FINANCING AND POLICY CHALLENGES OF THE RENEWABLE ENERGY INDUSTRY IN MALAYSIA: A REVIEW

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ABSTRACT

The renewable energy (RE) sector in Malaysia has developed rapidly with the implementation of government policies, such as the National Energy Transition Roadmap (NETR) and the Malaysia Renewable Energy Roadmap (MyRER). This study is based entirely on data sources from the literature review and policy. Approximately 45 sources were identified, reviewed, and assessed systematically between 2010 and 2025. The overall challenges in the renewable energy sector are addressed in this article through the financial, policy, and infrastructural barriers that confine large-scale uptake. A critical examination of recent studies and official reports is conducted to identify long-standing impediments and assess the effectiveness of national policies in realising Malaysia's renewable energy objectives. The identified impediments include high initial investment demands, an uncertain policy regime, limited institutional support, and financing challenges, which are among the major constraints to sector development. The study further emphasises the role of government intervention, private investment, and public–private partnership in the successful execution of RE projects. With Malaysia aiming for 70% renewable capacity by 2050, the industry still faces macroeconomic headwinds, including volatile exchange rates, rising interest rates, and inflationary pressures. The research contributes to the field of knowledge by offering insights into the renewable energy challenges of Malaysia and providing concrete recommendations for enhancing policy environments, improving access to funding, and promoting inter-stakeholder coordination.

Keywords: *renewable energy, energy policy, financing challenges, sustainability, green investment*

INTRODUCTION

Malaysia's renewable energy (RE) sector is undergoing a radical shift with ambitious policy initiatives, such as the National Energy Transition Roadmap (NETR) and the Malaysia Renewable Energy Roadmap (MyRER). These focus on supplementing Malaysia's broader decarbonisation strategy and its Paris Agreement pledge to reduce economy-wide carbon intensity by 45% by 2030, compared to a 2005 base year [1]. To achieve these objectives, Malaysia aims to achieve 31% RE capacity in 2025, 40% in 2035, and 70% in 2050 with an emphasis on a transition away from dependency on fossil fuels towards a cleaner, low-carbon energy foundation [2].

The MyRER is the operational plan to decarbonise the power sector, which sets out on three workstreams: (1) baseline capacity and RE potential identification, (2) technology-specific target development, and (3) long-term strategic roadmap development. Two development scenarios are projected: business as usual (BAU) and new capacity target (NCT) to examine Malaysia's RE development trajectory up to 2035 [3].

Malaysia's economic growth, industrialisation, and urbanisation have all been factors that have promoted growth in energy use, which has predominantly been met by natural-based fossil fuels such as coal and natural gas. The generation of electricity has increased by 25% over the past ten years, from 137.4 billion kWh in 2014 to 177.75 billion kWh in 2023 [4]. Recognising the environmental impact of maintaining dependence on fossil fuels, the government has initiated steps towards building renewable energy sources to secure energy, affordability, and sustainability.

Reiterating its aim in May 2023 to unlock economic potential by accelerating low-carbon transition planning, with a focus on solar energy, hydro energy, and new technologies such as hydrogen and bioenergy. The NETR formulates two principal objectives: (i) 70% RE capacity installed by 2050, and (ii) ending new construction of coal-fired power stations [2]. These ambitions are complemented by financial incentives, including the Green Investment Tax Allowance (GITA) and green Income Tax Exemption (GITE) schemes, which aim to attract private investment in green infrastructure projects [5].

Despite such policy enhancements, Malaysia's RE companies are still confronted with daunting challenges. The decline of the Malaysian ringgit against the U.S. dollar has made the cost of importing equipment higher, while rises in interest rates abroad have pushed the cost of capital-intensive RE projects higher. Inflationary stress has also pushed operating margins tighter. Thus, ensuring Malaysia's renewable energy targets implies overcoming

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macroeconomic constraints through synergistic policies, effective financing tools, and firm institutional coordination.

This paper critically examines challenges facing Malaysia's renewable energy industry through policy analysis, sectoral appraisal, and economic perspectives. Specifically, it (i) identifies the deterrents preventing RE development, (ii) reviews government policy and incentives effectiveness, and (iii) develops strategic recommendations to facilitate sustainable sectoral growth.

