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Review

A review on Malaysia's solar energy pathway towards carbon-neutral Malaysia beyond Covid'19 pandemic

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ABSTRACT

COVID'19 pandemic has devastated several industries and solar energy is no exception. In its economic relief package, Malaysia has announced approximately US$ 2.9 billion in expenditure for the installation of new grids, LED street lights and rooftop solar panels. The Government will also open the tender for a 1400 MW solar power project in the year 2020, which is expected to generate 5 billion ringgit (US$1.1 billion) in investments. As these measures are intended to sustain the existing growth of solar energy potential in the country, it is vital to assess its status quo. Hence, this paper aims to review the current status of renewable energy in Malaysia as well as the initiatives taken before the pandemic to promote solar photovoltaic (PV) technology to meet the energy demands through the low-carbon pathway.

Contents

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Abbreviations

APG	ASEAN Power Grid
ASEAN	Association of Southeast Asian Nations
BIPV	Building-Integrated Photovoltaics
BNEF	Bloomberg NEF
COVID	Corona Virus Disease
CGC	Credit Guarantee Corporation
CSP	Concentrated Solar Power
DHC	District Heating and Cooling
EE	Energy Efficiency
EEVs	Energy Efficient Vehicles
EV	Electric Vehicles
FIT	Feed-In Tariff
GDP	Gross Domestic Product
GITA	Green Investment Tax Allowance
GITE	Green Income Tax Exemption
GTFS	Green Technology Financing Scheme
GWh	GegaWattshour
HVAC	Heat Ventilation and Air Conditioning
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
JICA	Japan International Cooperation Agency
LSS	Large Scale Solar
MESTECC	Ministry of Energy, Science, Technology. Environment and Climatic Change
MIDA	Malaysian Investment Development Authority
MW	MegaWatts
NAP	National Automotive Policy
NEM	Net energy metering
NREPAP	Renewable energy Policy and Action Plan
PIA	Promoting to Investment Act
PV	Photovoltaic
RE	Renewable Energy
SEDA	Sustainable Energy Development Authority
SELCO	Self-Consumption
SMEs	Small and Medium-sized Enterprises
SREP	Small Renewable Energy Program
TNB	Tenaga Nasional Berhad
VRE	Variable Renewable Energy
GCPV	Grid-Connected Photovoltaic
OGPV	Off-Grid Photovoltaic
PH	Pakatan Harapan

1. Introduction

The burning of fossil fuels, such as coal and oil to produce electricity is one of the main contributors to global warming and climatic changes. Many countries are highly dependent on fossil fuels, particularly for the industrial sector to ensure sustainable socio-economic development (Mohsin et al., 2019). Energy demand continues to rise and it will most likely increase fossil fuel consumption, resulting in a further increase of CO_2 emissions. Therefore, governments across the world have been taking initiatives to address this issue by encouraging the implementation of renewable energy (RE) through various national programs (IEA, 2019b). RE is generated from naturally abundant sources such as sun, wind, biomass, etc. It is, therefore, regarded as an eco-friendly form of energy that has zero to minimal amounts of CO_2 emissions. While renewable and alternative energy has great potential to replace the dependency on fossil fuels, the progress of bringing it into the mainstream has been slow in most developing countries (Malahayati, 2020). Malaysia is no exception, introduced several measures in its 8th Malaysia Plan during 2001 for rapid RE integration to its national grid (Oh et al., 2018). Transition to RE in Malaysia has been challenging due to several issues such as difficulties in securing funding, unappealing tariffs and the absence of incentives for utilities, and lack of awareness among key decision-

makers in the industry (Oh et al., 2010).

Currently, only 8% of Malaysia's energy is generated from RE while it has pledged to attain 20% by 2025 (SEDA, 2019a). According to the Malaysian Investment Development Authority (MIDA), thriving RE technologies in Malaysia include solar energy, hydroelectric and biomass. However, compared to most RE technologies, recent developments in solar photovoltaic (PV) systems have led to its phenomenal growth in Malaysia and across nations (Sreenath et al., 2020a, 2020b). Malaysia experiences hot and humid weather with a generous amount of rainfall all year round due to its geographic location. It receives an abundant amount of solar radiation throughout the year, with most places having daily solar radiation mean of 4.7–6.5 kWh/m^2 (Petinrin and Shaaban, 2015). Therefore, applications involving solar energy have also been gaining popularity in Malaysia due to favourable climate conditions of the country. Realizing the solar energy potential and in general RE (Hannan et al., 2018; Tang, 2019), the Government introduced several new programs and schemes. Net energy metering (NEM), the feed-in tariff (FIT), large scale solar (LSS), self-consumption (SELCO) and RE incentives are some examples of schemes intended to reduce the bills as well as the fiscal load to attain a carbon-neutral environment (Chatri et al., 2018).

Recent COVID'19 pandemic has impacted energy industries and markets across the globe (Anderson et al., 2020). Furthermore, the movement control orders and travel restrictions have closed the businesses, resulting in reduced PV cells production and subsequent installations. To keep the existing momentum as well as to achieve the Paris agreement targets, the Malaysian Government and solar energy companies in the country must reshape the policies and strategy (Abdullah et al., 2019). Therefore, this review aims to address the following objectives; 1) determine the status quo of solar PV technology and related application in Malaysia; 2) establish the key factors affecting renewable energy development in Malaysia; 3) understand the updated energy framework of Malaysia: Energy Policies, Assessment, criticize, track the RE progress; 4) compare RE growth in Association of Southeast Asian Nations (ASEAN) countries; 5) Impact of COVID'19 on the Malaysian Energy Market and Energy Security; 6) Government's response to COVID'19 pandemic to sustain the solar industry.

Furthermore, the solar energy field is fast evolving with some unprecedented developments in the recent past. Reviews published lately focus broadly on analysis of RE integration and enhancing grid requirements with control methods. Other aspects published recently include impact and status of RE in Malaysia, policies influenced by public opinion, sustainable ideas for the development of RE, climatic change mitigation in Malaysia and feasibility studies on solar utilization in Malaysia (Abdullah et al., 2019; Al-Shetwi et al., 2019; Ghazali et al., 2019; Kaman et al., 2019; Khan and Go, 2020; Qazi et al., 2019; Wahid et al., 2017). Existing works do not provide any insight into how a potential framework is crucial to support and achieve future RE goals. Challenges, issues and conflicts are highlighted to ensure the long-term sustainability, reliability and energy security for the development of RE in Malaysia by considering different policies, assessing and monitoring solar PV. Hence, this works presents an up to date overview of the solar energy technologies, factors affecting renewable energy and the policies in Malaysia based on the qualitative approach. The development and promotion of renewable energy to fulfil the energy demands of future generations have been summarized with a particular focus on the post COVID'19 scenario.

1.1. The rationale behind solar energy technologies as a future energy source

In the case of solar thermal technology, the energy obtained from the solar source is directed to meet the requirements of different end-users in different sectors such as building, industry and residential sectors and applications (Heng et al., 2019). For example, the building sector, including both residential and commercial, covers a wide range of purposes from cooking to water heating (Naghavi et al., 2020). In the case of industry, it serves a variety of applications from low-temperature to high-temperature. To satisfy the use of heat ventilation and air conditioning (HVAC) based on the category requires a considerable allocation of total final energy demand. For example, in Malaysia, HVAC in buildings and industry requires 59% and 29% of total energy consumption. According to the IRENA report, REmap indicates the total energy demand and consumption by buildings and industries are 90% and 24%, as shown in Fig. 1a) and b).

Moreover, the IRENA report shows that in Malaysia, the district heating and cooling (DHC), in other words, HVAC depends on non-renewable energy for the total energy demand in 2010 is about 89%. Cooling is one of the prominent concepts and fast-growing in most emerging economies, that use waste-energy in buildings to minimise power consumption. Over the last few decades, the usage of electricity for cooling in buildings across the region has increased drastically. Till now, only 15% of households in Southeast Asia have air conditioners, showing the remarkable ability for further growth in major markets. By 2040, the future of cooling in Southeast Asia investigates the increase in demand in energy consumption, peak electricity demand and CO_2 emission, and lays an alternative

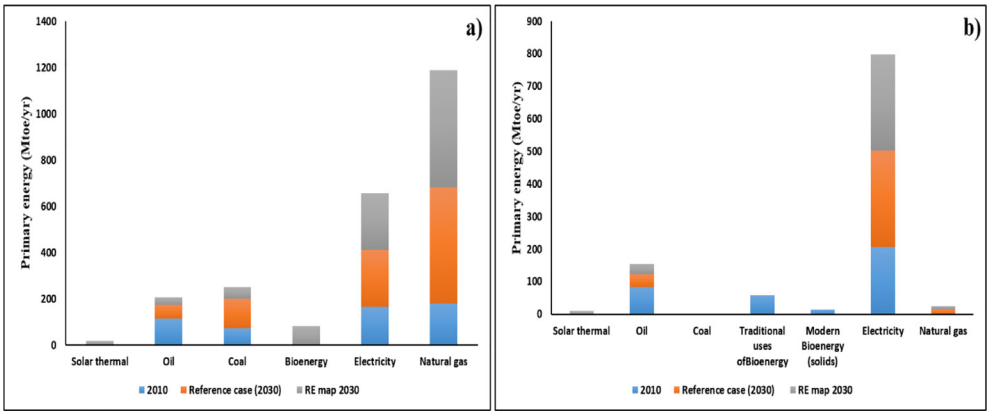

Fig. 1. Represents the total energy demand from different renewable sources **a)** For industry, **b)** for buildings.

