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Integrating Qualitative and Quantitative Methods in Sustainable Finance to Guide Public Policy for Green Investments

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Abstract
This study investigates the role of sustainable finance in advancing investments in renewable energy and green technologies while addressing associated challenges and opportunities. The research aims to analyze the impact of sustainable finance strategies on investment flows, identify key barriers to their effective implementation, and propose strategic recommendations to enhance investment in this sector. This study seeks to support the global transition to a greener and more sustainable economy by optimizing policies, funding mechanisms, and financial practices. Using a mixed-methods approach, this study integrates qualitative and quantitative analyses, including literature reviews, causality analyses, and country-specific case studies. Secondary data generated from industry reports, academic publications, and financial databases form the basis of the analysis. Findings from the Sustainable Finance-Investment Interaction Model reveal that sustainable finance significantly enhances renewable energy investments. However, high initial costs, policy uncertainty, and restricted access to finance remain substantial obstacles. Despite these challenges, opportunities driven by technological advancements and increasing global climate awareness provide a strong foundation for growth. This paper presents recommendations for governments, investors, and financial institutions to strengthen the role of sustainable finance in accelerating renewable energy investments. Emphasizing integrating environmental, social, and governance (ESG) factors into financial decision-making, the study highlights the need for supportive policies to address financing barriers. By aligning financial systems with sustainability objectives, this research contributes to the broader discourse on sustainable finance and underscores its transformative potential in driving the global green transition.

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Introduction

Investment in renewable energy and green technologies has become necessary rather than optional in this era of globalization and climate change challenges (Li et al., 2022). The global economy faces increasing pressure to reduce dependence on fossil resources and transition to cleaner and more sustainable energy sources (Androniceanu & Sabie, 2022). The concept of sustainable finance offers an essential approach incorporating environmental, social, and corporate governance (ESG) factors into investment and financial management decisions. This approach creates investment opportunities that promise long-term economic compensation and sustainable social and environmental benefits (Tseng et al., 2019). Renewable energy and green technologies lie at the center of this transition, offering sustainable alternatives to fossil fuels, significantly contributing to global climate change (Kabeyi & Olanrewaju, 2022). Investments in this sector yield economic, environmental, and social benefits such as job creation and improved energy access, emission reductions, and the preservation of natural resources, and social benefits such as promoting equitable and inclusive development (Candra et al., 2023).

Despite these potential benefits, implementing sustainable finance strategies to support investments in renewable energy and green technologies faces significant challenges. These challenges include high start-up costs, policy uncertainty, and limited access to finance. Addressing these barriers requires a comprehensive understanding of sustainable finance principles and the identification of opportunities to effectively mobilize investments in renewable energy to achieve sustainable development goals.

Previous studies have explored the relationship between sustainable finance strategies and investments in renewable energy and green technologies. Taghizadeh-Hesary and Yoshino (2020) highlighted the impact of sustainable finance strategies on renewable energy investment. Xu et al. (2020) examined green technology adoption and financial performance. Anton and Nucu (2020) examined financial innovation in renewable energy utilizing a case study approach. Li and Yang (2022) focused on sustainable finance practices in green technology companies. Hsiao et al. (2019) further underscored the role of financial management in driving sustainable investment. Although these studies offer valuable insights, they primarily address specific aspects of sustainable finance strategies and their implications for renewable energy and green technologies. However, a significant

research gap lies in understanding how these strategies can be optimized to generate sustainable added value and positively affect the environment and the global economy.

This research addresses these gaps by integrating sustainable finance strategies to enhance investments in renewable energy and green technologies. This study hypothesizes that sustainable finance strategies positively influence investments in renewable energy and green technologies. Further, policy uncertainty and limited access to finance are challenging these strategies. It hypothesizes that tailored strategies integrating ESG principles can maximize investment potential and accelerate the transition to a sustainable, low-carbon economy.

To achieve these goals, this paper aims to examine the concepts and principles of sustainable finance in the context of renewable energy and green technology investments. This study also aims to identify the primary challenges and opportunities in mobilizing investments in this sector. Furthermore, it seeks to develop strategic recommendations for policymakers and stakeholders to overcome these challenges and optimize investments in renewable energy and green technologies. This study will contribute to the academic literature and industry practice by addressing these objectives and providing actionable insights for integrating ESG principles into investment decisions. Moreover, this study will offer practical guidance for policymakers to design and implement policies supporting sustainable investments, accelerating the transition to a greener and more sustainable economy. This study also underscores the importance of aligning sustainable finance with renewable energy investments to effectively achieve global climate and development goals.