However, participation was low due to difficulties with financing, restrictive licensing requirements, and an unappealing tariff [6]-[8].

Nawang et al. [9] reviewed that changes in policies and a lack of government initiatives also pose challenges in RE development. Eitan [10] states that Energy policy is the governmental act implemented by the installers of renewable energy sources, distributors and consumers. The Malaysian government has executed several policies to guarantee sustainable energy in the future.

LITERATURE REVIEW

Malaysia's Development of RE

The development of RE in Malaysia has been a journey of a few decades, with hydropower as the initial major renewable resource. It began in the 1980s and was part of rural electrification and urban supplies, complemented by major installations in Sarawak, Perak, and Pahang [11]. However, even after some success, electricity production in Malaysia remained heavily dependent on fossil fuels, with oil and natural gas as its primary sources.

By the 1990s, concerns over resource depletion, energy security, and environmental sustainability promoted interest in alternative energy resources such as solar, biomass, and biogas. The extensive availability of agricultural residues, particularly those from palm oil processing, has made biomass a significant renewable resource [6],[8]. Technological and cost challenges, together with poor government incentives, checked mass adoption.

The Malaysian government followed up with the launch of the Small Renewable Energy Power (SREP) Program in 1999, the country's first official effort to involve the private sector in renewable energy development. The program offered incentives to small-scale projects utilising biomass, biogas, mini-hydro, and solar technologies, but uptake was slow due to cumbersome licensing procedures, uncompetitive tariffs, and insufficiency of funds [7].

The U.S. Energy Information Administration [12] ranked Malaysia as the world's 21st largest producer of energy in 2023, and as Southeast Asia's second-largest oil producer and fifth-largest liquefied natural gas (LNG) exporter. Nevertheless, the government has pledged to raise the share of renewable energy to 70% of installed capacity by 2050, which will require an estimated USD 143 billion in investment [13]. The easing of the 2021 renewable energy export prohibition is expected to result in increased regional competition and investment by the private sector.

The Landscape of the Renewable Energy Industry

Malaysia's RE industry initially focused on hydropower but has diversified since then into solar photovoltaics (PV), biogas, and biomass. The development of the sector was driven by large utility companies, such as Tenaga Nasional Berhad (TNB) and Sabah Electricity Sdn. Bhd. (SESB), and Sarawak Energy, as well as new private-sector players. Of the 60 projects approved under the SREP program, only 10 were successfully commissioned, producing a total of 51.55 MW by 2008 [14].

TNB was at the forefront in initiating early renewable ventures, including mini-hydro, solar PV (Suria 1000), and wind pilot plants. However, mass deployment was limited by capital cost and funding constraints [15].

In the 2010s and 2020s, Malaysia also witnessed the growth of private renewable firms such as ITRAMAS Corporation Sdn. Bhd., which became Malaysia's leading integrated solar power developer. Since its incorporation in 1999, ITRAMAS has evolved from a green technology service provider to a vertically integrated solar power company with an installed capacity of more than 200 MWp by 2024. Its contribution to large-scale solar (LSS) schemes helped fuel greater investor confidence and market maturity 16].

Policy Structure and Government Strategies

A series of evolving policies has guided Malaysia's renewable energy development towards diversifying its energy mix and reducing its dependence on fossil fuels. These policies include the Renewable Energy Act 2011, the Feed-in Tariff (FiT) programme, Net Energy Metering (NEM) schemes, and LSS projects.

FiT was introduced in 2011 by the Renewable Energy Act 2011, governed by the Sustainable Energy Development Authority (SEDA). The FiT scheme guarantees long-term offtake contracts for renewable electricity at premium fixed prices and underpinned by a 1.6% RE Fund charged to electricity consumers [17]. FiT succeeded in pushing the initial RE uptake but then reached quota caps in 2015 [18].

The NEM schemes followed FiT subsequently, beginning with NEM 1.0, where consumers had the option to sell excess solar electricity to the grid in lieu of bill credits. This was followed by NEM 2.0, which introduced a one-to-one offsetting mechanism, significantly improving project bankability [19]. The current NEM 3.0 reserves 500 MW of capacity in the residential, government, and commercial segments, promoting self-consumption and distributed generation [20].

