

Sustainable Energy Investment in Malaysia: The Current Situation and Challenges

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Abstract: Investment in renewable energy in Malaysia is a crucial step toward achieving sustainable energy transition by leveraging the country's natural resources, including solar, hydropower, and biomass energy. The analyzed statistics indicate that investment in small and medium hydropower stations has been the most prominent, despite the vast untapped potential in the biomass energy sector.

The study revealed that Malaysia has adopted several investment mechanisms aimed at supporting and attracting investors while reducing the costs associated with renewable energy. Additionally, the country has implemented key strategies, including The Malaysian Renewable Energy Roadmap (MyRER) 2035, to promote sector growth. However, statistics from the International Renewable Energy Agency indicate that Malaysia has not yet achieved its goal of reaching 20% renewable energy in its energy mix by 2025. This shortfall is attributed to several challenges, primarily the lack of government support, insufficient funding for investment projects, and a shortage of expertise in handling advanced technologies in the sector.

Keywords: Renewable energy, investment, sustainable development, energy transition, strategy.

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I- Introduction :

Clean energies have provided numerous advantages to countries and governments, as they play an effective role in protecting the environment and fulfilling the requirements of sustainable development. Consequently, these energies have become a top priority in national plans and have garnered significant attention, prompting countries to accelerate the adoption of diverse programs, strategies, and policies to promote energy transition projects, especially given their substantial contribution to achieving energy security.

In this context, Malaysia stands out as one of the countries that has embraced this process, aiming to reduce dependence on fossil fuels. Accordingly, Malaysia has adopted various programs and initiatives to support and activate investment projects in this sector, with a particular focus on solar energy, hydropower, and bioenergy.

Based on this, the study aims to explore the Malaysian experience in investing in renewable energies by analyzing the current state of the sector using data and statistics on alternative energy production. Furthermore, the study highlights the various strategies and technologies Malaysia has implemented to promote the use of clean energy and achieve sustainable development.

Study problem:

Malaysia, in addition to its strategic geographic location, possesses abundant natural resources that enable it to invest in renewable energies. In this context, the country has worked on developing its technologies in this field and has adopted several long-term strategies aimed at achieving sustainable development. However, Malaysia faces a number of challenges that hinder the progress of this sector. Based on the above, the study's main research question can be formulated as follows:

What is the current state of investment in renewable energies in Malaysia?

Study hypothesis:

To answer the research question, we propose the following two hypotheses:

- The lack of government funding for renewable energy projects is a major reason for the weakness of investment in this sector.
- The private sector supports energy transition policies by providing modern technologies.

The importance of the study:

The study plays an important role **scientifically** in the field of specialization, due to the realistic analyses it provides through the statistical method and highlighting the various gaps that hinder Malaysia's efforts in alternative energies. From a **practical perspective**, it is of great value to those interested in the field in Algeria, as they can benefit from the Malaysian experience and apply some of the lessons learned to develop the renewable energy sector in Algeria.

Methodology and study plan:

The study relies on **the statistical method** by collecting statistical data related to the percentages and volume of renewable energy production from 2014 to 2023, and analyzing it in detail using **the analytical method** to clarify the reality of investment in this field.

To comprehensively cover the various key elements of the topic, the study has been structured as follows:

1. The concept of Energy Investment

2. Renewable energy investment areas in Malaysia
3. Malaysia's strategy for investing in renewable energies
4. Challenges of investing in renewable energies in Malaysia

1. The concept of Energy Investment:

In this section, the focus will be on the concept of investment in renewable energy. Before that, it is important to define renewable energy and its key areas in order to highlight its significance in the economic and political sectors.

