

CHALLENGES OF RENEWABLE ENERGY INDUSTRY IN MALAYSIA

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Abstract. The purpose of this study is to highlight the challenges faced by the Renewable Energy (RE) industry in Malaysia. This conceptual review examines previous research and articles on renewable energy in Malaysia and internationally, including current statistics, developments, and the status of renewable energy worldwide. The review covers key areas related to renewable energy, including its definitions, purposes, barriers, problems, challenges, principles, policies, strategies, and recommendations. The findings indicate that one of the major challenges faced by the RE industry is the high initial investment cost, which may discourage investors from financing renewable energy projects. Changes and inconsistencies in policies, together with insufficient government initiatives, also present significant challenges to the development of the industry. Therefore, government initiatives and appropriate measures, support from financial institutions and private investors, and cooperation among energy producers are crucial for ensuring the success and sustainable development of RE companies in Malaysia. This study is limited to reviewing and discussing the challenges affecting the RE industry in Malaysia. Future quantitative research is recommended to provide empirical evidence and further strengthen the existing literature. The findings may assist industry participants, including project developers, technology and product innovators, investors, financial institutions, and policymakers, in improving their knowledge and understanding of the challenges faced by the industry and the strategies that can be adopted. The study may also encourage greater cooperation and collaboration among stakeholders to improve Malaysia's existing renewable energy structure and policies and support future policy development. Growing concerns regarding climate change and environmental, social, and governance (ESG) issues have increased global awareness of cleaner energy sources and measures to reduce greenhouse gas emissions and environmental impacts. Consequently, increasing demand for clean energy has strengthened the importance of addressing challenges affecting the RE industry.

Keywords: *renewable energy, economy, Malaysia, financial, policy*

Introduction

Malaysia's renewable energy sector is also transforming speedily under the policy leadership of the National Energy Transition Roadmap (NETR) and the Malaysia Renewable Energy Roadmap (MyRER). In 2021, the Ministry of Natural Resources, Environment and Climate Change (NRECC) set a target to reach 31% of RE share in the national installed capacity mix by 2025. This target supports Malaysia's global climate commitment is to reduce its economy-wide carbon intensity (against GDP) of 45% in 2030 compared to 2005 level. Realization of the Government's vision is crucial in supporting the nation to achieve its Nationally Determined Contributions (NDC) targets. The Malaysia Renewable Energy Roadmap (MyRER) is commissioned to support further decarbonization of the electricity sector in Malaysia through the 2035 milestone. This is expected to drive a reduction in GHG emission in the power sector to support Malaysia in meeting its NDC 2030 target of 45% reduction in GHG emission intensity per unit of GDP in 2030 compared to the 2005 level, and further reduction of

60% in 2035. The scope of MyRER includes three workstreams; assessing the baseline installed capacity and RE resources potential, developing technology-specific RE targets and scenarios, and developing a strategic roadmap. The MyRER considers two distinct scenarios for RE development in the nation towards the 2025 Government committed RE target and through to the 2035 milestone which are Business as Usual (BAU) scenario considers the implementation of existing policies and programmes without further extension and/or introduction of new programmes and New Capacity Target (NCT) scenario aims for higher RE capacity target to align with further decarbonization of electricity sector in Malaysia toward 2035 milestone. This scenario is aligned with the capacity development plan of Planning and Implementation Committee for Electricity Supply and Tariff (JPPPET 2020) for Peninsular Malaysia, JPPPET 2021 inputs for Sabah and current outlook for Sarawak.

The MyRER formulates strategies to achieve the Government's committed target of 31% RE share in the national installed capacity mix and to further decarbonize the power generation sector until 2035 by maintaining affordability and system stability. To achieve the stipulated RE targets and aspirations, commitments by policy makers, industry players and strategic partners including financial institutions shall be the determinant in ensuring the successful implementation of this Roadmap. This Roadmap will optimize the socio-economic benefits from the development of RE in Malaysia, whilst positively contributing towards the global climate-change agenda in decarbonizing the power sector for a better future. Energy has been the main contributor towards the rapid growth of Malaysia's economy. As Malaysia is progressing towards becoming a decarbonisation of the electricity sector in Malaysia, its dependence on RE sector will also increase correspondingly. As the economy continues to expand, Malaysia's primary energy supply is projected to grow at 2.8 percent a year, from 65.9 Mtoe in 2005 to 130.5 Mtoe in 2030, driven mainly by the demand for coal and gas in the electricity generation sector and oil products in the transport sector. Within the last ten years, the total electricity generated in Malaysia has increased almost 25%, from 137.4 billion kWh in the year 2014 to 177.75 billion kWh in the year 2023. In May 2023, the Government reaffirmed its commitment to unlock economic opportunities through a low-carbon transition, setting out the ambitious target to achieve 70% RE installed capacity in the power mix by 2050. NETR aims to reinforce this ambition and inform an accelerated RE rollout by affirming two essential targets which is 70% RE installed capacity share by 2050 and no new coal power plant. In alignment with these strong RE ambitions, an accelerated pathway is needed to scale RE uptake in Malaysia over the next three decades.