The LSS initiative, launched in 2016, accelerated the deployment of solar energy through competitive auctions, resulting in a nearly 50% decrease in the levelized cost of electricity (LCOE) from LSS2 to LSS3 [21]-[22].

Subsequent developments, such as the Corporate Renewable Energy Supply Scheme (CRESS), launched in 2024, and the Community Renewable Energy Aggregation Mechanism (CREAM), launched in 2025, extend the market to community and business

players. CRESS promotes direct corporate purchasing of renewable energy through third-party grid access, and CREAM encourages rooftop leasing and neighbourhood solar production within a 5 km radius [4].

Financing instruments such as the GITA and the GITE have been amended to encourage investment in emerging sectors, including hydrogen, bioenergy, and electric charging points [5].

Literature Insights Summary

The literature discussed highlights Malaysia's substantial success in formulating and implementing renewable energy policies. However, the persistent barriers, such as high initial capital costs, limited access to finance, policy uncertainty, and grid integration concerns, continue to constrain development [9]-[10]. In addition, while government-led programs such as FiT, NEM, and LSS have initiated capacity growth, their long-term sustainability relies on institutional coordination and uncompromising regulation.

Literature also highlights a growing concern with macroeconomic risks such as exchange rate instability, inflation, and fluctuating interest rates, which affect the performance of renewable businesses [23]-[25]. These findings suggest that both financial and policy interventions are necessary to ensure Malaysia's transition to a low-carbon energy economy is successful.

METHODOLOGY

Research Design

The study employs a qualitative conceptual review approach to investigate the barriers, challenges, and opportunities in Malaysia's RE industry. The research design aims to integrate secondary data from academic literature, policy documents, and institutional reports to provide a comprehensive overview of the industry. Because the context of renewable energy is largely influenced by macroeconomic, political, and institutional conditions, qualitative design enables a comprehensive comprehension of complex interdependencies better than statistical quantification.

This structure enables the integration of past and contemporary developments, linking Malaysia's renewable energy development to broader concerns of energy transformation, sustainability, and economic change. The intention with this approach is not merely descriptive but interpretative and analytical, to provide the foundation for the investigation of policy loopholes and suggest actionable policies for the nation's renewable energy development.

Data Sources and Collection

This study is based entirely on secondary data sources. Approximately 45 secondary sources were identified, reviewed, and assessed systematically between 2010 and 2025. The sources were selected for their relevance, credibility, and contribution to the knowledge of Malaysia's renewable energy policy, financing mechanism, and industrial development.

The sources were grouped into four broad categories, namely, peer-reviewed academic journals, which provided the theoretical and empirical basis for the study. The main sources are [6]-[9],[17]-[18], [25]-[26]. The research examined the performance of renewable energy, policy mechanisms, and financial barriers in both Malaysian and international contexts.

Moreover, government policy reports which are, [2], Ministry of Natural Resources, Environment and Climate Change [1], SEDA [20], and the Energy Commission of Malaysia [4] were referred to in an attempt to understand Malaysia's policy direction as well as national energy targets. Plans such as the NETR and MyRER were analysed for their role in contributing to decarbonisation goals and sectoral plans.

Besides that, institutional and industry journal sources which are Institutional statistics from organisations such as TNB [27], Malaysia Investment Development Authority [5], Malaysia Energy Centre [13], and Malaysian Green Technology and Climate Change Corporation [28] were used to provide the industry landscape, market condition, and financing schemes such as GITA and GITE.

Finally, the global energy and economic reports sources, such as reports by the U.S. Energy Information Administration [12], Enerdata[13], International Gas Union [29] and [11], have been used to compare the development of Malaysia's renewable energy with that of international and regional counterparts. Each of these 45 secondary sources strikes a balance between theoretical depth and policy relevance, bringing theoretical acumen and practical nuance to the discussion.

Inclusion and Exclusion Criteria

To ensure that the secondary data used is reliable and relevant, inclusion and exclusion criteria were established, including peer-reviewed articles or reports between 2010 and 2025. Studies on renewable energy policies, economic matters, investment frameworks, or sustainability in Malaysia or Southeast Asia. Policy papers, government frameworks, and official institutional reports from credible agencies.