1.1. Definition of renewable energies:

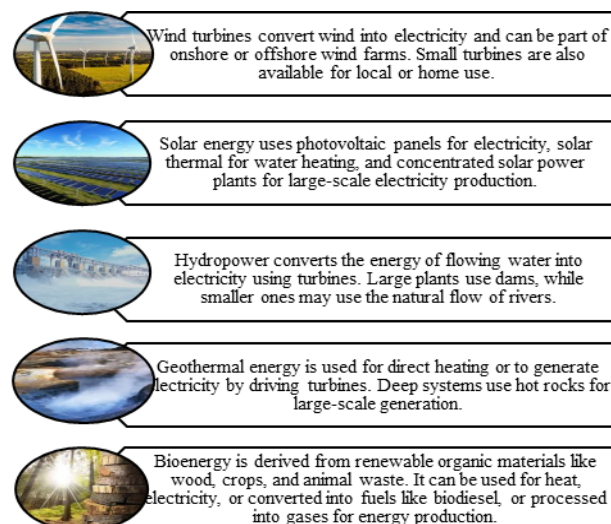
Renewable energy, often referred to as sustainable, clean, and future energy, is defined by **the International Energy Agency** as: “energy generated from natural resources that are continuously replenished, either directly or indirectly, including solar, wind, biomass, geothermal, hydro power, and hydrogen energy sourced from renewable origins” (Seifeddine, & Abdeldjalil, 2017, p. 5).

The definition of renewable energy provided by **the United Nations Sustainable Energy for All (SE4All)** is as follows: “Renewable energy is energy that comes from natural processes, such as sunlight and wind, which are replenished at a faster rate than they are used. Solar, wind, geothermal, hydropower, and biomass are typical examples of renewable energy sources”. The SE4All definition states that renewable energy is “replenished at a faster rate than consumed”, it is worth noting that other definitions may describe renewable energy as being replenished at a rate that is either equal to or greater than the rate of consumption, with variations depending on seasonal changes or the nature of the project (i.e., the replenishment rate may differ based on the extraction rate) (Economic Commission for Europe, 2016, p. 4).

In brief, renewable energy can be defined by three characteristics that distinguish it:

- **Its sources:** Natural and abundantly available, requiring only technology for investment.
- **The renewal factor:** These natural resources renew continuously and rapidly, unlike fossil fuels which deplete.
- **Clean:** Eco-friendly energies that contribute to achieving sustainability.

Figure 01: The Main Areas of Renewable Energy



Source: The figure was prepared by the researcher based on the data provided in: Investment in renewable energy generates jobs. Supply of skilled workforce needs to catch up, Research brief, international labour office, Geneva, p. 2.

1.2. Definition of Energy Investment:

Renewable energy investments involve directing financial resources toward initiatives, companies, and technologies that produce energy from sustainable sources. The goal is to promote the advancement and expansion of clean energy solutions, decrease reliance on fossil fuels, address climate change challenges, and stimulate economic development and employment within the renewable energy industry.

The concept of investment in renewable energy aligns closely with the broader definition of investment. It can be described as “all assets held by an investor, whether directly or indirectly associated with renewable energy, meeting general investment conditions such as capital availability, commitment, profit-seeking, and risk management”. Alternatively, it can be defined as: “allocating funds to renewable energy sectors with the intention of generating profit” (Zach, 2024).

1.3. The characteristics of investment in renewable energy include:

- **High investment risks:** Investing in renewable energy involves various risks, such as production uncertainties, technological challenges, construction delays, as well as legal and financial risks.
- **Significant profits:** Renewable energy projects typically achieve high returns and operational efficiencies, with some reaching up to 80%.
- **Substantial capital requirements:** Most renewable energy projects demand significant financial investment, particularly during the construction phase, with reduced costs during the operational phase.
- **Extended payback periods:** Renewable energy projects often have lengthy capital recovery times, attracting investors who are willing to commit to long-term assets rather than seeking quick liquidity.
- **Independence from raw material supply fluctuations:** Resources like sunlight and wind are unaffected by economic or political conditions, enabling consistent energy production regardless of external crises.
- **Government support:** Many countries back renewable energy initiatives, aligning with global efforts to reduce pollution and limit the release of harmful gases (Zach, 2024).