The schemes set particular targets for renewable energy contribution toward electricity generation of 31% in 2025, 40% in 2035, and 70% in 2050. Solar photovoltaic (PV) technology tops deployment because of Malaysia's favourable high solar irradiation levels, with hydropower as the second-largest renewable source. The government also brought in facilitating measures such as Green Investment Tax Allowances (GITA) and Green Income Tax Exemptions (GITE). With these aspirations, however, renewable companies are faced with an unfavourable macroeconomic environment. Increased global interest rates raised the cost of finance, while the Malaysian ringgit weakened substantially against the US dollar, raising the cost of importing equipment. Inflation, although mild, has created operational strains. This research review Malaysia's energy and economic background, which leads to the knowledge of the specific pressure placed on renewable energy companies. Malaysia

has emerged as a regional solar leader, with exports surging by 269%. Malaysia's target of achieving 70% renewable energy capacity by 2050 under the National Energy Transition Roadmap (NETR) reveals the government's aggressive commitment towards phasing out fossil fuels. While there is clear policy commitment, execution of renewable energy (RE) projects has been patchy with the companies facing massive challenges. While the relationship between macroeconomic variables and the firm's performance has been widely studied (Kandir, 2008). The depreciation of the Malaysian ringgit relative to the US dollar has critically driven the cost of importing solar modules and other core hardware higher, while interest rate has introduced the cost of debt financing to capital-costly projects.

As a result, energy needs to be increased to meet the growing demand. Continuous improvement of supply infrastructure will be required. While simultaneously ensuring its energy security over the long term and mitigating carbon emission by intensifying energy initiatives to improve efficiency and the development of Renewable Energy (RE) sources such as solar and biomass for sustainable progress. Despite the brand-new alternative and Technologies that are renewable and more effective are being developed and carried out annually, the strain brought on by Global consumption and rising energy demand outweighs the benefits brought by these improvements. This problem has resulted in a significant obstacle for the power industry, which is to have a policy for sustainable energy and a variety of sources of energy mix. The aim of this paper is to identify the key barriers to the growth of RE in Malaysia and investigate the broad plans of action and strategies that the government uses which will be the driving force behind the spread of RE in power generation. In addition, the paper will also highlight the impact of the strategic enhancements made by the government currently.

Literature review

RE in Malaysia

In Malaysia, the primary beginning of renewable energy was the use of hydropower in the 1980s. Hydropower was the only major renewable source being used on a large scale at the time, primarily to meet the needs of rural electrification and supply expanding urban centers. In addition to fossil fuels, large dams, particularly in Sarawak and Perak, provided baseload electricity. However, despite their abundance in local reserves, oil and natural gas continued to dominate Malaysia's overall electricity generation mix. By the 1990s, concerns about resource depletion, energy security, and environmental sustainability began to surface. Researchers and policymakers began to see the potential of solar, biomass, and biogas as alternative energy sources. Malaysia's large palm oil industry provided an abundant source of biomass residues, such as empty fruit bunches (EFB) and palm kernel shells. Small pilot projects were started, but they had problems with technology, money, and the limited support from the government at the time. The Small Renewable Energy Power (SREP) Program was established in 1999. It was one of the first efforts made by Malaysia to get the private sector involved in the development of renewable energy. The program aimed to promote small-scale biomass, biogas, mini-hydro, and solar projects. However, there was a low level of participation as a result of difficult financing, restrictive licensing requirements, and unappealing tariffs (Hannan et al., 2018; Kardooni et al., 2018; Shaikh et al., 2017).