Literature Review

Sustainable finance is fundamental in modern economic discourse, emphasizing socially and environmentally responsible investment practices. Defined as an investment strategy integrating environmental, social, and governance (ESG) factors, sustainable finance aims to generate long-term financial returns while achieving positive societal and environmental impacts. Unlike conventional investment strategies, it prioritizes sustainability alongside profitability. Khemir et al. (2019) highlight that sustainable finance encompasses diverse investment practices, including ESG integration in decision-making processes, to generate long-term economic value. Among the critical instruments of sustainable finance, green bonds have gained prominence. These bonds finance projects to mitigate climate change, such as renewable energy infrastructure and emission reduction initiatives. Tolliver et al. (2020) note that green bonds are key to scaling sustainable finance to support the Sustainable Development Goals (SDGs). However, the limited scope of green bond

applications and the high financial barriers to entry reflect a critical gap in understanding their role in mobilizing wider investments in renewable energy and green technologies.

Renewable energy and green technologies play an important role in the global transition to a sustainable, low-carbon economy. Solar, wind, hydro, and bioenergy as renewable sources offer viable alternatives to fossil fuels, significantly contributing to climate change. Khan et al. (2021) emphasized that innovations in green technologies can substantially reduce the global carbon footprint while enabling efficient and sustainable energy systems. Key technological advancements, such as energy storage, efficiency, and clean transportation, are critical to accelerating this transition. Bogdanov et al. (2021) argue that scaling renewable energy through technological innovation could drive a cost-effective global energy transformation. Despite these advancements, challenges such as policy uncertainty, insufficient funding, and technological limitations hinder the full potential of these innovations, revealing a gap in the alignment of sustainable finance strategies with technological development.

Investment in renewable energy and green technology offers environmental, economic, and social benefits. From an economic perspective, renewable energy supports employment opportunities, reduces energy costs, and fosters economic growth. Candra et al. (2023) suggested that investments in this sector contribute significantly to sustainable development by reducing greenhouse gas emissions and promoting a healthier environment. Socially, renewable energy enhances energy access in underserved regions, addressing energy poverty and supporting inclusive development. Pratiwi and Juerges (2020) highlighted the role of renewable energy in providing equitable energy solutions, fostering local economic opportunities, and improving living standards in remote areas. However, barriers such as high initial costs and inadequate financial support limit widespread adoption despite the evident economic and social benefits.

Although prior studies have explored the role of sustainable finance and renewable energy in addressing climate change and promoting economic development, there remains a lack of focus on integrating sustainable finance strategies with renewable energy and green technologies to overcome systemic barriers. This review identifies a critical research gap: how sustainable finance can be optimized to mobilize investments in renewable energy and green technology while aligning ESG priorities with global sustainability goals. The contribution of this research lies in providing a comprehensive framework that integrates sustainable finance mechanisms with technological advancements to enhance investment flows and policy effectiveness. This study fills the gap by offering novel insights into how strategic financial frameworks can overcome existing barriers, enabling a smoother transition to a low-carbon economy while encouraging long-term sustainability.

Method

A systematic framework methodology addresses the research objectives and explores the complexities of implementing sustainable finance strategies in renewable energy and green technology investments. This study employed a mixed-methods approach, which combines qualitative and quantitative analyses to ensure a comprehensive understanding of the research problem.

This study utilized a case study approach to facilitate an in-depth exploration of the successes and challenges of sustainable finance in renewable energy and green technology. A literature study was conducted to generate data from various reliable sources, including peer-reviewed journals, books, and relevant online resources. Advanced AI tools such as Consensus, Humata.ai, and Sci-space supported the data collection. These tools were utilized to simplify the identification of relevant academic papers, verify thematic alignment, and facilitate efficient document analysis. This study reviewed a total of 52 references with 46 articles (88.64%) from SCOPUS-indexed journals, including 76.09% from Q1 journals and 23.91% from Q2 journals, ensuring high-quality data inputs (see Figure 1).