2. Renewable energy investment areas in Malaysia:

In 2011, Malaysia took a significant step toward advancing renewable energy by enacting the Renewable Energy Act, which introduced the Feed-in Tariff (FIT) system. This initiative aimed to drive investment in renewable energy sources such as solar, wind, biomass, biogas, and small hydropower by offering long-term payment guarantees for energy supplied to the grid. Subsequently, in 2014, the government adopted the Incentive-Based Regulation (IBR), a systematic framework designed to gradually reduce fuel subsidies while aligning with global energy market reforms. Building on these efforts, Malaysia announced in 2018 an ambitious goal to achieve a 20% share of renewable energy in its energy mix by 2025, reflecting a strengthened commitment to sustainable energy development (Wan, & Others, 2019, p. 4). This is the percentage that will be verified later in this study based on the available statistics.

In this regard, Malaysia has several sources of renewable energy, including:

2.1. Solar Energy:

Malaysia benefits from significant solar energy potential due to its favorable location near the equator and its consistently warm and sunny climate year-round. The monthly solar radiation ranges from 400 to 600 MJ/m², with higher levels during the northeastern monsoon. During this period, winds from Central Asia travel through Malaysia towards the South China Sea and Australia between November and March. In contrast, solar radiation decreases during the southwestern monsoon, when winds shift direction, originating from Australia and moving toward Sumatra before reaching the Strait of Malacca between May and September (Fatima Zohra, 2024, p. 387).

2.2. Wind power:

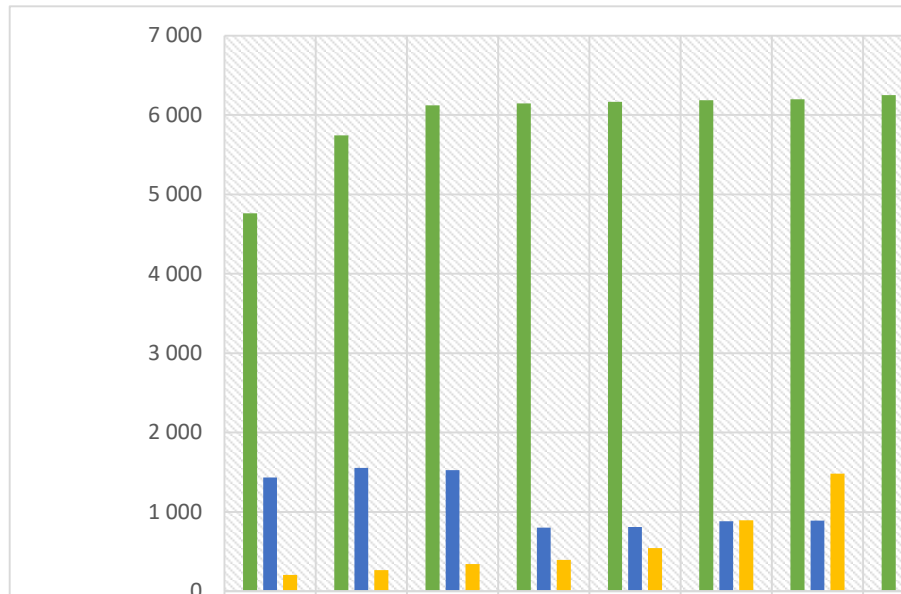
Wind energy in Malaysia holds potential despite the country having relatively low wind speeds compared to other nations. The prevailing winds typically come from the Indian Ocean and the South China Sea, with average wind speeds ranging from 1.5 to 4.5 m/s, and higher speeds in elevated areas. Peninsular Malaysia's Mersing and Kuala Terengganu, as well as Kudat and Sabah in East Malaysia, are identified as areas with higher wind potential. Offshore wind energy also remains underutilized, wind speeds are higher during the monsoon season (November to February), with potential sites like Mersing and Kudat showing average speeds of around 3 m/s at 60 meters. The southern region of Peninsular Malaysia experiences more wind, especially in January, due to monsoon winds (Wan, & Others, 2019, p. 7).