Table 1
Statistics of installed capacity and electricity generation in Malaysia compared to the rest of the world from 2010 to 2019 (IRENA, 2019d).

Year	Installed capacity, MW (Malaysia)	Electricity generation, GWh (Malaysia)	Installed capacity, MW (Rest of the world)	Electricity generation, GWh (Rest of the world)
2010	0.54	0.67	40,276.67	32,160.38
2011	0.54	0.67	72,029.69	62,443.37
2012	25.10	30.88	101,511.21	96,351.81
2013	97.12	53.74	135,740.15	131,701.12
2014	165.78	190.51	171,518.92	183,943.37
2015	229.10	275.41	217,242.54	242,371.88
2016	278.80	326.23	290,961.18	314,053.25
2017	370.07	333.02	383,597.83	425,872.64
2018	536.02	N/A	483,078.20	N/A
2019	882.02	N/A	580,159	N/A

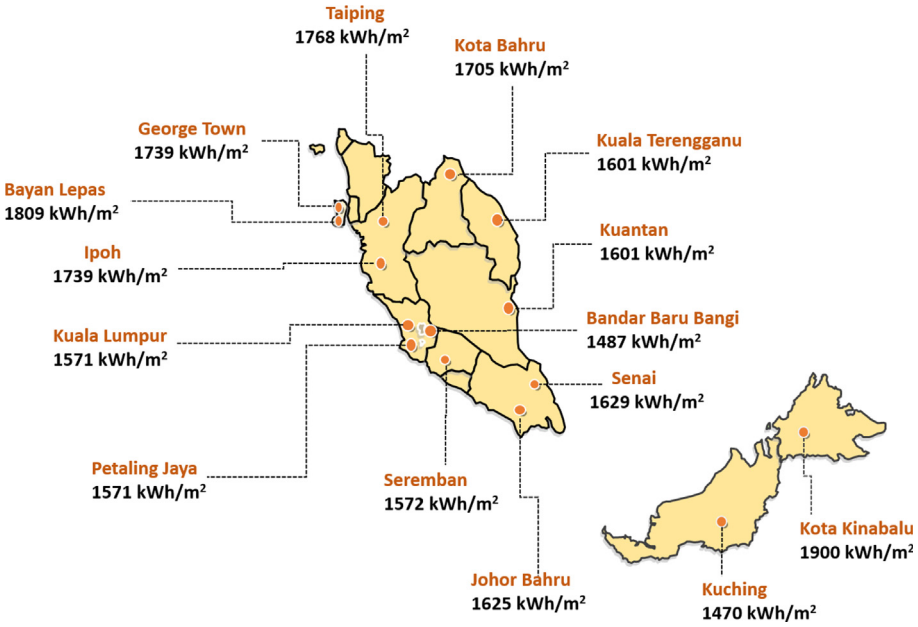

Fig. 2. Solar irradiance level of different towns in Malaysia.

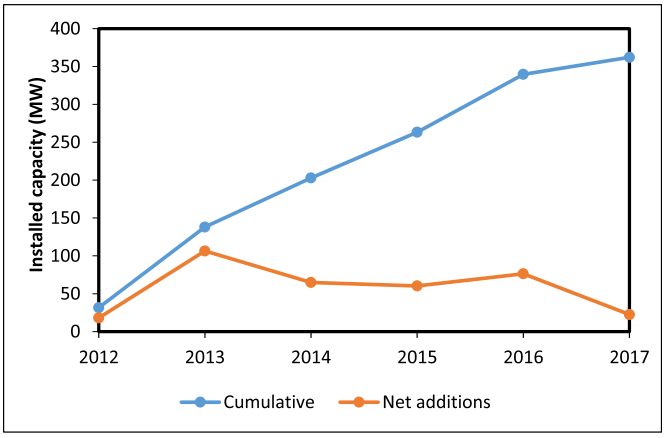

Fig. 3. Solar PV total installed capacities in Malaysia from 2012 to 2017 (IRENA, 2019d).

scenario that policy drives industry transformation to produce more efficient air conditioners. A sustainable development scenario, along with more robust policies, can address the efficiency in cooling equipment and buildings, which can lead to as much as 110 TWh savings by 2040 (IEA, 2019a).

IRENA's REmap analysis reports an increase in the use of renewable energy up to 38% by 2030, where the majority of it will be contributed by bioenergy and solar thermal. Solar energy has become one of the primary sources of renewable energy and widely used for different purposes such as generating electricity, heating and desalinating water. Two ways can produce this: 1.) Photovoltaics (PV) and 2.) Concentrated Solar Power (CSP). We only discuss the PV system because of climatic factors and other reasons restrict the development and usage of CSP in Malaysia.

1.2. Solar photovoltaics (PV)

The main principle behind solar PV is converting the sunlight into electricity. The generation of electricity and making it accessible to every corner of the country is possible with the help of PV technology in combination with mini-grids. Due to the reduction in the cost of solar panels, not only the electricity price is decreased but also becoming increasingly accessible to everyone. As a result, the solar PV installations have drastically increased in Malaysia as shown in Table 1.

Malaysia plays a pivotal role in the solar power industry and currently stands at the third position in the production of solar photovoltaic (PV) cells and modules. According to the Malaysian Solar PV Roadmap 2017, Malaysia will be a hub for solar cell

manufacturing by 2030. The electricity generated from renewable sources such as solar PV, biomass, biogas, mini-hydro, and solid wastes might be 11,227 GWh by 2020 as per the Renewable energy Policy and Action Plan (NREPAP). However, out of this 194 GWh (1.7%) is from solar PV and expected to improve the solar PV significance in the energy mix to 13,540 GWh by 2050. The increase in electricity generation from solar is due to the availability of sufficient sunlight and irradiance levels. The irradiance level of different towns in Malaysia is shown in the irradiance map, Fig. 2.

Moreover, solar power generation shows no sign of greenhouse gas emission, making Malaysia step forward towards a greener and cleaner energy. The promotion of solar power helps Malaysia achieve its long-term goals to lower the carbon intensity to 35% by 2030 (Malaysia, 2017). After the establishment of Building-Integrated Photovoltaics (BIPV) project in 2005, it mainly concentrates on the rapid market improvement of technology by considering various aspects such as policy and awareness, technical skills, market increment, support and growth of the technology to improve the nation's economy better. As a result, a clean and sustainable technology with a better BIPV market can be initiated to fulfil SEDA goals (Malaysia, 2011). Solar PV annual installed capacities from 2012 to 2017 for cumulative from FiT scheme were 31.6, 138.1, 202.9, 263.3, 339.7, and 362.2 MW and the installed capacities from 2012 to 2017 for net additions were 18.1, 106.5, 64.9, 60.3, 76.4, and 22.5 MW as shown in Fig. 3 (IRENA, 2019e). The gradual increase in electricity generation seen after the introduction of LSSPV farms from the Government and planning to add 200 MW more annually from 2017 to 2020. After the initiation of the FiT scheme, the electricity generated from the producers utilise the power initially, and the excess made tends to sell. Net energy metering (NEM) has been launched in 2016 by the Government to benefit the current FiT scheme and large-scale solar programs (LSSP) to replace the FiT by 2018 (Commission, 2016). NEM concept allows users to generate their electricity by installing solar panels and any excess power generated will be channelled back to the utility grid. However, one of the critical issues highlighted by the PV industry is the need to change the concept of NEM from the existing net billing to true net energy metering. This change is to improve the return of investment of solar PV under the NEM. Therefore, effective from January 1, 2019, the NEM is improved by adopting the true net energy metering concept to allow excess solar PV generated energy to be exported back to the grid on a "one-on-one" offset basis. Which means that every 1 kWh exported to the grid will be offset against 1 kWh consumed from the grid, instead of at the Displaced Cost previously (SEDA, 2019d).