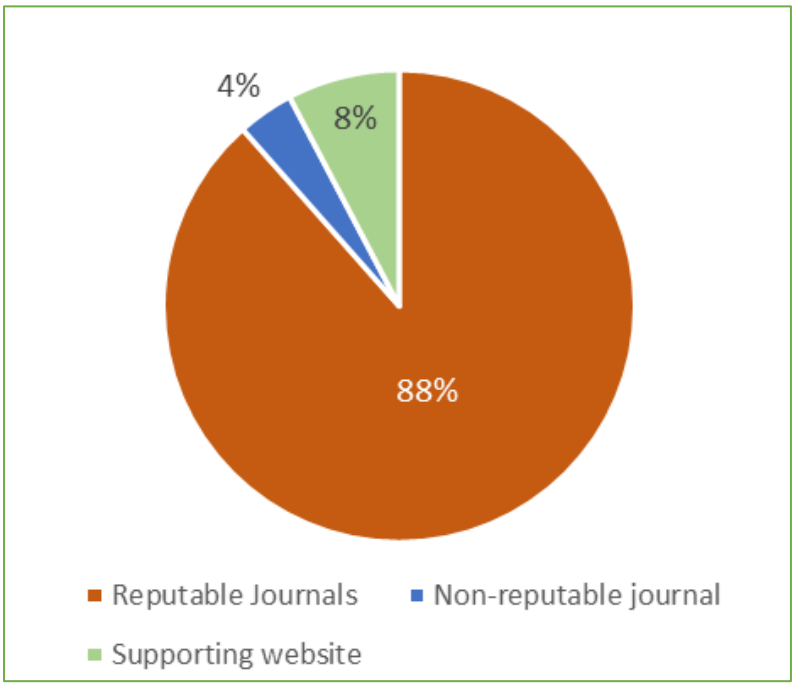


Fig. 1. The Composition of Reference Sources

Qualitative data analysis was conducted through document analysis to identify emerging patterns, themes, and relationships within sustainable finance, renewable energy investments, and green technology. Thematic analysis was employed to systematically categorize data into major

themes, including investment trends, barriers, opportunities, and strategies. This approach enabled an organized synthesis of literature findings, emphasizing critical insights and relationships relevant to the research objectives. AI tools played a crucial role in this procedure by facilitating a comprehensive literature review and allowing efficient identification of thematic patterns without manual reading.

Quantitative data analysis employed descriptive and inferential statistical methods to examine trends and relationships in sustainable finance and renewable energy investments. Descriptive statistics offered a summary of investment trends and sectoral growth. At the same time, regression analysis was performed to evaluate the influence of key factors, such as environmental, social, and governance (ESG) integration, on investment performance. The quantitative analysis aimed to quantify the impact of these factors on the adoption of sustainable finance strategies and to provide data-driven insights into the effectiveness of such strategies in promoting investment in renewable energy and green technologies.

This study employed data triangulation by synthesizing information from multiple sources to ensure the validity and reliability of the findings. The data triangulation includes peer-reviewed literature, case studies, and expert analyses. This approach enhanced the robustness of the research outcomes by corroborating insights across different data streams. Thus, it can minimize the potential biases.