2.3. Hydropower:

Malaysia holds significant potential in hydropower generation due to its vast network of rivers, with 189 rivers stretching over approximately 57,300 km, offering a strategic geographical advantage. In 2016, hydropower accounted for 13% of the country's total electricity production. The majority of large-scale hydroelectric plants are operated by Tenaga Nasional Berhad (TNB), with additional plants under construction in Nenggiri (300 MW) and Tekai (156 MW) in Kelantan. Small and mini-hydropower stations, with capacities below 30 MW, operate in a competitive market, allowing private developers to participate. These stations are primarily supported by Malaysia's Feed-in Tariff (FIT) program managed by the Sustainable Energy Development Authority (SEDA), contributing up to 200 MW to the country's energy production (Harun, & others, 2021, p.3).

2.4. Biomass:

Malaysia produces approximately 168 million tons of biomass, including resources from palm oil waste, rice husks, coconut waste, sugarcane residues, municipal waste, and forest residues. Biomass has experienced significant growth in Malaysia compared to other technologies, accounting for about 17% of the total investment in renewable energy as a strategic option for achieving sustainable finance. These resources represent a substantial part of Malaysia's renewable energy potential and can generate up to 2,400 MW of power. As the second-largest palm oil producer after Indonesia, Malaysia has a vast source of palm oil waste that can be utilized for biomass, providing an advantage over other renewable energy types in terms of availability and abundant resources. Additionally, this type of resource can be easily stored (Fatima Zohra, 2024, p. 388).

Figure 02: production of hydropower, bioenergy and solar energy in Malaysia (MW) 2014-2023.

Source: The figure is designed by the researcher based on the statistics provided in: Renewable Capacity Statistics 2024, (2042), the International Renewable Energy Agency (IRENA), Abu Dhabi.

Based on the aforementioned information and referring to Figure 02, which highlights investment areas in renewable energy in Malaysia, we conclude that:

- According to statistics from the International Renewable Energy Agency's report, wind energy production is absent due to the low wind speeds in Malaysian regions, as previously explained.
- The most invested sector in renewable energy is hydropower, where energy production has seen a consistent increase since 2014, reaching 6,251 MW in 2023. This reflects the role of small-scale hydropower projects in providing a sustainable energy source.
- Biomass energy production began to decline in 2016, previously estimated at 1,526 MW before that period, due to a set of challenges that will be discussed later.
- Solar energy production has experienced remarkable growth since 2020, reaching 1,933 MW in 2023. This indicates increased investment in the sector, supported by government policies aimed at promoting it.

3. Malaysia's strategy for investing in renewable energies:

The renewable energy sector in Malaysia is considered one of the most vital sectors that has garnered the attention of the Malaysian government with the aim of achieving sustainable economic development. The government has sought to invest in this field and increase funding for energy projects to reduce reliance on traditional non-renewable energy sources. Alternative energy sources have been recognized as a critical component requiring the establishment of appropriate infrastructure and the development of advanced technologies that facilitate energy production and generation. In this context, the Malaysian government has formulated several strategies that demonstrate its commitment to strengthening investment in this sector, along with various investment programs and financial incentives for energy project developers, including:

Figure 03: Financial Investment Programs for Renewable Energy in Malaysia.