Exclusion criteria are non-academic reports without credible sources or peer review. Technical engineering studies lack policy or economic importance. Older sources before 2010, unless historically required 14]. This systematic method of selection ensured that the introduction of updated, reliable, and topic-relevant data directly addressing Malaysia's renewable energy challenges was made.

Analytical Framework

The study utilises thematic content analysis as a technique to retrieve pertinent patterns, themes, and relationships among the examined studies. Thematic analysis is well-suited for qualitative synthesis since it permits the researcher to provide sense to ample textual data in a structured and systematic manner.

The process adhered to the six-step process [30]:

1. Familiarisation with data: Multiple readings of the chosen studies and policy reports were conducted to understand the context-related basis of renewable energy growth in Malaysia.
2. Coding initial codes: General issues such as financial constraints, policy uncertainty, technological limitations, and stakeholder engagement were coded across all sources.
3. Theme identification: data coded were grouped under broader themes, including policy and institutional frameworks, financing problems, technology readiness, and macroeconomic pressures.
4. Theme Review: Cross-referenced for internal consistency and representativeness with the source literature.
5. Defining and naming themes: These were explicitly defined through the synthesis of evidence and quotes across authors to enhance interpretative richness.
6. Synthesising and reporting: Yielded a final conceptual model defining the interdependence among macroeconomic determinants, policy instruments, and firm performance in Malaysia's RE industry.

Research Scope and Delimitations

The scope of this study is limited to the renewable energy sector in Malaysia, with a focus on key technologies such as solar photovoltaic (PV), hydropower, biomass, and biogas. Policy enforcement, financial structures, and macroeconomic drivers are primarily the focus of the study, as opposed to the technical system structure. Spatial emphasis lies in Peninsular Malaysia, and particular mention of Sabah and Sarawak is necessary in descriptions of hydroelectric and biomass opportunities. The study does not involve primary data collection (such as interviews or questionnaires) due to time and cost limitations. Nevertheless, by compiling secondary data from credible institutional and academic literature, the study is well-positioned to provide a comprehensive overview of the RE ecosystem.

Ethical Considerations

As this research relied solely on secondary data, there was no direct contact with human subjects. Everything was derived from publicly available scholarly and institutional materials. Proper accreditation and citation were maintained according to the IEEE referencing style. The researcher applied transparency, academic integrity, and intellectual honesty while reviewing and synthesising.

Summary of Methodology

The methodological framework behind this research is shown to be systematic congruence through transparent data collection, properly defined inclusion criteria, and proven methods of analysis. The utilisation of approximately 45 diverse and credible secondary sources ensures trust that the study is encompassing broad, evidence-based grounds of Malaysia's renewable energy sector.

This methodology not only adds to the robustness of the findings but also adds to their applicability to similar other developing nations in Southeast Asia. The findings derived from such a methodology provide a solid empirical foundation for the ensuing Discussion and Analysis section, where it critically examines the diversified problems facing Malaysia's renewable energy industry and evaluates strategic responses to assist its longrun sustainability.

DISCUSSION

Overview

The Malaysian RE sector has grown to become a crucial pillar of national development and sustainability, aligning with the nation's vision to achieve carbon neutrality by 2050. While stimulated by enormous policy incentives, financial incentives, and technological advancements, the industry still faces numerous barriers that limit its full growth and contribution to national energy security.

This section weaves together key conclusions drawn from the literature considered to address the structural, financial, policy, and macroeconomic challenges confronting Malaysia's renewable energy industry. It also examines the way market forces, institutional structures, and governance mechanisms operate and interact to shape sectoral performance.

Financial Challenges

High Capital and Investment Costs

Evidentially, the most critical problem beleaguering the renewable energy industry in Malaysia is the high initial capital expenditure required for project development. Noted by [9] are the points that renewable energy projects, particularly those within the solar, biomass, and biogas sectors, require enormous front-end capital expenditures for machinery, grid facilities, and technological procurement. The exorbitant costs discourage potential investors, particularly small and medium-sized enterprises (SMEs), from engaging in the RE business.