According to the ranking stated in the U.S. Energy Information Administration, in 2023 total energy production mix in 21st place ranking. Malaysia is the second-highest

producer of petroleum and other liquids in Southeast Asia and the fifth-highest exporter of liquefied natural gas (LNG) globally in 2023. Malaysia is strategically located in the South China Sea and borders the Malacca strait, both of which are important maritime routes for energy trade. According to Malaysia's National Energy Transition Roadmap, Malaysia plans to achieve a 70% share of installed electricity generation capacity for renewable energy by 2050. The government estimates it will need \$143 billion in investments to meet its target. To help develop its renewable sector, Malaysia lifted its ban on renewable energy exports that it initiated in 2021. The increase in demand for renewable energy from foreign markets will prompt development of domestic renewable generation capacity on a larger scale to meet the higher demand (Enerdata, 2023). From the *Figure 1*, it can be concluded Malaysia is rich with renewables sources such as solar, hydropower, biodiesel, biomass and biogas. There is also other renewables such as hydrogen and wind still in research status. MyRER also recommends exploring wind potential and the feasibility of wind energy integration. Preliminary estimate of wind potential in Malaysia has been conducted, but further investigation is required for realistic wind potential data. Additionally, new solutions such as hydrogen and energy storage technologies are also being explored. The future is promising with the National Energy Transition Roadmap (NETR) launched by the Ministry of Economy in July 2023. It has identified 10 flagship catalyst projects based on six energy transition levers for action, namely, energy efficiency, RE, hydrogen, bioenergy, green mobility and carbon capture, utilisation and storage (CCUS).

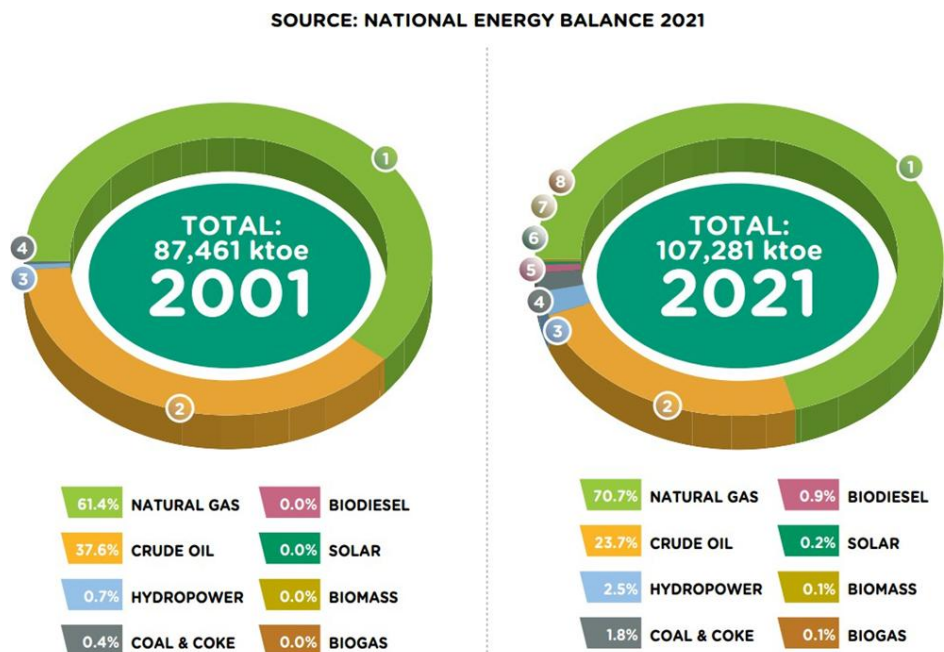


Figure 1. Primary production by fuel type.

RE industry in Malaysia

The renewable energy (RE) industry in Malaysia began modestly, anchored in hydropower. Large dams in Bakun Dam Sarawak, Kenyir Dam Pahang, and Temenggor Dam Perak provided electricity primarily for industrial and rural electrification purposes (Department of Irrigation and Drainage Malaysia, 2019). In the 1980s and 1990s, hydropower dominated the renewable energy landscape. By the late 1990s, Malaysia's

