%) [26]. The degression rate for solar PV is 8%, biomass and biogas are 0.5%, and there is no degression for small hydropower. The effective period for solar PV and small hydropower are both 21 years, whilst biomass and biogas are both 16 years. Note that for a certain type of RE, there exist subcategories that are entitled to different rates depending on their capacity. There are also criteria for bonus FiT rates, such as the support and utilisation of locally manufactured or assembled solar PV components [27].

3.2.2. Net Energy Metering (NEM). The NEM scheme was introduced in 2016 to stimulate RE investment and uptake, and there are three versions of NEM up to date [28]. Eligible consumers install solar PV systems primarily for their own in situ generation and consumption, whilst any excess energy will be exported back to the national grid, and credit will be paid in return of such electricity provision. Consumers can still use electricity from the grid under unfavourable conditions such as on rainy days where there is no solar energy output. A bi-directional meter is utilised to import and export electrical energy.

NEM 1.0 suffered unattractive financial return by displaced cost method. Later, NEM 2.0 was introduced in January 2019, and the true net energy metering concept on a ‘one-on-one’ offset basis was adopted, so people pay less in electricity bills [29]. In light of keen responses from the PV industry, NEM 3.0 will be implemented from 2021 to 2023 with a total quota allocation of about 500 MW, leveraging the abundant solar energy as an equatorial country. The NEM 3.0 will be divided into three new categories: NEM Rakyat, NEM GoMEn (Government Ministries and Entities), and NOVA (Net Offset Virtual Aggregation) [28]. All categories are subjected to conversion to self-consumption (SELCO) after ten years, in which the electricity generated is only for own usage and excess energy is not allowed to be exported to the utility grid.

3.2.3. Large Scale Solar (LSS). LSS is a competitive bidding programme to drive down the levelised cost of energy (LCOE) for the development of extensive solar photovoltaic plant, and it envisions to replace the FiT scheme. The eligible capacity ranges from 1 MW to 30 MW and higher. Energy Commission is the implementing agency for this scheme. There are four bidding cycles to date: LSS 1 (2017-18) and LSS 2 (2019-20) have total export capacity of 450.9 MWac and 562.0 MWac respectively, whilst LSS 3 (2021) and LSS 4 (2022-23) have total shortlisted capacities of 490.9 MWac and 823.1 MWac respectively [30]. In 2021, the state of Kedah had the highest capacity awarded (355.77 MW) and an operational capacity of 194.99 MW in LSS [30].

3.2.4. myGreen+ and Green Electricity Tariff (GET). Offered in October 2019 by TNB, a Malaysian multinational electricity company, myGreen+ was an RE subscription plan to preclude unwieldy installation of solar rooftops or other RE installations.

The tariff rate of myGreen+ subscription in 100 kWh-blocks was 8 sen/kWh, with a minimum subscription of 100 kWh (1 block). TNB would match 100% of the myGreen+ subscription from electricity generated by renewable resources, and customers would be issued a Green Consumer Certificate by TNB. Without any surcharges, customers could alter or terminate their myGreen+ subscription blocks freely after enrolment. The Malaysia Green Attribute Tracking System (mGATS) was the certifying agency, which provided each myGreen+ with a unique identification number to ensure they were not double-counted. Recently, the myGreen+ scheme has been reformulated to GET, with a subscription period of one year [31]. The new subscription rate is 3.7 sen/kWh, with a minimum subscription of 100 kWh-blocks for residential and 1000 kWh-blocks for non-residential consumers. As of 29th December 2021, the total opening quota is 333.33 GWh, with 21.27 GWh (6.4%) being subscribed by 135 customers. GET customers will receive an internationally recognised Malaysian Renewable Energy Certificate (mREC) [31].

Malaysia has an ambitious RE penetration goal of 31% by 2025 and 40% by 2035 [20], which seems to be quite demanding, having achieved merely 2% in 2019. However, it is unsure that whether the proposed RE goal includes (large) hydropower or not, since there has been a prolonged debate on such inclusion due to the affordability and environmental impacts.

4. Comparative analysis of RE policies between Japan and Malaysia

On the report of *bp Statistical Review of World Energy 2021* [32], the primary energy consumption (PEC) in Japan in 2020 is 17.03 exajoules, which is about 3.1% of the world's PEC (557.1 exajoules); whereas the PEC in Malaysia in 2020 is 4.11 exajoules, constituting 0.7% of the global PEC. By calculation, Japan's PEC in 2020 is 19.3% lower compared to 2010 levels, and for Malaysia it is 22.7% higher.