Additionally, the cost of grid connection and utility system reinforcement, including transformers, switchgears, meters, and protection systems, is typically borne by project developers [31]. The absence of standard cost-sharing arrangements also tends to exacerbate financing constraints, particularly for projects operated outside the Peninsular grid, such as those in Sabah and Sarawak.

Limited Access to Finance and Risk Perception

Malaysia's banks remain cautious about lending to RE developers due to the high risk and long payback duration of such investments being perceived. The lack of comprehensive risk assessment models for RE schemes has the impact of restricting credit availability and increasing the cost of borrowing compared to conventional energy sectors.

Nawang et al. [9] note that financiers view renewable energy projects as technologically risky, with short histories of profitability. Such assumptions lead to risk-averse lending and deter the development of new financing instruments. Low availability of green bonds, sustainability-linked sukuk, and impact investment vehicles also restricts the development of the green finance market in Malaysia.

Exchange Rate and Inflationary Pressures

Macroeconomic uncertainty adds yet another layer of complexity to financing renewable energy. The depreciation of the Malaysian ringgit (MYR) against the U.S. dollar has had a significant impact on increasing the import costs of solar modules, inverters, and other key inputs. At the same time, higher global interest rates have pushed debt servicing expenses upwards, putting further pressure on the viability of projects.

Inflation, albeit relatively low, has also contributed to the escalation of operating expenses. These budgetary pressures underscore the industry's vulnerability to macroeconomic external shocks and emphasise the need for hedging strategies, fiscal stabilisation, and procurement diversification to enhance project sustainability.

Policy and Institutional Challenges

Inconsistent Policy Implementation

Despite Malaysia having established an effective policy structure under the Renewable Energy Act 2011, including the FiT, NEM initiatives, and the LSS program, its implementation has been uneven. Researchers such as [7],[18] found that frequent policy shifts, quota limits, and bureaucratic delays undermine investor confidence.

The initial FiT program, although successful in promoting early renewable energy adoption, soon reached its quota ceilings and was later replaced by NEM programs. However, repeated policy changes without adequate continuity have created ambiguity among developers and financiers. Additionally, regulatory framework differences at the state level, especially between Peninsular Malaysia and East Malaysia, cause administrative hurdles for investors who prefer uniform compliance protocols.

Institutional Coordination and Governance Gaps

The RE sector is supported by several government organisations, including the Ministry of Economy, NRECC, SEDA, MIDA, and the Energy Commission. Although this multi-agency structure facilitates specialisation, it has also generated fragmented governance as well as overlapping mandates. According to [10], this lag in institutions often leads to project delays in approval, unequal licensing processes, and incompatible national and regional energy planning. For instance, although the NETR sets ambitious national objectives, their implementation at the regional level is uneven, particularly in integrating renewable power into the existing grid system.

Regulatory and Market Barriers

The Malaysian electricity market remains centrally controlled, with TNB being the sole off-taker of electricity generated from renewable resources. Although TNB has been aggressive in adding renewable energy to its grid, the monopsony market structure limits competition and innovation by independent power producers (IPPs).

Furthermore, renewable generators face technological challenges in accessing the grid, especially in remote and rural locations. In the absence of sufficient investment in smart grid technology and energy storage devices, grid integration may be limited, resulting in cyclic curtailing during peak production hours.

Technological and Infrastructure Challenges

Malaysia's renewable energy potential, in the form of solar and biomass, remains underutilised due to infrastructural and technological limitations. Although Malaysia has high solar irradiation levels and vast biomass resources, the lack of localised research and development (R&D) capacity and limited technology transfer from foreign developers prevent extensive deployment. Hannan et al. [7] and Shaikh et al. [8] note that Malaysia's renewable infrastructure is heavily reliant on imported components; therefore, the industry is vulnerable to disruptions in the international supply chain. Additionally, inadequate storage technology restricts the reliability of intermittent sources such as wind and solar.

Infrastructure deployment, particularly in rural Sarawak and Sabah, is hindered by logistical challenges and low grid penetration, which further restricts the renewable energy supply. To counteract such impediments, Malaysia must enhance its domestic technology capability, support industrial partnerships, and invest in battery energy storage systems (BESS) and grid development initiatives.