economic development led to higher electricity demand and growing reliance on coal and natural gas, raising concerns about energy security and fuel diversification. During this time, biomass and biogas projects made use of palm kernel shells and empty fruit bunches (EFB), byproducts of Malaysia's palm oil industry. The owner and operator were Tenaga Nasional Berhad (TNB), Sabah Energy and Sarawak Energy (Povera, 2017). There are 321 firm listed in Seda website service provider for photovoltaic. Small pilot projects were launched, but significant industrial scale-up was prevented due to a lack of structured policies and investor incentives. The first attempt by the government to encourage private sector participation was the Small Renewable Energy Power (SREP) Programme in 1999. It enabled mini-hydro, solar, biomass, and biogas-based independent power producers (IPPs) to generate up to 10 MW from renewable sources. However, unattractive tariffs, grid connection issues, and limited bankability restricted its success. The Ministry established a Special Committee on Renewable Energy (SCORE) to oversee the program and defined eligible projects as those up to 10 MW of installed capacity. These projects could sell electricity to two of the three major utilities in Malaysia such as Tenaga Nasional Berhad (TNB) in peninsular Malaysia or Sabah Electricity Sendirian Berhad (SESB) in Borneo. Project developers had to negotiate a REPPA with the relevant utility according to a “willing buyer, willing seller model” and were granted a license for 21 years after the commissioning of a plant.

TNB being the largest power utility company in Malaysia, the renewable energy development was stated with TNB from earlier. From the 60 SREP projects approved, only 10 developers have requested and been given licenses to proceed with the implementation of their projects, with total generating capacity of 51.55 MW with REPPA signed with Tenaga Nasional Berhad, TNB as of March 2008. Due to a number of reasons, the remaining 50 are yet to be implemented. Besides the 10 projects implemented under SREP, TNB, the largest power utility company in Malaysia, has also implemented RE power generation projects involving as follows: (1) Mini Hydro: 13,643 kW, 44 sites, unit capacities in the range of 48 1,100 kW. (2) Solar PV (Suria 1000-MBIPV): 168.515 kW, 16 sites, unit capacities in the range of 3.06 92.01 kW. (3) Solar PV (TNB Mini Grid): 1,231 kW, 25 sites, unit capacities in the range of 10 250 kW. (4) Wind (TNB Mini Grid): 200 kW, one site at Pulau Perhentian, Terengganu. TNB and its subsidiaries such as TNB Renewables Sdn. Bhd., TNB GSPARX, TNB Engineering Corporation Sdn. Bhd, is focusing on the grid of the future allows for seamless adoption of green energy into the grid, allowing reducing carbon footprint. TNB has an adverse impact from Covid-19 pandemic. Demand has started to show improvements, growing at 0.6% against a contraction of 6.2% in year 2020.

Malaysia's renewable energy sector has seen dramatic change over the past two decades, especially with the advent of niche engineering companies that have pioneered mass-scale solar development. One of such companies is ITRAMAS Corporation Sdn. Bhd., which was founded in 1999 and is one of the nation's early players in green technology, renewable energy, and intelligent infrastructure development. ITRAMAS has, over the years, evolved from a supplier of engineering services to Malaysia's largest vertically integrated developer of solar power plants and EPCC contractor. ITRAMAS also diversified its operations into energy efficiency, electronics manufacturing, smart city systems, and most notably, renewable energy engineering. ITRAMAS has led the way in growing solar photovoltaic (PV) electricity generation in Malaysia. Up to 2024 so far, the firm has successfully developed and commissioned 200 MWp worth of solar schemes, and is a market leader in the Large-Scale Solar (LSS) sector. The firm is not

only an EPC contractor but also a project developer and asset operator, which enables it to control the whole project life cycle from project start-up, permitting, and financing, through building, operating, and maintaining (O&M). Such a vertically integrated model distinguishes ITRAMAS from the majority of competitors who are specialized in just one part of the solar supply chain.

Its leadership within the Malaysian market has been supported by steady participation in national solar schemes, and most notably within LSS tenders administered by the Energy Commission. Through taking technical delivery and financing structuring in-house, ITRAMAS has helped de-risk Malaysia's renewable energy pipeline and deliver wider investor confidence. ITRAMAS journey commenced with LED technology, evolved into intelligent transport systems and expanded into solar energy. The predominant sector in ITRAMAS is constituting 60%- 70% solar sector. In 2015, ITRAMAS initiated the construction of the 150MW large-scale solar project a groundbreaking endeavour given. Challenges on covering an expansive 600-acre land was required and with a government's tight timeline, emphasizing the need for swift execution to alleviate concerns about project feasibility.