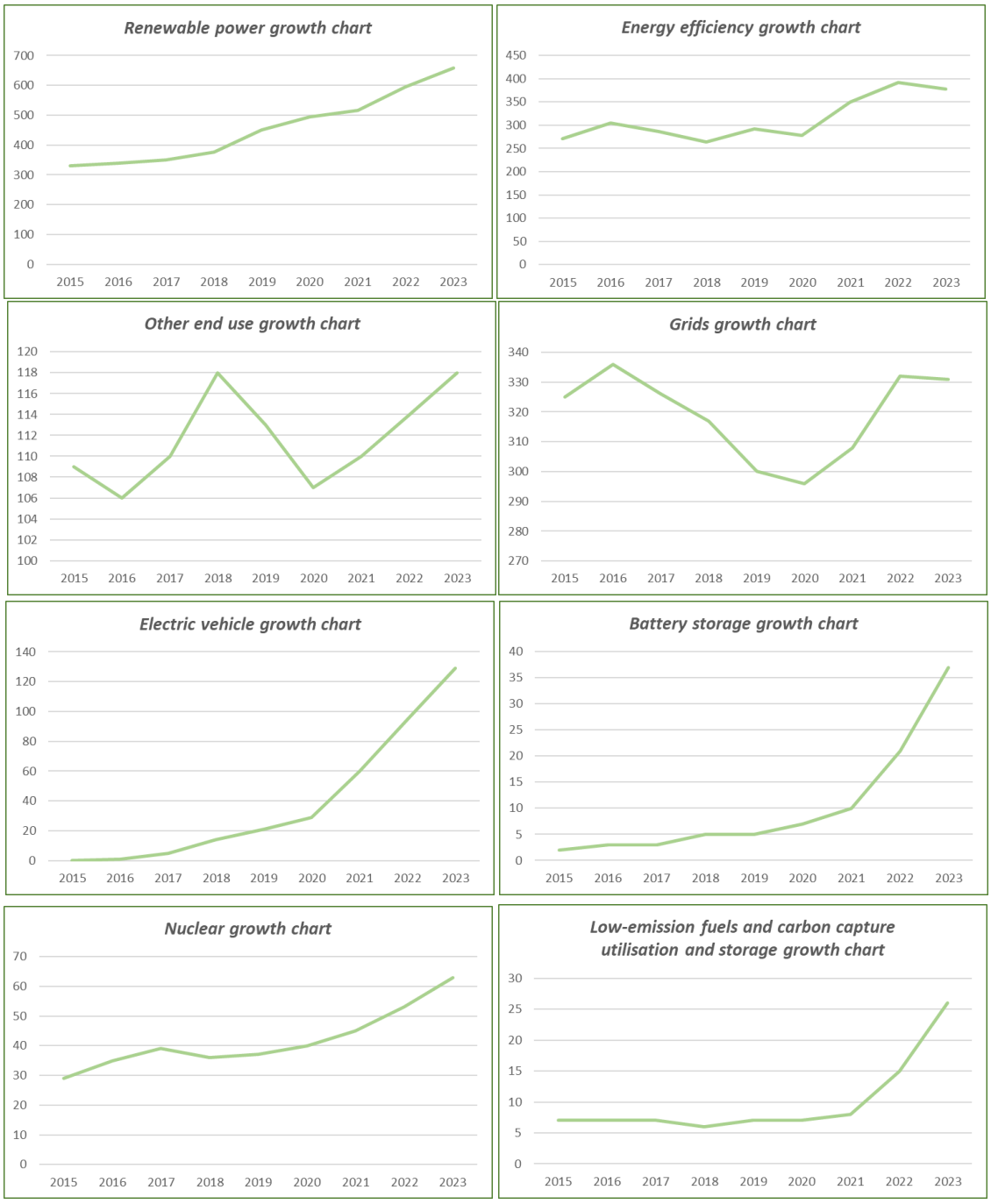
Ethical considerations were an integral part of the research process. This study carefully ensures the validity and reliability of all data sources and utilizes only reputable and verified sources. This research also maintains the confidentiality of secondary data. Further, this present study treats all information obtained strictly for research purposes. All referenced materials were cited correctly and acknowledged in line with ethical principles of academic integrity. The research process was also documented transparently to ensure clarity, replicability, and accountability.

Result and Discussion

Policies and regulations are essential to facilitate sustainable financial investments in the renewable energy sector (Lin et al., 2022). These investments can be encouraged and directed to support the transition to cleaner and more sustainable energy sources by adopting a proper policy foundation (Schmidt et al., 2019). Based on Annual clean energy investment data from 2015 to 2023, global renewable energy investment growth has significantly increased in recent years.

There is a significant increase in clean energy investment where the increase in Renewable power by 99.1%, Energy efficiency by 39.1%, Other end use by 8.3%, Grids by 1.8%, Electric vehicles

by 12,800.0%, Battery storage by 1,750.0%, Nuclear by 117.2%, and Low-emission fuels and carbon capture, utilization and storage by 271.4% (see Figure 2).



Source: www.iea.org, 2024
Fig. 2. Annual clean energy investment, 2015-2023

Governments and international regulatory bodies have taken significant steps to encourage capital allocation to renewable energy projects. Below are some of the policies and initiatives:

1. Presidential Regulation on Renewable Energy Development: In Indonesia, Presidential Regulation No. 112 of 2022 is expected to attract green investment, particularly from power plants, and promote the enhancement of the renewable energy mix. This regulation covers hydropower, geothermal, solar, wind, biomass, biogas, seawater power, and biofuels to increase the Domestic Component Level and encourage green industries (EBTKE, 2022).
2. Cooperation with Institutions and Ministries: The government of Indonesia has synergized with other agencies and ministries to strengthen regulations and programmes. The Ministry of Energy and Mineral Resources (MEMR) is proactively discussing and drafting other regulations related to renewable energy development (EBTKE, 2022).
3. Energy Transition Platform: The Ministry of Finance has established an Energy Transition Platform to support the energy transition in Indonesia. The platform aims to ensure the implementation of the energy transition through government policies and legal regulations. The platform also aims to obtain and channel government fiscal support for the energy transition (Jdihkemenkeugoid, 2023).
4. Steering Committee: The Ministry of Finance has established a Steering Committee to support and accelerate the implementation of energy transition tasks. This committee aims to ensure accountability, transparency, and intentionality in managing the Energy Transition Platform (Jdihkemenkeugoid, 2023).
5. Policy Comparison with Nordic Countries: Research has also examined policy comparisons between Nordic countries, optimally utilizing renewable energy by considering carbon reduction attempts, deforestation, and environmental effects (Apriliyanti & Rizki, 2023).