Socioeconomic and Market Challenges

Malaysian adoption of renewable energy also hinges on market readiness, social acceptance, and awareness. Kardooni et al. [6] point out that, still, renewable technologies enjoy low public awareness of their long-term economic benefits. Complicated and relatively expensive installation, as well as myths of unreliability, discourage small businesses and residential participants from engaging in solar programs such as NEM and CREAM.

Furthermore, the absence of established secondary energy markets, such as renewable energy trading or carbon markets, deprives private investors of available opportunities. Although attempts, such as Energy Exchange Malaysia (ENEGEM), aim to promote cross-border power trading, these systems are still in their nascent forms and require broader institutional support [32].

Impact of the COVID-19 Pandemic

The COVID-19 pandemic intensified the core structural vulnerabilities of the RE industry. The lockdowns and economic disruptions of 2020-2021 resulted in a sharp decline in energy demand, delayed project timelines, and disrupted global supply chains [33]. Many renewable energy firms experienced reduced cash flows, commissioning delays, and weakened access to financing.

TNB reported a 6.2% drop in energy consumption in 2020, followed by a modest recovery of 0.6% growth in 2021 [27]. These are reflective of the overall economic slowdown that temporarily revised progress towards renewable energy expansion. However, the crisis itself also highlighted the necessity to diversify Malaysia's energy mix to enhance system resilience and reduce vulnerability to global shocks.

Opportunities Amid Challenges

Despite these setbacks, Malaysia's renewable energy sector has a high potential for development and innovation. The government's plan to achieve 70% renewable capacity by 2050 is a commendable policy move. Innovative new mechanisms, such as CRESS and CREAM, provide corporations and the community with the opportunity to participate directly in energy transition activities [4].

In addition, Malaysia's involvement in the ASEAN Power Grid (APG) and cross-border electricity exchange, notably the Laos-Thailand-Malaysia-Singapore (LTMS) interconnectivity, positions the nation as an emerging regional hub for renewable energy. Strategic use of green bonds, sustainable sukuk, and blended finance tools can similarly mobilise funding for LSS, hydrogen, and bioenergy projects [34].

Synthesis of Findings

Discussion here reveals that the renewable energy challenges of Malaysia are complex and encompass fiscal, policy, institutional, and infrastructural spheres. While there exists measurable success from the government schemes, the long-standing existence of high capital costs, uneven policy implementation, and market rigidities continue to hold back long-term sustainability.

Malaysia's ability to capitalise on the opportunities of renewable energy hinges on efficient policy coordination, financial innovation, and technological advancements. Public–private partnerships, global cooperation, and integrated regional energy trading can serve as drivers for bridging current barriers. Ultimately, the success of Malaysia's renewable energy revolution hinges on its ability to integrate economic growth targets with environmental sustainability through inclusive and adaptive governance structures.

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CONCLUSIONS

Malaysia's RE sector is undergoing a major transition driven by ambitious national targets outlined in the NETR and the MyRER, particularly the goal of achieving 70% renewable capacity by 2050 and phasing out new coal-based generation. Despite these strong commitments, the sector faces persistent structural challenges. High upfront capital requirements, fragmented regulatory frameworks, and weak institutional coordination continue to hinder large-scale RE deployment. Macroeconomic pressures, including currency depreciation, inflation, and rising interest rates, further elevate project costs, especially for solar developers reliant on imported technologies. Additional barriers, including limited R&D, constrained grid capacity, and a shortage of technical expertise, hinder the scaling of renewable technologies. Nevertheless, Malaysia's evolving institutional landscape offers promising opportunities. New programmes such as the CRESS, the CREAM, and the ENEGEM represent meaningful steps toward more inclusive and market-driven RE participation. These initiatives support corporate procurement, community-based generation, and international energy trading, reflecting Malaysia's commitment to the APG and broader energy transition objectives. The analysis identifies four pillars critical to Malaysia's RE transition: (i) policy coherence and coordinated governance among federal and state agencies; (ii) financial innovation through expanded green finance, public–private partnerships, and sustainable bonds; (iii) technological advancement via investment in storage systems, hydrogen, and grid modernisation alongside human-capital development; and (iv) regional integration to position Malaysia as a future clean-energy exporter.

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