Despite all the efforts, the solar industry in Malaysia still faces two major challenges:

- Lack of knowledge and awareness on the financial returns from solar PV investment and benefits among the Malaysian public and the business community.
- An easy application process and reasonable loan interest rate do not exist due to the lack of awareness on solar technologies and solar PV-related financing for bankers (SEDA, 2020c).

SEDA Malaysia is diligently trying to increase the awareness of solar energy as a suitable form of RE by implementing different marketing strategies and techniques. For example, they are actively engaging the public via digital platforms such as social media, websites, dedicated microsites, conducting tours and displaying posters during roadshows, open days, and approaching the local authorities, etc (SEDA, 2020c).

2. Factors affecting renewable energy development in Malaysia

Several factors play a critical role in promoting or affecting the growth of renewable energy in Malaysia. A culmination of these factors overcome issues faced by the renewable energy sector. This section summarizes the crucial elements affecting RE implementation and aiding to develop a positive environment in which RE exploitation can succeed (Abdmouleh et al., 2015). These factors are discussed in detail in this section.

2.1. Project financing

Significant demand to develop RE projects in a country requires enormous capital investment. Moreover, certain projects involve high-risk factors due to fast-evolving technology and lack of sufficient resources. Developing countries like Malaysia need investments from both private and public sectors to implement RE projects. The Government should take the initiative to provide loans and funding to the organisations for research and development of RE. During the initial stages, the Government must come with a basic framework and encourage initial investments through banks for the growth of RE. Recently, the Malaysian Government announced a tender worth of RM 3.2 billion, which involves RE and energy efficiency (EE) projects. Financial security is also the biggest concern for Renewable Energy Power Purchase Agreement does not offer enough cash flow for bankers that leads to reduced confidence between bankers when considering investment (Petinrin and Shaaban, 2015). The Malaysian Government requires to make a collective attempt to confirm sustainable and effective funding mechanisms are to bring into effective action to facilitate the growth of RE projects that would then promote the sustainable development of the country (Sharvini et al., 2018).

Hence, financial aspects play a significant role in the promotion and implementation of RE. More investments, funding and other kinds of support such as loans should be provided to encourage the RE projects.

2.2. Public investments

The Government mainly controls this category, and it supports RE projects through loans and grants to the public and private institutions. Government grants awarded to the organisations are often non-returnable and are provided to encourage the growth of RE in the country. Grants and loans are assigned from the public subsidies to satisfy the purpose and fulfil the targets. Malaysian Government provided 1.28 Million USD loan to develop the renewable energy in RE projects during 2016 from Japan International Cooperation Agency (JICA) and others. If we consider the global trends in renewable energy investment, the pattern follows the increase of 21% in 2014, 14% in 2015, only 2% in 2017, whereas it declines in 2016 by 15% (IRENA, 2019c). Malaysia needs investments of 33RM billion to fulfil the target of 20% of electricity generation from RE sources by 2025. From the past few years, investments in the clean energy sector have been slowing after a significant increase in 2017. Energy research company Rystad Energy warns the impact of COVID'19 could lead to a complete halt in the growth rate of renewable energy installations. COVID'19 shows an indirect effect on financing projects in frontier markets as well as recent technologies where risk-sharing practices are not approved. Smaller firms with projects not yet started could be strongly affected, as their financing becomes insufficient. Installation of solar PV/T components such as inverters and shortage modules are pushing to higher prices (Shah, 2020). These consequences provide a view about the real-time impact of COVID'19 on all major sectors

leading to the global financial crisis.

2.3. Environmental taxes

Carbon or energy taxes were introduced to help the incentives under different aspects such as efficient HVAC systems, where the renewables are exempted from this. For instance, carbon tax merits, includes overtime, it may face ups and downs, assigned to external bodies, it assists most of the price signal and demerits such as execution will be a problem. This might be due to political interference, few industries might be exempted from this policy, and other factors might impact the effectiveness are considered to be important aspects under environmental taxes. The Malaysian legislation provides petroleum entities with expenditure-based tax incentives that align with other countries in similar lower-middle-income brackets under the Promotion of Investment Act (1986) (Kraal, 2019). Malaysian Government imposes carbon tax with a revenue recycling plan and the emission standard program to reduce the CO_2 emission level from fuel emissions. The CO_2 emission intensity of GDP reduces by 7.26% under a carbon tax and 6.38% under emission standards by introducing carbon dioxide emission policies (Yahoo and Othman, 2017). To develop the renewable energy sector, the Malaysian Government has provided pioneer status and an investment tax allowance from 2001. Additionally, the Energy Commission and MIDA are the two agencies involved in the implementation of these incentives that made significant progress in renewable energy generation by 2008 (Hashim and Ho, 2011).

To promote investments and local businesses, the Malaysian Government introduces a stimulus package of USD 4.8 billion during the outbreak of COVID'19. The central bank has issued loans for small- and medium-sized enterprises (SMEs) worth of 2 billion-ringgit and each SME entitled to receive up to 1 million ringgits. Additionally, the Government also supported businesses worth 100 million Ringgits to upgrade their workers' skills (Medina, 2020). The Government has announced an RM20 billion stimulus package that includes tax breaks for the influenced sectors, together with electricity bills discount of 15% and 4% trimmed of EPF contribution by employees that are pointed to spur private consumption (Kwek, 2020).

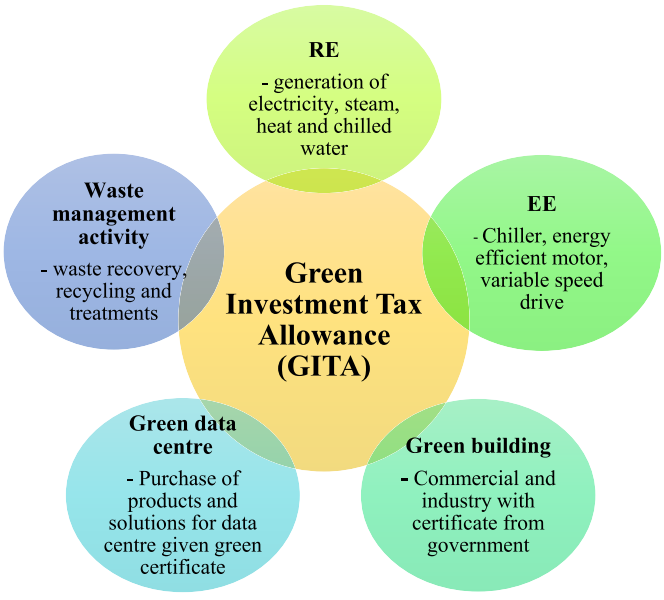

Fig. 4. Overview of Green Investment Tax Allowance (GITA). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

2.4. Risks and challenges to green investment

The primary concern for most of the green projects is accessing the finance towards the new technology that causes trouble to the investors, followed by the underlying investment framework. Depending on the structure of the sector, the risks and challenges for investors differ. Few barriers to green investments in developing countries have been identified from different studies, including the G20 Development Working Group. Based on various aspects, the risks and obstacles are categorized into technology risks, policy and regulatory risks, market risks, investment barriers, and capacity constraints (Amin et al., 2014).

To overcome these conditions, financial incentives play a crucial role in the development of Green technology. The Malaysian Government has taken initiatives to strengthen the development of green technology through incentives by attracting investors and industries to support renewable energy. These incentives for the development of green technology benefited with investment tax allowances (ITA) for the purchase of green technology assets and income tax exemption (ITE) for the use of green technology services and systems via the MIDA. The Malaysian Government has provided RM 2 billion for green technology financing scheme as an incentive for the development and investment of green technology. Moreover, these incentives cover a range of green technology activities in areas such as energy, transportation, building, waste management, and supporting services activities under the Budget 2014. It helps to move the expired projects such as RE, and EE under tax incentives promoting to Investment Act (PIA), 1986. The Government has provided attractive incentives such as the formation of a legalized environment and effective pricing policy, which results in the initiation of sustainable and renewable energy in Malaysia (Petinrin and Shaaban, 2015).

Green Investment Tax Allowances (GITA) aims to reduce the usage of energy and to preserve the other sources of energy, promote the usage of renewable energy, to recycle waste; to minimise greenhouse gases emission and to save the earth and lives. Moreover, this project mainly focuses on elements such as RE, EE, Green Building, Green Data Centre and Waste Management Activity are explained in Fig. 4 below (SEDA, 2020b).

The Government also offers Green Income Tax Exemptions (GITE). These services should meet the criteria: The registered body under this service should have a green policy either in the environment or in sustainability; the registered body should recruit five full-time employees, including at least one person related to green technology compulsory; The income falls under exemption only if it comes from green technology services. Green technology services mostly deal with Renewable Energy (RE), Energy Efficiency (EE), Green Building, Green Data Centre, Green Township, Certification and Electric Vehicles (EV) are shown in Fig. 5 in detail (SEDA, 2020a).