These policies demonstrate a global and national commitment to encourage capital allocation for renewable energy projects to reduce carbon emissions and promote sustainable energy sources. Innovative financing schemes have been developed to overcome financial barriers to renewable energy investment. Renewable energy investments still face several financial barriers, such as high start-up costs, high risk, and lack of access to finance. Several innovative funding schemes have been developed to overcome these barriers. Table 1 explains the funding schemes, potential, and implementation.

Table 1. Funding Schemes, Potential, and Implementation

Funding Scheme	Description	Potential	Implementation
Green Bonds	Securities are issued to finance environmentally friendly projects, including renewable energy projects.	Green bond investors are interested in sustainable investments. Green bonds also offer lower interest rates than traditional ones, which are considered safer investments.	In Indonesia, PT Pembangkit Listrik Negara (PLN) issued green bonds worth IDR 4.5 trillion in 2022 to finance renewable energy projects.
Green Sukuk	Islamic financing instruments are issued to finance environmentally friendly projects, including renewable energy projects.	Green sukuk are shariah-compliant. It benefits investors looking to invest ethically and responsibly. Green sukuk is also an attractive funding alternative for investors in countries with large Muslim populations.	The Financial Services Authority (OJK) issued the first State Green sukuk in 2021 to finance renewable energy and other environmentally friendly projects.
Crowdfunding	An online platform that allows individuals to invest in projects in small amounts	A renewable energy crowdfunding platform enables the wider public to invest in renewable energy projects and contribute to a sustainable energy transition.	Renewable energy crowdfunding platforms in Indonesia, have helped finance various renewable energy projects.
Venture Capital	An investment fund that focuses on investing in start-ups with high growth potential.	Venture capital can help innovative renewable energy companies secure funding to develop new technologies and penetrate new markets.	Some of the venture capital firms in Indonesia that focus on renewable energy investments.
Government Grants and Incentives	Many governments offer grants and incentives to encourage investment in renewable energy.	Grants and incentives can help reduce the cost of renewable energy projects and make them more attractive to investors.	In Indonesia, the government offers various incentives for renewable energy, such as higher electricity purchase rates, and tax reductions.

Based on Table 1, these innovative funding schemes can help overcome financial barriers to renewable energy investment. The schemes can also encourage faster development of the renewable energy sector. It is important to note that no single solution exists to overcome all financial barriers. A combination of various innovative financing schemes and supportive government policies is required to create an ideal environment for investment in renewable energy (Huang et al., 2021).

Case Study: Implementation of Sustainable Finance in Various Countries

Germany has a very effective renewable energy policy comprising subsidies, fiscal incentives, and feed-in tariff schemes. With the 'Energiewende' (energy transition), the country has successfully increased its renewable energy installation capacity. Germany has a Renewable Energy Sources Act (EEG) that guarantees purchase prices for renewable energy, such as solar and biomass. The EEG also provides a feed-in tariff scheme that guarantees a purchase price for renewable energy suppliers, encouraging the development and installation of renewable power systems. Germany also has fiscal incentives in the form of lower corporate income tax for investments in the renewable sector to encourage the development of the renewable industry. Investors can reduce corporate income tax by 50% of the investment. In addition, Germany also has education, certification, and other programs that aim to encourage the development and utilization of renewable energy. The country also has a tax reduction policy for using clean fuels, such as bioethanol and biodiesel (Res-legal.eu, 2019). Germany's renewable energy and sustainable finance policies have been a model for many other countries, which have developed similar or different programs tailored to local needs and conditions.

Denmark has set a target to become free from fossil fuels by 2050. Denmark is becoming one of the leading countries in wind energy production through an integrated approach that includes policies, investments in wind technology, and funding schemes that support renewable energy. Denmark has set a target to become free from fossil fuels by 2050. Denmark is becoming one of the leading countries in wind energy production through an integrated approach that includes policies, investments in wind technology, and funding schemes that support renewable energy. This integrated approach includes policies, investments, and technologies needed to develop renewable energy. Denmark is a country that has succeeded in developing renewable energy, such as wind energy, and has also become a world role model in developing renewable energy. Denmark's energy security policy focuses on sustainable energy consumption, especially wind energy. The government ensures that domestic energy supplies are met mainly by alternative energy by issuing various policies and incentives to increase domestic production. Denmark also uses an integrated approach in developing renewable energy, which can be seen from wind power as the most extensive use of new energy sources for Denmark's national electricity supply (Tianotak et al., 2023). Apart from that, cooperation between Indonesia and Denmark in developing renewable energy in Indonesia is increasingly strengthened through the INDODEPP scheme. The aim of this collaboration is primarily to reduce the use of GHG emissions in the energy sector, as well as to achieve Indonesia's Nationally Determined Contribution (NDC), the goal of the Sustainable Development Goals (SDGs), namely clean and affordable energy and handling climate change (Tianotak et al., 2023). Denmark has become a