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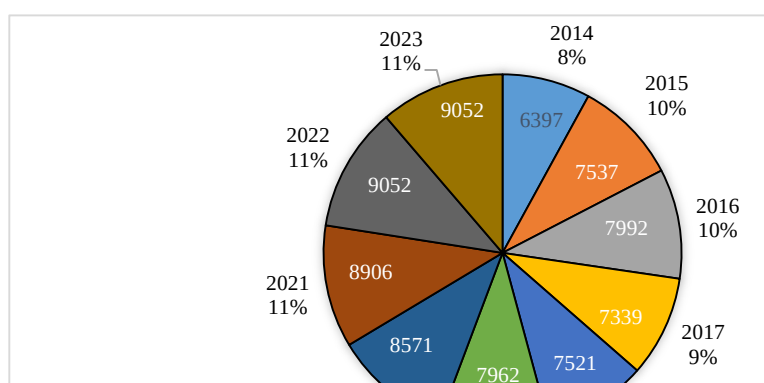
Program	Objectives
Feed-in tariff (FIT) mechanism	The FIT is financed by the Renewable Energy Fund, which is generated through the collection of a 1.6% surcharge on the electricity bill. In 2021 alone, projects under the FIT generated a total of 1.35 TWh. This included 33% solar PV, 12% biomass, 34% biogas, and 21% small hydropower.
Large Scale Solar (LSS) program 2016	The LSS program, which is based on a bidding process, was introduced with a total quota of 1250 MW allocated for the period between 2017 and 2020. By the end of 2022, the bidding rounds for projects set to be commissioned in 2022 and 2023 attracted offers with as low as USD 0.043 per kWh. A total of 30 projects were selected by the government with a combined electricity generation capacity of 823 MW.
Net Energy Metering (NEM) program	The NEM program was implemented to manage solar electricity consumption, with a total of 500 MW allocated for domestic, commercial, and industrial use by the end of 2020. In 2018, the program was revised to include compensation for excess electricity at fixed rates, which led to an increase in installed solar capacity. In 2020, the launch of NEM 3.0 further allocated an additional 500 MW. The program offers four primary financing options for rooftop solar systems: solar leasing, Power Purchase Agreements (PPAs), and a hybrid of both (hybrid PPAs).
Green Technology Financing Schemes (GTFS) 2010	It initially approving USD 0.8 billion in green funding. This led to a total of USD 1.6 billion in green investments, including renewable energy projects that collectively generate 532.9 MWh of electricity annually. By the end of 2019, 35 projects had been certified, costing USD 0.37 billion in total, with 25 of these projects securing bank loan approvals amounting to USD 0.2 billion. Approximately half of these projects were solar energy-based.
Green Investment Tax Allowance (GITA)	A tax deduction was granted on the costs associated with issuing Green Sustainable Investment (SRI) bonds until 2020. Additionally, an amount of USD 1.43 million was allocated through a grant program to support the independent expert review costs incurred by the issuers of these bonds.
Green Income Tax Exemption (GITE)	It is an additional tax benefit designed to complement GITA, aiming to promote investments in sustainable projects and renewable energy ventures.

Source: The table is designed by the researcher based on the information available in: Malaysia energy transition outlook, (2023), International Renewable Energy Agency IRENA, Abu Dhabi, pp. 40-52.

3.1. Malaysia's Renewable Energy Strategy and Investment Goals for 2025:

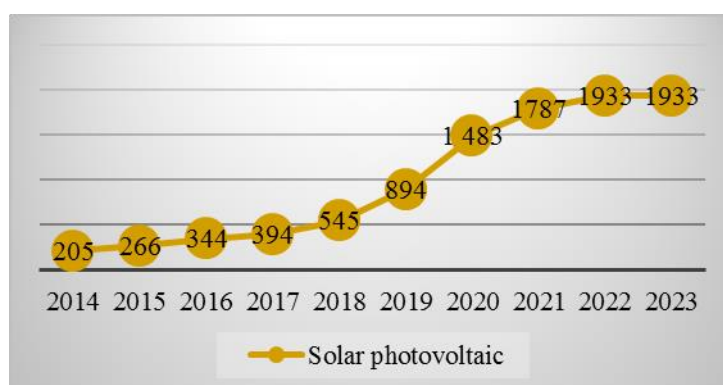
By 2025, the Malaysian Government aims to enhance the development of renewable energy, with a particular focus on biomass, positioning it as the fifth fuel source under the nation's energy diversification plan. This plan, introduced in 2001, set a goal of achieving 5% renewable energy in electricity generation by 2005, which corresponded to a capacity of 500 to 600 MW. Over time, the policy has been reinforced with fiscal incentives. In 2018, Malaysia revised its target to 20% renewable energy in the energy mix by 2025, requiring an 18% increase from the 2% share in 2018. To meet this ambitious goal, the country aims to attract USD 8 billion in renewable energy investments within this timeframe. The government is also working to improve governance and create a more favorable investment environment for foreign investors in the renewable energy sector (Fatima Zohra, 2024, p. 387).