RE policies and initiatives in Malaysia

Malaysian government has implemented various of RE policies that aim to diversify its energy mix, reducing dependency on fossil fuels, and promoting green technology in response to the global climate and energy demand. Nawang et al. (2021), review that the changes in policies and lack of government initiatives also become as the challenges in RE development. Eitan (2021) states that Energy policy is the governmental act implemented by the installers of renewable energy sources, distributors and consumers. Several policies have been executed by the Malaysian government to guarantee sustainable energy in the future. This section explains each policy in detail as follows:

Feed-in Tariff (FiT) policy in Malaysia

Feed-in Tariff mechanism has been implemented in Malaysia since year 2011 by incorporating RE Act 2011, where 1.6% of RE Fund (KWTBB) will be collected from the customers of TNB, the largest and sole utility company in Malaysia. The collected fund is channeled to Sustainability Energy Development Agency (SEDA) a government agency setup to manage and administrate the FiT mechanism (Tan and Chow, 2016). Fit policy is to offset the high investment cost of RE. Malaysia's Feed-in Tariff (FiT) system obliges Distribution Licensees (DLs) to buy from Feed-in Approval Holders (FIAHs) the electricity produced from RE and sets the FiT rate. The DLs will pay for RE supplied to the electricity grid for a specific duration. By guaranteeing access to the grid and setting a favorable price per unit of RE, the FiT mechanism would ensure that renewable energy becomes a viable and sound long-term investment for companies, industries and also for individuals. Companies that hold the DLs is responsible to distribute electricity (e.g. TNB). FIAHs is a individual or company who holds FIAHs certificate issued by SEDA Malaysia. The holder is eligible to sell renewable energy at the FiT rate. FiT incorporated into the 10th Malaysia Plan (chapter 6) on June 2010 subsequently on October 2010, incorporated into National Budget 2011 and Economic Transformation Programme. Basri et al. (2015) states that in March 2007, the European Union targeted 20% renewable energy for 2020, emphasizing small-scale units. Bouznit et al. (2020) states that a FiT is a payment system that pays for those who produce

energy in their homes. Wong et al. (2015) console that although Malaysia has multiple RE resources, such as biomass, biogas, Mini hydro and solar resources, it is far from reaching its goal. The FiTs were implemented to support RE and to pass the challenges.

Net energy Metering

Feed-in tariff (FiT) has been implemented in Malaysia since 2011 and reached its maximum capacity quota by the end of 2015 as stated by Tan and Chow (2016) and since the FiT becomes more mature after implementation, the government of Malaysia finally introduced the NEM scheme in early 2016 with the intention to replace the FiT by 2018 has declared by Oh et al. (2018). The government offers a 500 MW quota for the PV system under this scheme. In NEM 1.0, every exported energy unit into the grid will be credited in the next billing at a displaced cost of 0.31 RM/kWh units. The NEM system implies that an algebraic deduction is performed between the electrical energy produced by the PV system and the energy consumption (Christoforidis et al., 2013). Under NEM, customers are allowed to consume the RE generated electricity under normal conditions, however, in the case of excess energy generated by the RE system, it could be sold to the TNB by feed back to the grid preferably at a certain premium or retail prices determined by the Energy Commission (EC) as stated by Tan and Chow (2016). Energy generated that is consumed first by NEM users implies less energy will be imported from the utility grid and this translates to more savings for the consumers. These savings will be significant for consumers who fall under the high electricity tariff block. The main purpose of NEM is for self-consumption to reduce demand from the grid and hence, maximum energy demand can be mitigated during peak hours where Oh et al. (2018) affirm the statement. Additionally, according to Oh et al. (2018) NEM was also initially allocated with a 500 MW capacity quota which needs to be evenly distributed with 100 MW per year for Peninsular and the state of Sabah (i.e., 90 MW for Peninsular and 10 MW for Sabah) over a period of 5 years (2016-2020), of which the quota is to be divided into three categories, i.e., 10% for domestic households while commercial and industrial will get an equal share of 45% each.

Net energy metering 2.0

In order to conclude the disadvantages of NEM 1.0, the Malaysian government innovated the idea of NEM 2.0 from 1st January 2019. This program is limited to consumers of Peninsular Malaysia who registered with Tenaga Nasional Berhad (TNB), where the bill for export is calculated according to the same tariff but in reverse order. Thus, for higher use of load, the higher rate will be levied on the export bill. Due to this improvement, the 500 MW quota was removed 1 month before the end date of 31st December 2020. Similar to NEM 1.0, surplus power can be carried over for up to 24 months. Surplus energy will be forfeited after that period. The offset period of this scheme is also 20 years, similar to the previous scheme. Islam et al. (2020) states that the initial NEM did not assist in the return of investment outcomes. However, NEM 2.0 allows for consumers to net-off energy sold to the grid one-to-one. This is to say that PV installers are able to net off each unit of 1 kWh of electricity with 1 kWh of electricity from the grid in their subsequent electricity bill.