country that plays a vital role in Indonesia's renewable energy development. Several Danish energy companies also plan to invest in Indonesia, such as Copenhagen Infrastructure Partners (700 million USD), Vestas (400 million USD), and Howden (40 million USD). An integrated approach is also used to develop renewable energy in other regions, such as in Esbjerg, which is a model for planned energy production. This city is an example of an industry with the location needed to develop renewable energy (EBTKE, 2021).

Indonesia has developed green financing schemes to support renewable energy and sustainable development projects as part of its commitment to the Paris Climate Agreement, including its first green bond issuance in 2018. Indonesia has developed an innovative financing strategy through the Integrated National Financing Framework (INFF), which creates coherence between planning and financing strategies for the SDGs. Indonesia has also pioneered innovative financing, including launching the first green sukuk and developing Islamic financing, blended finance, and impact investing. The other funding scheme, such as non-government funding, should also be strengthened and aligned with the Sustainable Development Goals. Funding capacity from government and non-government sources is optimized through various innovative funding schemes, as mandated in Presidential Regulation No. 111 of 2022 on SDGs (sdgs.bappenas.go.id, 2024).

A sustainable finance approach in renewable energy requires collaboration between the government, private sector, and civil society to create an ideal environment for investment (Khan et al., 2022). Sustainable finance can accelerate the transition to a cleaner and more sustainable energy system through supportive policies, innovative financing schemes, and practical implementation (Wang et al., 2021). Successful implementation in various countries demonstrates the potential of sustainable finance to drive the essential investment in renewable energy, which is critical to address climate change challenges and ensure sustainable economic development (Shahbaz et al., 2021).

Investment Challenges and Opportunities in Green Technology

Investments in green technologies and renewable energy face a complex set of challenges. First, the high initial cost of developing green infrastructure and technologies is often a significant barrier (Liberalesso et al., 2020). Second, political and policy uncertainties can affect the stability and sustainability of long-term investments in the sector (Pizarro-Alonso et al., 2019). Third, limited access to finance and credit for renewable energy projects, especially in developing countries, restricts their ability to compete with conventional energy sources (Amesho & Edoun, 2019). Fourth, more knowledge and awareness of green technologies' economic and environmental benefits are needed to enhance the adoption and implementation (El-Kassar & Singh, 2019).

On the other hand, there are significant market opportunities for investment in green technologies. Growing global awareness of climate change and sustainability has increased the demand for clean energy and green technology solutions (ÓhAiseadha et al., 2020). Technological innovation continues to lower the cost of renewable energy production, increasing its competitiveness over fossil fuels (Sohag et al., 2021). Governments worldwide encourage investment in clean energy through subsidies, tax incentives, and other supportive policies, promoting a more conducive environment for the sector's growth (Yang et al., 2019). Furthermore, investments in green technologies offer the potential for attractive returns through operational cost savings, improved efficiency, and access to new markets (Stucki, 2019).

A comprehensive strategy is required to address challenges and maximize opportunities to encourage investment in green technologies. Firstly, developing a stable and supportive policy framework is essential to attracting investment (Polzin et al., 2019). Second, enhancing financial accessibility through innovative funding mechanisms, including green bonds, sustainable funds, and subsidized credit schemes, can reduce financial barriers (Zhang et al., 2021). Third, collaboration among government, industry, and research institutions is needed to accelerate innovation and lower technology costs (Lerman et al., 2021). Fourth, public education and awareness initiatives on green technologies' economic and environmental benefits can increase market acceptance and demand (Liu & Giovanni, 2019). Through implementing these strategies, opportunities for investment in green technologies can be maximized, contributing to the global transition to a low-carbon economy. Investment in green technologies is critical to achieving global climate and sustainability objectives and offers significant economic opportunities (Du & Li, 2019). By addressing the challenges and capitalizing on the opportunities, stakeholders can accelerate the adoption of green technologies and renewable energy, supporting sustainable development and climate change mitigation strategies.