The current health and economic crisis due to COVID'19 do not understand global efforts to take on the world's inevitable challenge of climate change. Government launch sustainable stimulus packages to increase their climate goals taking advantage of the current situation by introducing clean energy technologies. The coronavirus crisis is already performing notable damage around the globe and needs to grab this opportunity to accelerate clean energy rather than obstructing clean transitions (IEA, 2020b).

2.5. Market failures in existence

The main issue in market failures, especially in Malaysia is the inconsistency in resources distribution by the suppliers to resolve

Fig. 5. Representation of Green Income Tax Exemption (GITE) services. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

the consumers' demand. Erratic pricing structures is a drawback for renewables, uneven pricing of renewable energy products, power/information asymmetries, alteration in market power, fossil fuel subsidies, and failures to absorb social and environmental externalities into costs. The fossil fuel/nuclear subsidies, which obstruct the distribution of renewables on top of the energy tariffs that are not entirely cost-reflective. Besides, trade barriers come into play by imposing high prices/taxes on imported RE products such as import duties (Murdock, 2018). The other factors significantly affect the RE development in Malaysia such as the existence of market failure, technological constraints, lack of regulatory framework, lack of proper governance, no institutional measures, and finally limited oversight on implementation and achieving targets are to be considered.

3. Energy framework of Malaysia: energy policies, evaluation and monitoring

In Malaysia, Renewable energy is gradually making its footprints to improve or better the renewable energy usage step-by-step by focusing on different elements. Again, these elements involve a combination or mixture of policies and programs to develop the country's economy. Some of the critical policies and plans are established to meet the set goals and currently implement new strategies to provide RE to future generations. These consist of (i) Malaysian National Renewable Energy Policy, (ii) Renewable Energy Act 2011, and (iii) Sustainable Energy Development Authority Act 2011. These policies are explained below in detail.

3.1. Malaysian National Renewable Energy Policy

Currently, the Malaysian Government is focusing on the growth of "fifth fuel" as a renewable energy resource, particularly biomass under the country's Fuel Diversification Policy. Initially, the set target was 5% electricity generation through renewable energy by 2005 that is 500–600 MW of installed capacity and whereas the policy started in 2001. The fiscal incentives, such as investment tax allowances and the Small Renewable Energy Program (SREP), supported this policy to aid the interaction of small renewable energy generation plants to the national grid. The SREP agreed to sell their electricity to Tenaga Nasional Berhad (TNB) up to 10 MW of capacity generated from renewable projects for a during of 21 years license agreement (Business Monitor International, 2008). From the 9th Malaysian Plan (2006–2010), resources such as natural gas, coal and hydropower have been evolved as significant contributors, while the electricity generation had fallen by less than 1% due to the dependency sources like oil/diesel. At the same time, the nation has given priority to sustainable development in order to reduce the dependency on non-renewable resources. The Government mainly focuses on the energy policies to find a better way to promote the growth of non-fossil energy sources such as biomass-derived from oil palm and other feedstocks from 2009 to 2020 (Sharvini et al., 2018).

Malaysian Government initiated the policy of vision to achieve the 2019 goals and constructively implementing a few programs/projects and establishing projects to authorise the renewable energy source to everyone. The main idea behind the implementation

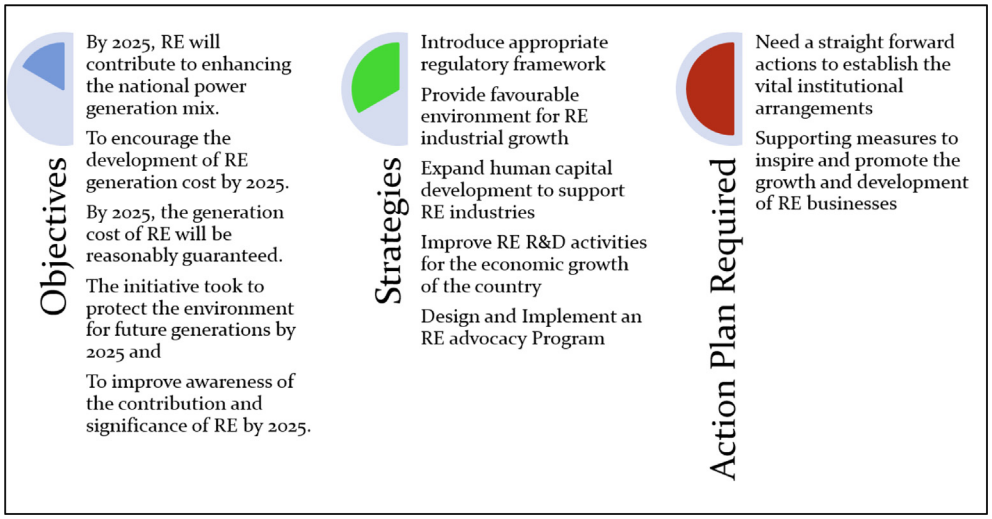

Fig. 6. Renewable energy policy Objective, strategies, and action plans for the growth and development of Renewable energy business.

Table 2
Overview of renewable energy balance by Malaysia.

Renewable energy sources	Supply by Technology	Transformation & losses	Consumption by sector
Renewable waste	0	0	0
Pellets	−4984.8 TJ	37.2 TJ	0
Transport	0	0	11,784.3 TJ
Industry	0	0	29,299.6 TJ
Residential	0	0	37,105.9 TJ
Commercial	0	0	22,334.7 TJ
Other	0	−1091.2 TJ	0
Total transformations & losses	0	−10,660.7 TJ	0
Solid Biofuels	35,592.6 TJ	0	0
Solar PV	832.6 TJ	0	0
Liquid biofuels	11,784.3 TJ	0	0
Hydropower	73,231.2 TJ	0	0
Electricity	−338.2 TJ	3787.6 TJ	0

of increased Net Energy Metering and Solar Leasing, Large Scale Solar Programme 3 (LSS3), Non-Solar RE Projects and initiating RE facilitation programme in SEDA Malaysia is to attain at least 20% of RE capacity mix by 2025.

The RE policy is drafted to promote the importance and need for sustainable development by conveying the idea to all the stakeholders. The most and foremost thing for any RE policy approval and acknowledgement is by combining energy, industry, environment, green technology, and information dissemination policies that contribute to excellent opportunity and challenge in its prototype. The Government should impose a tax on the firms that release CO_2, to reduce CO_2 emission or storage if they want to continue in the market.

The main aspects that need to consider for any RE policy are: to highlight the current market failures, to assign long-term sustainability; to encourage new firms; to understand the significance of the environment as an economic growth contributor, to advance the human capital resources in R&D technologies, and to enhance the consistency of current policy. These objectives, strategies, and action plans of the National RE vision policy helps for the growth and development of any industry/firm mentioned in the below Fig. 6 (Agency), 2008; SEDA, 2019b, c).

3.2. Renewable energy act of 2011

This Act is responsible for beginning the production of RE and other related matters, where a unique tariff system is to be established and implemented. This Act involves several aspects and stages to achieve renewable energy. Malaysia makes a compulsory renewable energy act 2011 by introducing feed-in tariffs (FIT) system on December 1st, 2011, with an annual installed capacity caps to 2030. The renewable energy act considered to grab the attention of different policymakers and funding agents to economically and potentially support RE and promote the Malaysian RE resources. Several factors that play a crucial role in the development of RE and the framework that contributes for the development of RE were as follows, preliminary, FiT system, connection, purchase and distribution of RE, information gathering powers, RE fund, FiT, enforcement, general and savings and transitional (SEDA, 2019c).

According to the 2019 renewable energy balance sheet of Malaysia,the contribution of different renewable energy sources divided into three major parts such as supply by technology, transformation & losses, and consumption by sector (IRENA, 2020). The overall renewable energy balance sheet is shown below in Table 2.

Hydropower is with 73,231.2 TJ under-supply by technology category and under transformation and losses category electricity is contributing highest with 3787.6 TJ. In the case of energy consumption, the residential sector has the highest with 37,105.9, followed by industry.