However, based on the statistics shown in the following Figure 4, we observe that the first part of this strategy has not been fully achieved. The data indicates that only 11% of the total renewable energy target has been achieved by 2023, equivalent to 9,052 MW of renewable energy. Nevertheless, a significant growth in renewable energy production since 2014 can be observed, reflecting an overall improvement in performance in this sector, despite not yet reaching the set target.

Figure 04: total renewable energy in Malaysia 2023 (MW)

Source: The figure is designed by the researcher based on the statistics provided in: Renewable Capacity Statistics 2024, (2024), the International Renewable Energy Agency (IRENA), Abu Dhabi.

Malaysia also has made significant investments in solar energy. Since 2013, the country has benefited from a reduction in the overall costs of photovoltaic solar systems, with the cost of electricity generated from solar falling by more than 50% between 2013 and 2019, from USD 0.187 per kWh to USD 0.089 per kWh. In the commercial sector, the cost decreased from USD 0.175 to USD 0.078 per kWh (Malaysia energy transition outlook, 2023, p. 49). This has helped increase the share of solar PV production, as shown in Figure 05.

Figure 05: solar PV in Malaysia (MW) from 2014 to 2023

Source: The figure is designed by the researcher based on the statistics provided in: Renewable Capacity Statistics 2024, (2024), the International Renewable Energy Agency (IRENA), Abu Dhabi.

Malaysia has also invested in other renewable energy technologies, such as biomass energy, where the generation costs from biomass power plants were around USD 0.11 per kWh in the TNB area (Malaysia energy transition outlook, 2023, p. 49).

3.2. The Malaysian Renewable Energy Roadmap (MyRER) 2035:

The Malaysian Renewable Energy Roadmap (MyRER) acts as the main strategic framework for developing and expanding renewable energy (RE) in the country. It aims to increase the share of RE in Malaysia's energy mix while enhancing energy security and reducing greenhouse gas (GHG)

emissions. This commitment aligns with Malaysia's global objective to lower emissions intensity relative to GDP by 45% by 2030, compared to 2005 levels. Furthermore, the government has revised its renewable energy target to reach 70% by 2050, with the National Energy Transition Roadmap launching key initiatives from 2023 onward (Mobilizing Investments for Clean Energy in Malaysia, community report, 2023, p. 8).

The country is implementing a comprehensive action plan to attract investments in renewable energy, which includes:

- Reforming energy governance to support renewable energy.
- Streamlining the management of the regulatory framework for renewable energy.
- Creating a framework for easier grid connection and usage.
- Enhancing awareness and promotional efforts aimed at investors.
- Making market entry easier and more appealing for potential investors (Roman, & others, 2020, p. 1).
- Strengthening policy support for achieving net-zero emissions, such as carbon pricing and setting potentially binding targets for carbon reduction.
- Investing in the country's project delivery capacity, focusing on supply chain and implementation, while nurturing a network of local manufacturers, suppliers, and service providers.
- Boosting technological potential by investing in business models that facilitate a broader adoption of renewable energy and low-carbon technologies, such as low-speed wind, tidal energy, hydrogen, and carbon capture (How Malaysia's energy transition can attract investment and inspire consumer confidence, 2023).

Amidst this strategy and to overcome the challenges impeding its execution, particularly following the onset of the COVID-19 pandemic, the Malaysian government announced a stimulus package worth USD 36 billion at the end of June 2021. This package included several initiatives aimed at boosting clean energy investments, such as:

- launching the fourth phase of Malaysia's Large Scale Solar (LSS) auction program, targeting a total capacity of 1 GW.
- It allocated USD 3.1 billion (MYR 13 billion) for the installation of LED street lighting and rooftop solar PV systems, as well as funding for new transmission lines.
- The total planned investment in renewable energy capacity within this package amounted to USD 3 billion, with project investments ranging between USD 10 million and USD 50 million (Malaysia energy transition outlook, 2023, p. 24).