Impact of Sustainable Finance on Renewable Energy Investment

The application of sustainable finance has shown a significant positive impact on investments in renewable energy (Khan et al., 2021). Integrating environmental, social, and governance (ESG) criteria in investment decisions promotes capital allocation to sustainable projects and initiatives, which supports the global transition to a low-carbon economy (Khemir et al., 2019). The investment data show that renewable energy projects funded through sustainable finance schemes often achieve higher rates of return and lower risks than traditional investments. It is mainly due to improved efficiency, reduced operating costs, and government incentives for clean energy.

Table 2. Comparison of Renewable Energy Projects and Traditional Investments

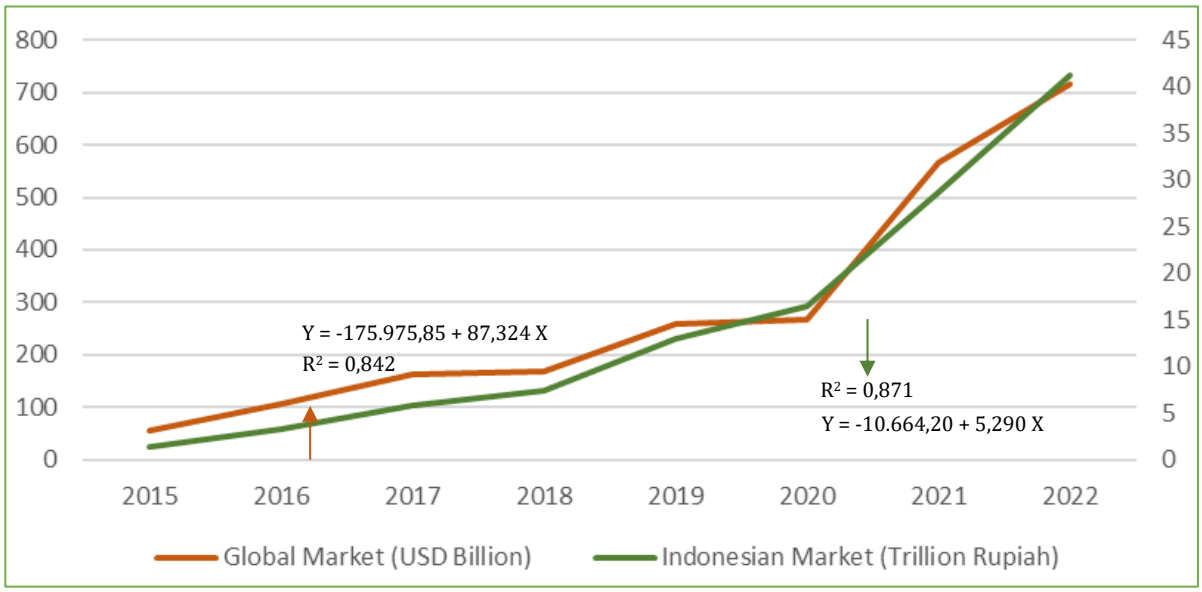
Parameters	Renewable Energy Projects	Traditional Investment
Return On Investment (ROI)	High ROI potential as renewable energy prices increase and production costs decrease. Example: a. The IRENA 2020 study shows that the global average internal rate of return (IRR) for renewable energy projects is 8.4%. b. In Indonesia, household-scale rooftop solar projects can achieve an IRR of 20-30% with a net metering scheme.	Generally offers a more stable and easily calculated ROI than renewable energy projects. Example: a. The average annualized return for equity mutual funds in Indonesia is around 10-15% over the last 5 years. b. Bank deposits offer lower returns, around 4-6% per year.

Source: www.irena.org, 2024.

Table 2 compares renewable energy projects and traditional investments on Return on Investment (ROI). Renewable energy projects show a high ROI potential as energy prices increase and production costs decrease. For example, the IRENA 2020 study indicates that the global average Internal Rate of Return (IRR) for renewable energy projects is 8.4%. In Indonesia, household-scale rooftop solar projects can achieve an IRR of 20-30% with a net metering scheme. In contrast, traditional investments generally offer a more stable and easily calculated ROI than renewable energy projects. For instance, the average annualized return for equity mutual funds in Indonesia is around 10-15% over the last 5 years, while bank deposits offer lower returns, around 4-6% per year. This comparison highlights the higher potential but volatile returns from renewable energy investments compared to more stable but lower returns from traditional financial instruments.