Net energy metering 3.0

Starting from 1st February 2021, the government has allocated an additional 200 MW capacity from solar systems under NEM 3.0. This allocation is divided into two, which are 100 MW under NEM Rakyat (housing building) and another 100 MW under NEM GoMen (government building). Another 300 MW is reserved for release on 1st April 2021 for NOVA, which is for commercial and industrial. The quota of this one can be taken for 3 years. The biggest change in this plan is the time of offset, which is only 10 years also stated by Curran (2020). It means, in the initial 10 years, it is exactly the same as NEM 2.0, where the excess electricity is supplied to the grid and will be given credit next bill at a retail rate in reverse direction. The NEM 3.0 consists of three programs which are assigned to a specific market sector. The first program is NEM Rakyat, which covers the residential segment. A 100 MW capacity is allocated to this program, effective on 1 February 2021 stated by Joshi (2018).

Large Scale Solar Program (LSS)

LSS program is an utility-scale program as stated by two authors namely Fisch et al. (1998) and Nyholm et al. (2016). It may be implemented through a competitive bidding. Luthander et al. (2015) states that the lowest bidder receives the allowed quota. Malaysia assigned 500 MW for the third time for LSS. Large-scale solar farms use it attempts to apply bids to minimize the levelized cost of energy (LCOE) stated by Nyholm et al. (2016) and Luthander et al. (2015). LSS and the energy commission is the implementing agency for the past. The lowest offer price wins the installation quota. LSS must have an in-built capacity of at least 30 MWh at one interconnection point so that it can be connected to the transmission system. A reverse auction method is utilized by the scheme to award bidders based on the lowest bid for offtake prices. LSS 3 registered a 50% discount over offtake bids received in LSS 2. Financing through debt is also prevalent in this scheme. There is only one off-taker, Tenaga Nasional Berhad (TNB), and the expense is actually being passed on to electricity consumers. The rate of electricity for electricity from the PV farm includes but is not limited to Engineering Procurement and Construction (EPC), land cost, project development cost, financing cost, O&M cost and interconnection cost (Luthander et al., 2015).

Corporate Renewables Energy Supply Scheme (CRESS) and Community Renewable Energy Aggregation Mechanism (CREAM)

Malaysia also takes initiatives to launch a scheme namely Corporate Renewables Energy Supply Scheme (CRESS) which allows the company to buy green power directly via third-party grid access. CRESS was officially launched in September 2024. As off June 2025 the scheme had secured corporate supply commitments total around 1.3GW under grid PPAs. Tenaga Nasional Berhad (TNB) has signed a 21 years agreement with DayOne to deliver up to 500MW of renewable power, which initially deliver 200MW to its data centers in Johor. CRESS facilitates “willing buyer, willing seller” model, bypassing quota limitations and speeding recruitment of corporate-scale RE capacity which has stated by The Star reporter on 16 June 2025. CRESS empowers corporate entities to commit to substantial green energy consumption, aligning with business ESG targets and arousing large-scale solar uprise. Subsequently, in 2025, the Government introduced a program to encourage community participation in renewable energy generation. By incentivizing individuals to lease their rooftops for solar photovoltaic installations, the program aims to enable communities to generate clean

energy and earn additional income by selling excess solar power directly to Local Green Consumers. Government launches a scheme namely Community Renewable Energy Aggregation Mechanism (CREAM). Security Energy Commission (SC) of Malaysia has prepared a guideline for CREAM. The purpose of this guideline is to regulate the direct procurement of green electricity generated from Local Community Solar Plant ("LCSP") owned by Local Energy Generator and Aggregator ("LEGA") to the Local Green Consumers registered with the Electricity Utility Company ("EUC") via Electricity Supply Network in Peninsular Malaysia.