Malaysia (non-Annex I) and Japan (Annex I & II) are parties to the Kyoto Protocol [23] and Paris Agreement, and they also strive to meet the United Nations Sustainable Development Goals (UN SDGs) by 2030, for which two of them are Goal 7 (affordable and clean energy) and Goal 13 (climate action). Malaysia is neither a member nor association country of the International Energy Agency (IEA), even though its neighbouring countries (Indonesia, Singapore and Thailand) have attained association status [33]. Japan has been an IEA member since 1974.

Both countries were stricken by the same oil crises in the 1970s and had constructed policies to divert away from oil, hence increasing awareness on developing and utilising RE. The RE development boom in Malaysia and Japan both happened in the noughties, as the energy demand soared high and the effect of climate change became more apparent during this time.

There has been an increasing political and regulatory risk related to the power grid in Japan, as the electric grid still remains unintegrated and unable to cope with the intermittency of RE technologies. It is noteworthy to mention that Japan's electricity market has been mostly controlled by the ten privately-owned regional power companies [34], where there arises the incompatibility of operating conditions such as in electrical frequency. These companies have formed a power lobby that held the electricity monopoly and often influenced energy policies in their vested interests, rather than that of their nation [35]. The responsibility for the promotion of RE in Japan is mostly assumed by the Ministry of Economy, Trade and Industry (METI). In 2013, seven out of the ten electricity utilities even announced that they would stop signing agreements to further integrate RE into their electrical systems [36]. In contrast, Peninsular Malaysia only has a sole utility company which is TNB, that nurtures a monopsony (single buyer) environment in FiT, possibly acting in an advantageous manner to suit its own interest and profitability.

The contract duration of FiT in Malaysia is 21 years for biogas and biomass, or 16 years for small hydropower and solar PV [27]; and in Japan it is 20 years for both solar and wind power generation [18]. According to the same sources, the initial FiT rate for solar PV with a capacity greater than 10

kW in Japan is 40 yen/kWh (RM1.46/kWh), whereas for FiT solar installation with capacity of 4–24 kW in Malaysia is RM1.20/kWh. The FiT in both countries experience degression, where the degression rate for solar PV in Malaysia is 8% per annum, and for Japan the degression amount is roughly 4 JPY per annum.

Exclusively in Malaysia, there exists a voluntary RE subscription plan which is Green Electricity Tariff (GET) as discussed in Section 3.2.4. For the GET scheme, one might question why people are willing to pay a premium for RE if a conventional electricity subscription is more economical. Despite the costly nature, this action is called offsetting, which is a voluntary and conscience-driven action, with different levels of commitment by one's financial capability and sustainability goals. For companies, carbon offsetting can boost their brand image as they advocate for climate and sustainable causes. As a role model, MESTECC spearheaded the myGreen+ scheme by being the first subscriber, where they bought RM1,600 worth of RE block to offset their monthly electricity bills by 10% [37].

The transition to carbon-neutral and RE sources is a boon for both country's long-term socioeconomic and sustainable development, however it has a costly initial investment. Governments should focus on the full-scale introduction and implementation of RE instead of worrying about the uncertainties and temporary economic damage that may be inflicted. The inhibitors to adoption of RE may include corruption/embezzlement, country development status, economic issues, geopolitical tensions and much more. In addition, governments could attract citizens to purchasing sustainable technologies that utilises RE such as solar water heating system and rooftop turbine ventilator, in the form of discounts or rebates to increase awareness.

5. Conclusion

Malaysia as a developing country is a key and conscious player in devising and implementing RE plans, having legislated numerous laws and policies. However as some of these laws and policies have not been so successful, such as the SREP programme, there are lessons to be learnt. Japan as a developed country also shares similar RE programmes with Malaysia, such as the FiT scheme, that it is still ongoing in Japan. The likely energy scenarios in both countries are quite optimistic, setting lofty RE penetration targets of 36% by 2030 in Japan and 40% by 2035 in Malaysia.

Government entities, utility companies and policymakers should recognise RE as a mutual goal for the country so it can be achieved through synergy, and not influenced by commercialisation and politicisation of RE in an improper manner. It is vital to attract investments and involvements from various stakeholders, and gain the trust and willingness of citizens, since most of them are still reluctant to move towards RE due to the lack of knowledge and worryingly evaluating the risk and uncertainty of investment.

Humanity is still relatively nascent to the advancement of RE technologies, where the full potential energy of nature is yet to be effectively utilised. It is genuinely constructive for Malaysia to look upon Japan as a formidable player in the RE sector, and for both countries to study each other's strengths and shortcomings. This could favourably lead up to eventful collaborations between the two aspiring nations.

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