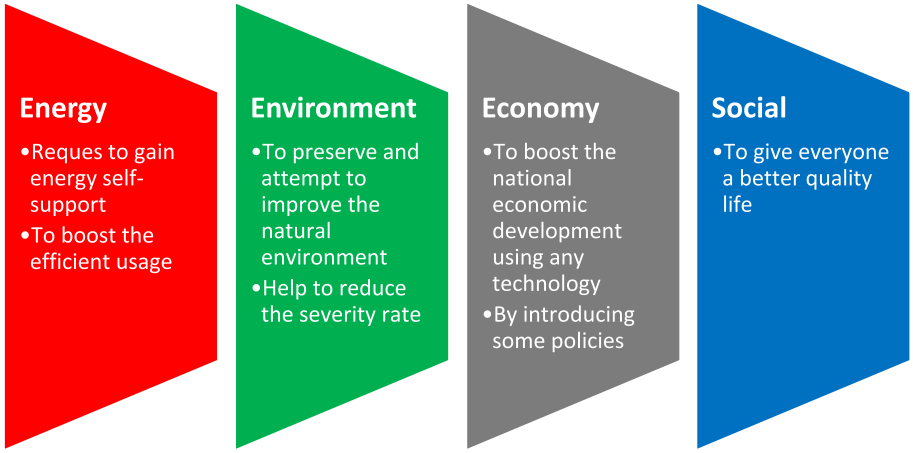

Fig. 7. National Green Technology Policy depends on four different factors. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

3.3. National green technology policy

The Federal Government took the initiation of the National Green Technology Policy after understanding the significance of green technology and for the development of green technology in the country. The National Green Technology Policy implemented a suitable plan that spread over accomplishing energy autonomy and reducing climate change that is one of the growing assets of economic growth for the country. The Government imagined green technology is the best option that potentially influences the low carbon economy of the country supported by most of the countries. The Malaysian Government had decided to the global society that seeks to minimise the greenhouse gas emission thus apart from contributing to less severity on climate change, the national green technology policy to improve the nation's economic growth. Moreover, green technology policy mainly relies on four critical factors, as shown in Fig. 7.

The new National Green Technology Policy builds on four pillars and five strategic thrusts. This policy is introduced to minimise degradation of the environment, zero/low greenhouse gas emission, use of energy and natural resources, and promote the use of renewable resources (Foo, 2015).

3.4. Sustainable Energy Development Authority Act of 2011

Sustainable Energy Development Authority (SEDA) is a Malaysian government agency responsible for promoting and implementing sustainable energy. The main intention of this Act is to use or produce the strength to fulfil the current requirements without affecting the needs of the future generation, which includes renewable energy also. Moreover, Malaysia aims to become a sustainably advanced nation by 2020. Therefore, the implementation of Green technology as a driving force to increase the future economy that potentially helps to enhance sustainable development and green growth of the country. Additionally, the National green technology policy mainly concentrates on a wide range of sectors such as energy, building, waste management, and transportation. The total energy consumption from each sector was collected and among all the sectors, residential and industry consume more energy of 33%, 30% compared to commercial (23%) and transport (15%) (IRENA, 2019a).

3.5. Financial support to encourage small and medium scale industries to use renewable energy

Different financial aids should provide to support the small and medium scale industries at various levels of the business cycle. The Government should take initiatives to help them from promotion to commercialisation through grants or subsidies or credits. These small-scale businesses or scale-ups can easily access to rural areas and assure the potential development of RE. The Malaysian Government should bring more and more schemes and subsidies to support small and medium scale industries to develop RE, which is not up to the standards yet.

As a solar industry, all the alliances must be on board in search to develop the growth of Malaysia's PV market (SEDA, 2020c).

(i) Incorporation of solar energy with PV as a part of the Government's vision set to install lower financing cost solar PV on all government buildings including schools, hospitals, and universities to promote solar energy as a practical form of RE.
(ii) In terms of PV service providers a high standard of customer service such as post-sales, delivery needs to establish in the Malaysian PV market and motivate higher involvement in the regional/worldwide PV market.
(iii) To adapt green financing framework and encourage banks to offer loans for PV projects.

3.6. Attractive loans to support small and large scale to use and supply green technology

Malaysian Government introduced the Green Technology Financing Scheme (GTFS) to support and establish green technology. The main aim of this scheme is to encourage and enlarge the utilization of green technology and supply. Moreover, the Government supports the industries that produce and use green technology by providing financial credits up to 60% by credit guarantee corporation (CGC) and promises to bear the 2% interest/profit rates. This scheme was under agencies like the Ministry of Energy and Green Technology and Water, Malaysia (Malaysia, 2019b).

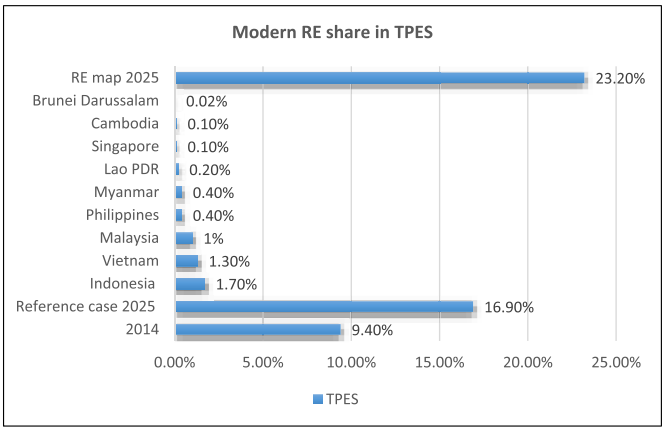

Fig. 8. A contribution towards increased RE share to 23% from ASEAN countries.

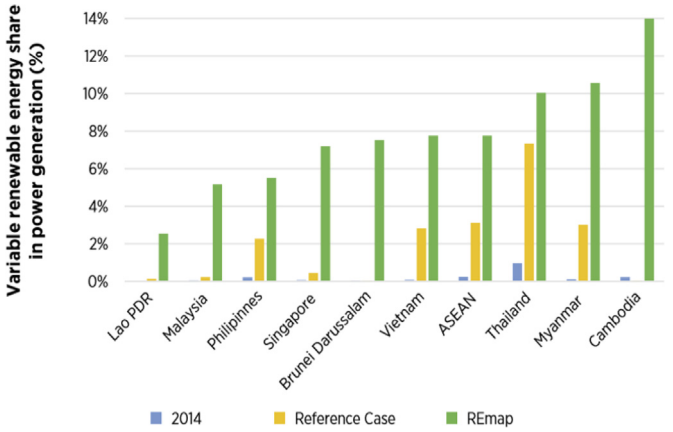

Fig. 9. Variable renewable energy shares of ASEAN member states in power generation from 2014 to 2025 (Nicholas Wagner, 2016).

3.7. Is malaysian RE target specific, achievable and precise?

Malaysian Government implements the Eleventh Malaysian Plan as an initiative to meet the short-term goals and develop renewable energy successfully. The Government is progressing according to the Plan and very close to complete, the set targets within the time-bound. Moreover, the Government introduced a sustainability 2030 goal to decrease buildings electricity consumption by 25% and assuring the reduction of CO_2 emission by up to 40% per unit of GDP by 2020. The energy commission with the help of SEDA implemented NEM and set a goal to generate 450 MW of electricity in peninsular Malaysia by 2020 using solar PV. The Ministry of Energy, Science, Technology. Environment and Climatic Change (MESTECC) and SEDA have stated that Malaysia's net energy metering (NEM) has reached 108 MW at the end of November last year. Under the new NEM policy, a target of 300 MW generation can be achieved by this year (Sharon, 2020).

However, several RE projects targeted for renewable energy installed capacities are still ongoing. Out of those, hydro based plants are playing a significant role in the development of RE. According to the National Automotive Policy (NAP) 2014, the main aim of Malaysia is to become the hub of green technology by 2030. This can be achieved by implementing electric vehicles, solar rooftops, sustainability buildings and ways to convert waste into energy. In the meantime, several efforts and initiatives taken by the Government to achieve the target within the stipulated timeframe.

3.8. RE monitoring in Malaysia

Sustainability Energy Development Authority (SEDA) and Energy Commission are the central bodies to monitor the overall energy production from renewable sources. SEDA Malaysia has its database (PV Monitoring System, PVMS) regularly to monitor the PV performance based on irradiance. Moreover, the performance of the PV systems reported on a daily and monthly basis of over 129 sites over Malaysia (PVMS, 2020). According to the latest report, the Malaysian Government has introduced a National PV Monitoring Performance Database to monitor the performance and reliability of selected grid-connected solar PV systems as an initiative. The Malaysia Electricity Supply Industries Trust Account (MESITA) is funding this programme under MESTECC. Malaysia is monitoring 150 grid-connected solar PV systems with a capacity of 1 MW on a real-time basis at initial stages. Later, the national energy policies and programmes will be designed and structured from this data as a reference (SEDA, 2020c).

3.9. 3.9 evaluation process

At this stage, the review of every individual program, schemes and policies are very critical to analyse the final report periodically, systematically and check the improvements related to technology, demand, market situations, strategies and new insights. These evaluations help to ensure the effectiveness, efficiencies, accuracy, and feasibility of these programs, schemes and policies to achieve future goals. This will provide a brief picture of the progress and helps to adjust the set targets if not met (Gungah et al., 2019).