The Energy Commission's framework explicitly sets the 5 km supply radius and defines roles: LEGAs handle lease agreements; TNB fosters grid stability and billing infrastructure. The program is framed to be cost-neutral, with open grid access that avoids increased consumer tariffs, and supports Malaysia's renewable targets of 40% by 2035 and 70% by 2050. Homeowners can lease roofs to Local Energy Generators and Aggregators (LEGAs), who install PV systems and sell electricity to local households and businesses within a 5 km radius via TNB's distribution network. CREAM as a grassroots approach to renewable adoption for enabling residential participation and building resilience via localized, shared solar ecosystems.

Green Investment Tax Allowance (GITA) and Green Income Tax Exemption (GITE)

The Government has made a strong stance in renewable energy targets by increasing the share of renewable energy in the electricity generation capacity mix to 70% by 2050. In line with Malaysia's aspiration to be an inclusive, sustainable and carbon neutral nation by 2050, the Government had announced an extension and revision of Green Technology Tax Incentive during the 2024 National Budget. The revision of Green Technology Tax Incentives provides tax incentive based on a tiering approach and categorised into three (3) categories as follows Green Investment Tax Allowance (GITA) Project for Business Purposes, Green Income Tax Exemption (GITE) Solar Leasing and Green Investment Tax Allowance (GITA) Asset for Own Consumption. Based on the revision, the qualifying activities for GITA Project for Business Purpose are expanded to cover new green technology projects namely green hydrogen, electric vehicle charging station and renewable energy source from wind energy. Both GITA Project for Business Purpose and GITE Solar Leasing to be submitted to Malaysia Investment Development Authority (MIDA). Meanwhile, GITA Asset for Own Consumption to be submitted to Malaysian Green Technology and Climate Change Corporation (MGTC) (Malaysian Investment Development Authority [MIDA], 2023).

Materials and Methods

This study is conducted to highlight the overview and challenges in financing the RE industry in Malaysia. Even though many research have been done relating to RE financing in Malaysia, this research were either focus or discuss only on a specific policy, challenges, and awareness. Therefore, this paper will fill in this gap by discussing the challenges in RE industry, including the impact of COVID-19 pandemic towards RE development, followed by strategies and recommendation to enhance the RE development. The review of sources started from identifying the definitions, findings and conclusions of the research papers covering RE in Malaysia and international including the current statistics and status of RE around the world including Malaysia. Topics that developed specifically for the conceptual review on RE are

broadly reviewed including the definitions, purpose, barriers, problems, challenges, principles, policies, strategies and recommendation. The impact of COVID-19 on RE is also discussed in this paper to show the future development and strategies to continue financing RE in Malaysia.

The conceptual review approach is applied by examining relevant journal articles, reports, policy documents and industry publications related to renewable energy development and financing. The sources are reviewed based on their relevance to the research objectives, particularly those discussing financial barriers, investment costs, government policies, renewable energy incentives, technological development and the participation of financial institutions and private investors. The selected literature is then compared to identify similarities and differences in the challenges reported by previous studies. Particular attention is given to the Malaysian context while relevant international studies are also considered to provide a broader understanding of renewable energy development and to identify practices that may be applicable to Malaysia. The information gathered from the selected sources is organized according to several key themes, namely renewable energy development, financing challenges, policy and regulatory issues, investment barriers, government initiatives and strategies for future development. The findings from previous studies are critically reviewed and synthesized to identify the major factors that influence the growth and sustainability of the RE industry in Malaysia. This approach enables the study to provide a comprehensive understanding of the current situation of the industry and the challenges faced by relevant stakeholders. The review also provides a basis for proposing appropriate strategies and recommendations that may support policymakers, financial institutions, investors, project developers and other industry participants in strengthening renewable energy development in Malaysia.

Results and Discussion

The COVID-19 pandemic had an impact on the majority of businesses worldwide, resulting in countries experiencing a sudden drop in their gross domestic product and a looming global recession level of employment, income, and gross domestic product (GDP). Financial challenges can be related to the difficulty in raising the sources of funds in financing the RE projects contributed by the high costs of capital (Nawang et al., 2021). Renewable energy project developers were responsible for the costs of grid connection and utility system reinforcement including cables, transformers, switchgears, protection equipment, and meters, and were required to distribute electricity into the network between 11 to 33 kV. Numerous green energy projects are currently underway, with funding from grants. This is because new Technologies are subject to some uncertainty, so it imposes a barrier to its growth. The result of this uncertainty is in high costs for funding research, development, and deployment. This in turn artificially raises the price of clean options for energy, putting off their full integration into the energy marketplace. The initial cost of efficacy frequently equipment is significantly more expensive than the typical alternator, and the payback period or economic return may be unacceptable. Projects involving green or renewable energy generally face difficulties obtaining financing and approval for a bank loan due to the high level of risk and lack of technical information from the financiers (Nawang et al., 2021).