4. Challenges of investing in renewable energies in Malaysia:

Although Malaysia has made significant strides in investing in renewable energy, it faces various challenges. Some of these challenges include:

4.1. Regulatory and political Framework:

- A key challenge in Malaysia's renewable energy sector is the regulatory environment. While the government has introduced some incentives to boost renewable energy, there is a need for more comprehensive and supportive policies to attract investors and facilitate the development of projects (The Challenges and Opportunities for Renewable Energy Development in Malaysia, 2023).
- Large investors and governments often make decisions based on outdated views, unaware of the market changes in the renewable energy (RE) sector. This lack of awareness leads to delays in capitalizing on opportunities for RE to enter the market. For example, even though the cost of photovoltaic (PV) technology has dropped significantly over time, policies are

still based on older pricing. As a result, conventional energy projects may take priority over solar energy projects due to this outdated pricing knowledge.

- Additionally, the government's lack of focus on maintaining RE facilities leads to higher long-term repair costs. These high maintenance expenses, combined with prolonged delays in approval processes and inconsistent access conditions, hinder progress toward meeting RE goals and may affect RE policy in Malaysia. Ultimately, these factors raise political risks and deter investors from committing to RE projects (Dasilah, 2021, pp. 468-469).

4.2. Infrastructure:

- Another significant obstacle is the construction of the required infrastructure for renewable energy projects. This encompasses the development of solar and wind farms, hydroelectric dams, and biomass plants. These projects demand considerable investments and effective planning for infrastructure development. (The Challenges and Opportunities for Renewable Energy Development in Malaysia, 2023).

4.3. Financing and Investment:

- Solar projects require significant upfront capital.
- Renewable energy is considered high-risk by financial institutions (Ahmad Ludin, 2024, 31).
- The government and the private sector face difficulty in providing the raw materials for bioenergy production, which is considered one of the most abundant energy sources in the country. This requires increasing the local production of raw materials and reducing their costs.

4.4. Technology Integration:

- Grid stability is challenged by the intermittent nature of solar and wind energy.
- There is a lack of energy storage solutions to balance supply and demand.
- The existing infrastructure needs modernization to support smart grid development (Ahmad Ludin, 2024, 31). The integration of renewable energy sources into these grids faces several obstacles, as they were initially designed for conventional energy sources, and thus will struggle to adapt. In addition, the state must adapt to the outcomes of technological development and artificial intelligence in this field, as it will offer significant benefits and improve performance and production at a lower cost.
- The shortage of skilled labor capable of handling new technological advancements, and therefore, there is a need to launch training programs and courses to qualify them in using these technologies and enhance their skills in renewable energy and modern technologies.

II- Conclusion:

This study shows that Malaysia has implemented several investment programs and projects to achieve sustainable energy transition, and has sought to capitalize on the available natural resources, especially hydropower, as indicated by the statistics. However, these efforts still face challenges related to financing and infrastructure. Based on this, the following conclusions were reached:

- The available natural resources in Malaysia have helped realize the goal of sustainable energy transition, especially with the availability of hydropower and biomass energy.
- Malaysia has implemented various investment programs, such as the FIT mechanism and the Green Technology Financing Scheme (GTFS) 2010, which aim to provide financial incentives to investors and reduce the costs of renewable energy.
- Malaysia's investment vision for 2025 and the Malaysian Renewable Energy Roadmap (MyRER) 2035 demonstrate the significant focus placed on the renewable energy sector in

the country. Through these two strategies, many goals have been set, and significant efforts have been made to address the challenges hindering their implementation, particularly the impacts of the COVID-19 pandemic.

- Renewable energy investment programs and strategies have faced several challenges, particularly the lack of political support that requires keeping up with developments in clean energy technologies and financing issues. Therefore, it is crucial for the government and the private sector to create a more stable investment environment.

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