4. Comparing renewable energy growth in ASEAN countries

4.1. Contribution of each country to increase RE using different approaches

The requirement of RE significantly varies and depends on several factors such as population, economy and energy demand. Based on the above factors, different strategies needed to expand the renewables in each country. In ASEAN, the total primary energy supply from modern renewable energy was 9.4% in 2014 and expecting to reach 17% by 2025 under reference case. However, as per the RE maps, it is still 6% behind the desired target of 23%, where the contribution from few ASEAN countries than other countries on renewables is desperately required to fulfil the gap. However, an understanding of what can individual country, different sectors contribute followed by costs, and benefits of different technologies are implemented to achieve this 23% renewable energy target (Nicholas Wagner, 2016).

Fig. 8 shows the increased renewable energy share contribution of each country from reference case (16.9%) to REmap (23.2%) in 2025, but it depends on the size of the individual country's energy system. To meet the desired target of 23%, the top four countries such as Indonesia, Vietnam, Malaysia and Thailand, contribute a maximum share of 80%.

The best way to increase the renewable share is by using a mixed approach that includes sectors such as power, heating, cooking, transport and other renewable sources to meet the target less than a year. Besides, there are several ways to increase the renewables in the energy system of a country but focusing on one particular sector alone compared to other industries may boost the rapid development and affects the economy/resource availability during the long run.

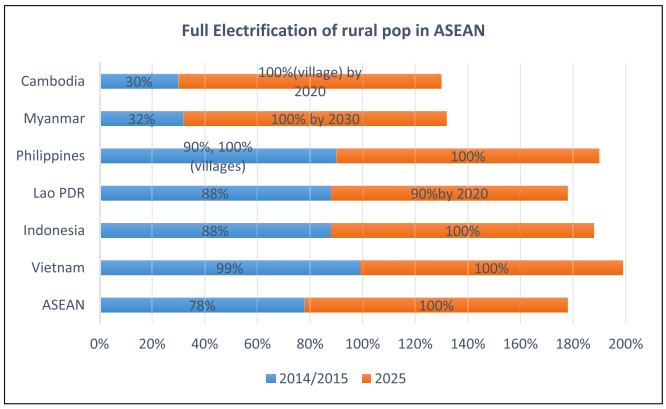

Fig. 10. Electrification rates of the rural population in selected ASEAN countries.

4.2. Variable renewable energy shares of ASEAN countries

The percentage of variable renewable energy (VRE) compared to individual countries or within individual power systems over ASEAN will be lower. But sometimes, if all REmap options are executed, the generation will pass 10%.

Among the all, hydropower is contributing the most renewable energy share followed by solar PV and wind. Solar PV and wind also play a crucial role in variable renewable energy, and the output is associated with the availability of the resource at a particular time, and against the power demand that differs with the country, as shown in Fig. 9.

However, the stability of the grid faces challenges due to the high share of variable renewable power in a power system, where it needs to be variable. ASEAN Power Grid (APG) is one of the best approaches to overcome the issues with integration VRE into the grid. However, the main problem is the distribution of power supply among different member states with organised frameworks within the countries/different countries. The implementation of power interconnectors, grid codes, trades for operation, design and maintenance of the market could be a better solution to resolve these issues (Nicholas Wagner, 2016). In 2015, ASEAN countries set a goal to improve the share of renewable energy in its energy mix to 23% by 2025 (ACE, 2016). The uncertain timing of electricity generation remains an issue to maintain grid stability, with a higher percentage of VRE sources like solar and wind (IEA-ETSAP, 2015; IEA, 2016). Increasing the grid's flexibility refers to a critical factor to address stability and reliability issues (IEA-ETSAP, 2015; Martinot, 2016). To achieve grid reliability, it needs to remain stable by maintaining a balance of demand and supply at every second (Huang et al., 2019). For instance, as per 2015 stats, Philippines produces 15% highest amount of electricity by renewable energy, and Thailand maintains a high grid reliability score by integrating the most diverse renewable energy source to the grid (IEA, 2020a). This indicates that the grid supports the current level of integrated renewable energy. So, grid stability is often affected with the increase in grid integrated RE; thus the current grid reliability is a good indicator to know the integration of existing renewable energy sources by a nation (Cochran, 2015). Huang et al. studied ASEAN grid flexibility to quantify and detail a load profile and calculate the worst-case ramp rate for each member nation (Huang et al., 2019).

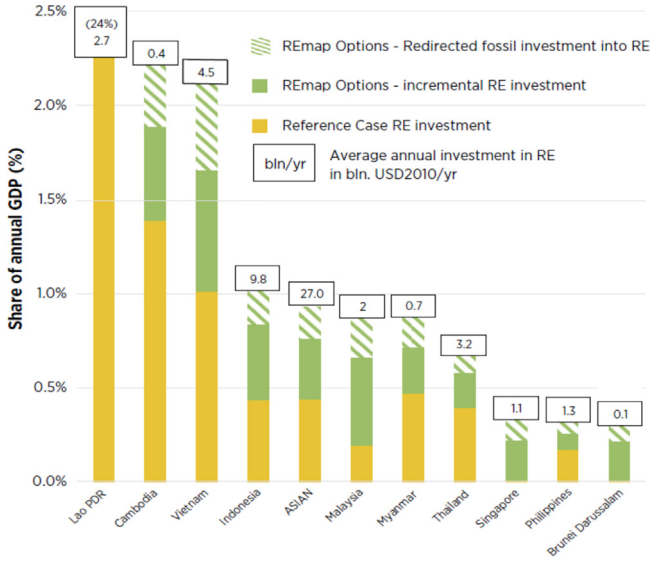

Fig. 11. Renewable energy investments need to reach the target by 2025 (Nicholas Wagner, 2016).

4.3. Full electrification in ASEAN rural regions

Some ASEAN countries like Malaysia, Brunei Darussalam, Singapore and Thailand already reached full electrification and its 99% in the case of Vietnam. Some other countries like Indonesia, Lao PDR and the Philippines are anticipated to attain full electrification by 2025, as shown in Fig. 10.

Due to the reduced electrification rates in Cambodia and Myanmar, they formulated some schemes and national plans to attain 100% electrification in Cambodia by 2020 and by 2030 in Myanmar.

4.4. Investments need to achieve the RE goal

A rapid increase in energy demand across ASEAN countries, the energy systems including electricity generation, transmission, heating, cooling, cooking and transport needs significant investments.

Approximately, USD 290 billion of total investment in renewable energy capacity estimated to meet ASEAN's 23% renewable target by 2025. Out of which an estimation of USD 27 billion per annum calculated only from present to 2025, which USD 13 billion per annum in reference case and remaining was with REmap options. Around USD 5 billion yearly redirect the investments from fuel technologies into renewables under REmap options. So, an additional investment of around USD 9 billion per year required in the reference case. The higher capital cost of these renewable technologies requires a higher investment, including all except bioenergy based.

From Fig. 11, the data showed that the two-third of total ASEAN investment requires between 2014 and 2025 for renewable energy considered from Indonesia, Vietnam and Thailand. In the reference case, almost 45% of investment takes place and the remaining 55% of REmap 35% allocated to new ventures and 20% to fossil fuels, where directional to renewable energy instead. As the GDP varies with country relative to share of investment, Lao PDR shows the highest at 2.5% whereas Brunei Darussalam with lowest of 0.3% (Nicholas Wagner, 2016).

ASEAN nations have seen their supply chains disrupted and experienced economic slowdowns due to COVID'19 outbreak. Specific ASEAN members have allotted a variety of fiscal and non-fiscal incentives to help industries to counter the economic effect. To deal with the long-term fallout of the pandemic, several ASEAN governments prepared stimuli by supporting their citizens with tax

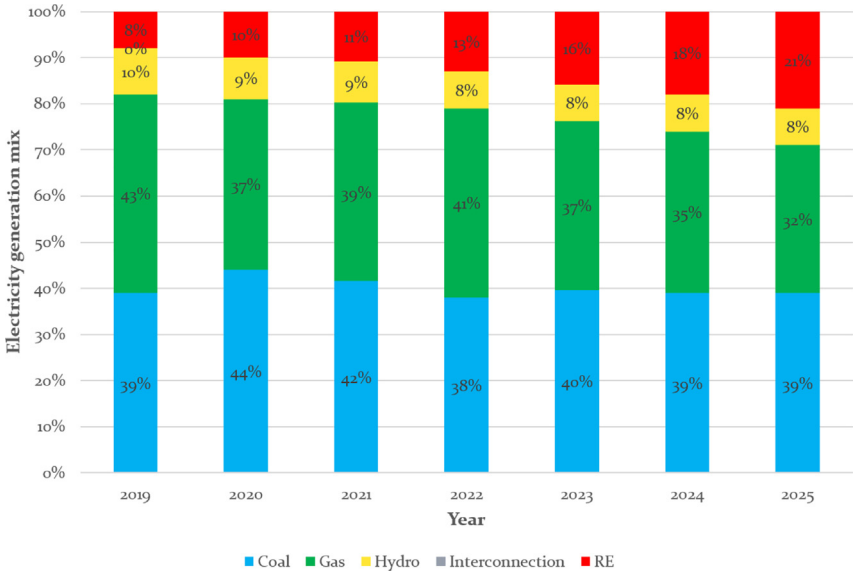

Fig. 12. Energy generation mix from different sources in Malaysia (2019–2025). Note: Data acquired from IEA (International Energy Agency) (Malaysia, E., 2019).

breaks (Medina, 2020).