Malaysia is also looking into the grid for future. Malaysia is the first of ASEAN member nations to enter into a multilateral cross border power trading arrangement,

which saw the purchase of electricity from Laos via Thailand. It was a historic milestone for the ASEAN Power Grid because the power transfer marked the beginning of its first leg of operations, with interconnections linking the grids in Laos-Thailand-Malaysia, called the LTM. LTM was extended to Singapore and is now known as LTMS. Other countries that support ASEAN Grid are in different stages of development, to connect the grids in Borneo, Indonesia and the Philippines. Malaysia plans to ride on this connectivity to export surplus RE to its ASEAN neighbours. To facilitate fair and competitive cross-border trading practices, the Government launched Energy Exchange Malaysia (ENEGEM). The RE trading platform that kicked off with a pilot auction of 100 MW to Singapore that is less than 2% of the nearly 7,000 MW installed RE capacity in Peninsular Malaysia before it is expanded to 300 MW. The pilot project to export at least 100 MW of RE to Singapore will test demand while ensuring ample supply in the local market. ENEGEM adopts a comprehensive and well-coordinated regulatory approach. It is aligned to international conventions that are crucial for the effective implementation and operation of across-border electricity exchange system. In addition, it ensures that the system operates securely, reliably and in a manner that upholds the principles of fairness and sustainability. The actual specifics can vary based on the regional context, the countries involved, and the details of Government plans and agreements.

Britain's Energy Regulator Launches Rules to Speed Up Grid Connection Britain's energy regulator announced rules to help speed up the connection of new power projects to the grid and clear so-called zombie projects from the connection queue. Regulator Ofgem said the current "first come first served" process for grid connection has led to a long queue of projects with a backlog of up to 15 years. Under the new rules, projects in the connection queue that have stalled or are unlikely to be built will be stripped out, making room for viable projects. Renewable energy industry has a opportunity for the utility-scale solar space is to venture to align Green Bonds with Sustainable Responsible Investment (SRI) and Sukuk. ITRAMAS focus is on dual-use of land to include agriculture, integrating an industrial park to create circular economy and placing emphasis on the incorporation of Battery Energy Storage Systems (BESS). It is also important to have more research on the public-private partnerships.

Conclusion

The challenges in RE industry need to be addressed properly by all the stakeholders including government, investors, producers as well as the public to ensure the success of RE in Malaysia (Nawang et al., 2021). Reaching RE objectives mean creating a cleaner and more sustainable environment. To encourage more investors to invest in RE projects, the Malaysian government's proactive efforts to diversify its energy mix and shift toward renewable energy must be supported by clear policies, frameworks, and guidelines (Eitan, 2021; Bouznit et al., 2020). When it comes to financing and funding the development of RE projects, both the assistance provided by the government and the collaboration of private sectors, financial institutions, and capital markets are absolutely necessary for RE to commercially acquire novel concepts and produce clean technologies (Nawang et al., 2021). Thus, Malaysian government should offer sufficient incentives to investors in the RE projects. In order to entice investment, the government must also offer guarantees to the private sector to demonstrate that RE investments will yield a substantial return. In addition, raising public awareness of the significance of RE

will boost Malaysia's RE industry (Kardooni et al., 2018). This can be done by offering sufficient knowledge, education and incentives to the public that can give positive perception on RE sectors in Malaysia. Thus, the cooperation by all the parties is needed to achieve these goals. In addition, in order to achieve clearly defined RE targets and progress toward a more sustainable energy future, particularly during and after the COVID-19 pandemic, the formulation of short-term, mid-term, and long-term action plans is crucial (Vaka et al., 2020). This study was limited by its reliance on second-hand data and geography to Peninsular Malaysia, and solar PV as the dominant technologies. Subsequent studies would have to sample firm-level financial and contractual data, model grid curtailment at the node level, and look at long-term workers' returns from TVET and higher education courses. Comparative studies across ASEAN nations could also determine regional best practices for responding to macroeconomic and structural challenges.

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Conflict of interest

The authors confirm that there is no conflict of interest involve with any parties in this research study.

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