5. Malaysian Energy Market and Energy Security

The oil and gas industry plays a vital role in determining the country's economy and energy sector and nearly donates 20% of Malaysian gross domestic product (GDP) in recent times. However, the purity and disposal lead to severe environmental issues such as air pollution, water pollution. Besides, Malaysia signed an agreement with Paris in 2015 to cut down the effect of greenhouse gases. As a note of it, the Government launched the Green Technology Master Plan (2017–2030) and assured the greenhouse gas emissions to 45% by 2030 (IEA, 2017).

Different technologies, new policies are required to support and encourage the growth of mix renewable energy resources in Malaysia. Greentech Malaysia established in 2010 to interrelate the initiatives, policies and schemes that consist of subsidies to generate their electricity in the form of loans, feed-in tariffs, grants, etc. Moreover, the Pakatan Harapan (PH) manifesto guaranteed to improve 20% of renewable energy supply by 2025. Also, the Ministry of Energy, Science, Technology, Environment, and Climate Change (MESTECC) is supported by the Energy Commission to frame the Government policies, and initiatives to cut down the fuel credit that enhances the share of RE in the generation mix.

The current and proposed energy mix needs to be analysed and still depends on fossil fuels, and gas holds 35% of total energy in 2018, followed by 57% of coal in the coming years. RE sources have a less percentage of share compared to other sources, which needs to be raised in the next few years, as shown in Fig. 12.

5.1. Energy security

Energy security is one of the significant problems that hide behind every country's energy policy. Energy security is a critical topic, which needs to be addressed in assisting the economy's path towards a higher platform (Ahmad, 2010). Malaysia has an excellent case study to evaluate the energy security scenario among all Southeast Asian countries. Energy security is nothing but the availability and steady supply of energy sources at a reasonable price.

5.2. Issues regarding energy security in Malaysia

The two main concerns related to energy security are an Over-dependence on fossil fuels and coal, and the fluctuation in the country's supply-demand balance.

The demand for energy is anticipated to increase remarkably in Malaysia from 96.3 TWh in 2009 to 206 TWh in 2035. To manage this rise in demand, Malaysia aims to recommend the efficient use of energy by introducing different initiatives like Malaysia Green Labelling program, and Green Building Index to transform its energy sources by increasing solar capacity (APEC, 2013). Malaysia needs investment, research and development in the energy sector to meet the growing energy demand. The Government has taken initiatives by introducing the National Energy Policy in 1979, the Four Fuel Diversification Policy in 1981, the Fifth Fuel Policy in the 8th Malaysia Plan from 2001 to 2005, 9th Malaysia Plan from 2006 to 2010 and finally, 10th Malaysia plan in 2011–2015 to achieve sustainable and clean energy and safeguard the environment from greenhouse gases emission. Recently, the 11th Malaysia Plan (2016–2020), given importance to deliver clean energy (Saleh Shadman, 2018).

Different mitigation plans have been introduced to improve energy security and sustainable energy by implementing the 11th Malaysia Plan, as follows:

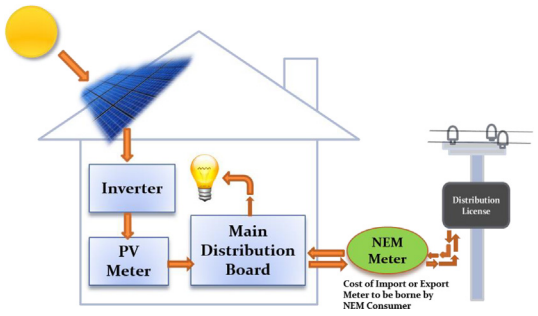

Fig. 13. Working principle of NEM.

1) Encourage collaborations with industries and institutes on energy planning
2) Involving consumers with efficient energy consumption
3) Guarantee the security of gas supply
4) Imposing the use of green fuel in the transportation sector
5) Safeguard the electricity supply management via the better organisation of resources
6) Increasing rural electrification

The new COVID'19 pandemic has created unusual global health and economic crisis. The energy sector plays a key role in modern life that is unprecedentedly impacted by the crisis that is crucial for global and national response and recovery efforts. Energy security remains the hottest topic and the crisis focuses on the analytical value of electricity infrastructure and know-how, underpinning the feedback to the coronavirus pandemic. It evidences that policy-makers support to ensure that current and future systems remain secure after they are transformed by the rise of clean energy technologies and the significance of electricity. To counter this economic damage from the coronavirus, the Government has drawn stimulus plans ensuring sustainable energy future does not effort from these blows (IEA, 2020b).

5.3. Malaysian Government's initiatives to promote RE

The Malaysian Government mainly targets renewable energy and energy efficiency to minimise power bills and reduces CO_2 emission. Malaysian Renewable Energy (RE) supports the solar PV initiative from the ministry to uptake the excess energy through the Net Energy Metering (NEM) program.

5.3.1. Net Energy Metering (NEM) scheme

According to SEDA, NEM is a solar photovoltaic (PV) program announced by Prime Minister under the 2018 budget as a replacement to the FiT scheme. The electricity generated from solar PV systems consumed initially, and any leftover will be exported to the grid. Later, they sell to the Distribution Licensee (TNB/SESB) at the premium rate predetermined by the Energy Commission, and the schematic representation of NEM is illustrated in Fig. 13. NEM applies to all the customers of TNB and SESB, including domestic, industrial and commercial sectors. As of Jan 1, 2019, under this scheme, 11 MW of energy was saved and the Government set a target of 20% by 2030.

5.3.1.1. Advantages of NEM. The benefit of this scheme is motivating every individual to play their part in RE generation that potentially solves the national energy security and climate agenda. Apart from decreasing greenhouse gases emission, the NEM also safeguards from any electricity tariff rise in the future. Moreover, an additional attachment of a battery or energy storage system to the PV system to enhance the self-consumption facility. Finally, the certified NEM scheme holders have the facility to acquire electricity when the grid failure occurred by generating electricity from their PV system (SEDA, 2016).

5.3.1.2. Disadvantages of net energy metering. In Malaysia, the NEM has become challenging because of its slow take-up rate. The excessive electricity sold to distribution licenses for the low displaced cost is one of the significant challenges of NEM (IRENA, 2019b).

5.3.2. Large scale solar project scheme

Large Scale Solar (LSS) refers to electricity generation through a photovoltaic power station at a scale large enough to be classified as utility-scale or large-scale. The most large-scale solar project has the capacity of more significant than 1 MW, with 1 MW being the minimum capacity. In Malaysia, companies that are interested in setting up a large scale solar plant will have to go through a bidding process announced by the Energy Commission. Only the shortlisted companies are granted the license to develop the Large-Scale Solar project.

The main objective of LSS is to accelerate electricity generation from solar PV and solar farms. Moreover, the commission launched the third cycle of the LSS scheme in February 2019 to improve the power generation from RE. To date, the Government has achieved an installed capacity of 958 MW from the two LSS project cycles. Incentives must be initiated to motivate more involvement from the industry for LSS (Malaysia, 2019a).

5.3.3. Self −consumption

Self-consumption (SELCO), where the electricity generated from PV panel is for individual usage and any excess production is not allowed to send back to the grid. The Government has taken initiatives to support all individuals, commercial and industries to install their clean solar panels to reduce their own cost of electricity. The main benefit of this program is to save more power due to the increased cost of electricity (SEDA, 2019e).

5.3.4. Feed-in tariff

The feed-in tariff (FiT) program starts in 2004 to increase investments in renewable energy. The FiT was implemented in Malaysia since 2011 for solar PV, but now it is replaced with the Net metering program. The FiT rates differ from technology to technology and installed capacities. The main aim of this program is to sell clean energy to the distribution license for a while. Moreover, the duration also depends on the specific renewable energy and technology used. For instance, the term for biomass is 16 years, and for biogas, small hydropower and solar PV technology, the duration is 21 years. The consumer or the Government will pay money for every kWh of electricity you generate that guarantees you to regain the spent money for the technology.

The Malaysian Government has taken these initiatives/implementing different programs to boost renewable and clean energy using different technologies shown in Fig. 14. The Government has taken a step forward to support and encourage all individuals, commercial and industries in all modes to completely utilise the resources towards a greener and sustainable energy.

SEDA Malaysia is implementing sustainable energy initiatives related to solar PV projects by functioning closely with all the state governments, institutions, agencies and other organisations. The state government has appointed SEDA Malaysia to implement the RE and EE initiatives, where it successfully launched two solar PV projects under the smart Selangor programme. The most important initiatives are:

1. Low carbon building facilitation programme, and
2. Solar PV installation facilitation programme

The main objectives under the low carbon facilitation programme are to give priority to the development of the energy management programme, improve awareness, progress human capital capacity on energy management, minimizing the cost of a yearly utility bill of the buildings, and recognizing the potential energy and greenhouse gases savings. Solar PV installation facilitation programme focuses on the 50 kWp installed capacity of Grid-Connected Photovoltaic (GCPV) to generate the EE and connected to the power supply to the building common area. Under the Off-Grid Photovoltaic (OGPV) project, a 1.2 kWp solar PV equipped for 12 houses to access electricity including battery storage and basic electrical appliances (SEDA, 2020c).

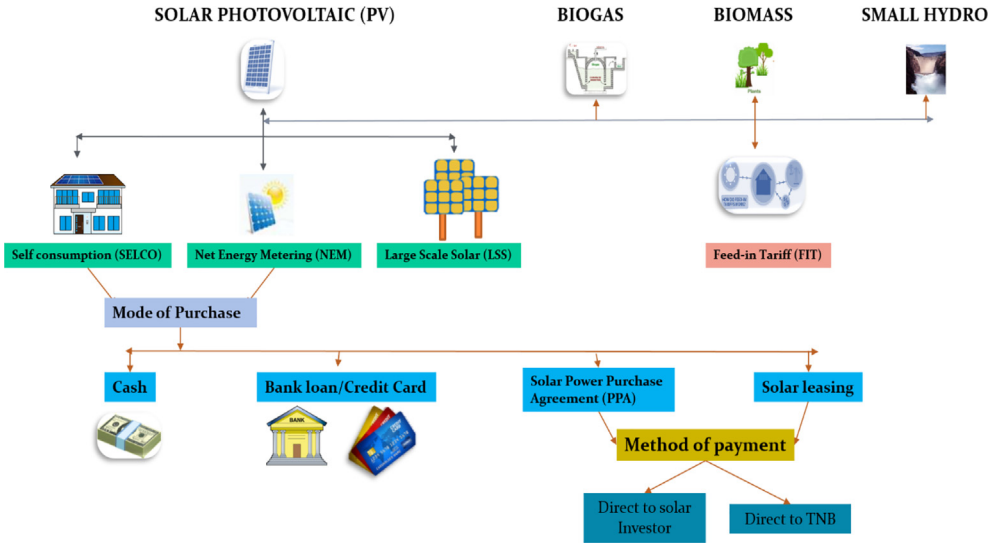

Fig. 14. Implementation of programs using different technologies to improve renewable energy.

6. COVID′19 pandemic measures to sustain the solar industry

The worldwide spread of coronavirus has disrupted various small and large scale industries and the solar energy sector is one of them. The materials used in solar arrays and solar panel construction has slow down as most of the manufacturing companies are located in China and other Asian hubs such as Malaysia, Vietnam, Singapore, Thailand, and South Korea have been affected strongly by the COVID′19 pandemic. Another major concern for sustainable projects like solar arises in the form of tax incentives (Kelley, 2020). COVID-19 has affected not only the solar sector but also the other related markets such as renewable electricity, electric vehicles (EVs), heating, cooling and the circular economy as officially announced by the World Health Organisation. The reports from the Government that the global solar demand in 2020 has been cut down by 16%.

Bloomberg NEF (BNEF) expected solar demand to reach around 121–152 GW (GW) in 2020, whereas in the last three decades, solar capacity shows the first annual fall in between 108 and 143 GW. BNEF and International Energy Agency (IEA) reported that the virus impacts the clean energy investment and the Government to use the drop in oil prices to check the fossil fuel subsidies. However, the main issues are with the growing tax receipts and most governments are planning to invest in high-carbon infrastructure by opting to trim the fuel taxes (Murray, 2020). Finally, COVID-19 made an impact on society to change the path towards decarbonisation and achieving the sustainable development goals (Macola, 2020).

7. Conclusion

Although China declared success in its fight against COVID′19 in mid-April 2020, the rest of the world, including Malaysia, continues to fight the pandemic. As a result, economies have devastated and that is expected to have a grave impact on future energy policies across the world. Climate action following the Paris Agreement required Malaysia to develop a new energy framework to meet its renewable energy goals. Owing to the unfolding situation, Malaysia will have to review its RE policy seriously. We conclude the following points from this exhaustive review.

- From the status-quo, it appears that the existing RE projects will continue but any rapid development, once perceived in this sector, would be challenging in Malaysia.
- Malaysia's solar energy pathway towards a low carbon society beyond COVID′19 needs collective effort from the Government, industries and small players to accomplish this vision.
- The Government is expected to generate RM5 billion (US$1.1 billion) in investments from solar power project by opening a tender for a capacity of 1400 MW in the year 2020. Such investment should be continued in the future to keep the momentum.
- The Government is identifying the key factors affecting RE development and actively promoting RE and sustainability-related policies, assessments, incentives. They have introduced an updated energy framework and growing public awareness on net energy metering, green energy, and sustainability indicates Malaysia's commitment to aim for a cleaner environment by avoiding CO_2 emission.
- Malaysia's strategy for the development of the energy sector compared to other ASEAN countries has been practical and well-judged that gives priority to meeting demand and ensuring the security of supply.
- There might be chances that renewable projects will get dropped while the Government battles the effects by launching a stimulus package to promote the investments and local businesses.
- The Government has offered tax breaks discount on electricity bills of 15% approximately as well as 4% trimmed EPF contribution by employees.
- The Government introduces sustainable stimulus packages to enhance the climatic goals taking advantage of the current situation by implementing clean energy technologies.
- Besides, the sustainable stimulus package introduced by the Malaysian Government, it could also learn from regional ASEAN nations as well as other countries in the world, how they overcome the drag due to COVID′19 pandemic and continue their efforts towards a cleaner future.

7.1. Recommendations

The plausible recommendations will address the gaps, and suggest measures to be followed for the active development of RE.

- Funds have to be disturbed equally between the private and public universities with a set of targets to entirely within the timeline.
- Standard and quality assurance from the fund receivers are considered and appreciable.
- The Government should take initiatives to conduct training programs and workshops to create self-employment and encourage start-ups, which can provide supporting/service to every corner of the country.
- The Government should be cautious about their projects and achieving goals on time, and plans have to be adequately organised or else cause a mix-up that leads to delay.
- A separate policy or a framework needs to be introduced for regular monitoring of climatic changes, CO_2 emission and committee have to be formed to regulate renewable energy contribution in the reduction of greenhouse emission.
- Energy efficiency policy and renewable heat have to be monitored, and the team is assigned to make sure that the waste heat is reduced.
- More awareness campaigns need to be conducted to educate the public about green technology and to protect the environment.
- The Government has to focus on green services by avoiding plastic and promote more green products.
- More attention should be given to solar cars and bicycles to minimise pollution and CO_2 emission.

7.2. Future goals

Malaysia aims and focuses on energy-efficient vehicles (EEVs) by switching the combustion engines into eco-friendly electric vehicles (EVs). Moreover, the Government has taken initiatives to be a marketing hub for electric vehicles by 2030. To encourage the fast-charging stations for electric vehicles to reduce the emission of pollutants that helps to achieve a carbon-free environment by managing the indigenous energy resources. Moreover, Malaysia is on course to reduce carbon emissions by 40% in the coming years, 45% by 2030 and full carbon neutral by 2050 for a cleaner environment for future generations. Additionally, the New Economic Policy (NEP) and government-linked companies involved a free-market economic policy and blue ocean strategies employed to promote the development of RE. The Ministry of Energy, Green Technology and Water, Malaysia is developing the Renewable energy Transition Roadmap 2050 as a substitute to the current National Renewable Energy Policy and Action Plan (Hannan et al., 2018).

Declaration of competing interest

The authors declare no conflicting interest regarding the publication of this manuscript.

This statement is to certify that all Authors have seen and approved the manuscript being submitted. On behalf of all Co-Authors, the corresponding author shall bear full responsibility for the submission.

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