Funding schemes for renewable energy vary in their effectiveness in attracting investment (Azhgaliyeva et al., 2022). Green bonds, for example, have proven to be very effective in raising funds for renewable energy projects due to their high transparency and accountability. The data reveals a significant increase from 2015 to 2022 in both the Indonesian and global markets. Green bonds offer several advantages, making them an attractive investment funding instrument. Regarding Transparency and Accountability, green bonds have a transparent and standardized framework to ensure funds are used for renewable energy projects that meet environmental and social criteria (Fu & Ng, 2021). It increases investor confidence and minimizes the risk of greenwashing. From the aspect of Portfolio Diversification, green bonds offer portfolio diversification for investors. It allows them to support sustainable initiatives while earning financial returns (Naeem et al., 2021). From the

aspect of Positive Environmental Impact, Investments in green bonds contribute directly to funding renewable energy projects, which helps reduce greenhouse gas emissions and limit climate change (Tolliver et al., 2020).



Source: www.climatebonds.net 2024; www.ojk.go.id, 2024
Fig. 3. Green Bond Growth Trend (2015 – 2022)

Figure 3 reveals the regression coefficient value for the increase in green bonds over the past eight years. The regression coefficient value is 87.324 for the global market. The significance value by p-value of 0.001 shows a high significance value. A similar situation is seen in the Indonesian market, where the coefficient of increase reaches 5.290 over the same period, with a p-value of 0.001. These results indicate a significant influence of the factors underlying the rise of green bonds in both the global and Indonesian markets over the observed period.

In addition to green bonds, green sukuk is an alternative funding that aligns with sharia principles and focuses on renewable energy projects. Green sukuk are sharia-based financial instruments that finance environmentally friendly and sustainable projects, including renewable energy (Santoso, 2020). The scheme offers several advantages that make it attractive to investors. The first is shariah compliance. Green sukuk are designed according to islamic shariah principles, ensuring the invested funds are not involved in haram activities (Foglie & Keshminder, 2022). It provides a sense of security and satisfaction for Muslim investors. The second advantage is transparency and accountability. Green sukuk has a transparent and standardized framework to ensure funds are used for renewable energy projects following environmental and social criteria

(Santoso, 2020). This advantage increases investor confidence and minimizes the risk of greenwashing. The next advantage is the positive environmental impact. Investment in green sukuk contributes directly to funding renewable energy projects, which helps reduce greenhouse gas emissions and eliminate climate change (Raeni et al., 2022). Furthermore, the next advantage is portfolio diversification. Green sukuk offers portfolio diversification for investors, allowing them to support sustainable initiatives while gaining financial returns (Pirgaip et al., 2020). Lastly, in terms of government support, several countries, including Indonesia, have demonstrated their commitment to developing green sukuk by issuing favorable regulations and policies (Liu & Lai, 2021). It provides legal security and attracts more investors.

Figure 4 illustrates the growth trend of green sukuk from 2015 to 2022. This study observes a notable increase in investments globally and in Indonesia. The regression line for the global market shows a coefficient of 4.577. It indicates a significant increase in the value of green sukuk. The R-squared value shows 0.824, which implies that approximately 82.4% of the variability in green sukuk issuance can be explained by the year. This strong growth trend is further confirmed by a p-value of 0.002, affirming the statistical significance of the trend.

Similarly, the Indonesian market's trend line reveals a coefficient value of 2.451. It points to robust growth, even though slower than the global market. The R-squared value for Indonesia is 0.795. It suggests that the passing years can explain close to 79.5% of the growth in green sukuk. Furthermore, the p-value of 0.003 confirms the statistical significance of the growth trend. This chart and the regression analysis prove the increasing importance and adoption of green sukuk as a sustainable finance tool. It reflects broader financial market dynamics and the rising commitment to sustainable investment practices globally and in Indonesia.

Source: www.climatebonds.net 2024; www.ojk.go.id 2024
Fig. 4. Green Sukuk Growth Trend (2015 – 2022)

Comparison of the Effectiveness of Various Funding Schemes

Funding is key in actualizing a sustainable energy transition through the implementation of renewable energy (Bogdanov et al., 2021). There are several funding schemes with their advantages and disadvantages. First, Green Bonds offer access to a broad global market with diverse investors (Naeem et al., 2021). Green bonds are attractive due to funding structure flexibility, including various tenors and interest rates, and high secondary market liquidity. However, the scheme requires large-scale projects with stable cash flows, high issuance, and regulatory compliance costs to attract investors. The second is green sukuk. It has strict sharia compliance, which makes it appealing to Muslim investors. The enhanced transparency system based on sharia principles is also beneficial (Ahmed et al., 2019). However, a smaller market with investor concentration, rigid funding structures, and low secondary market liquidity is challenging.

Furthermore, other schemes such as crowdfunding provide access to funding for small and medium-scale projects (Ari & Koç, 2021). The issuance cost is relatively low, and there is high public involvement in supporting renewable energy. However, the risk of depending on the number and enthusiasm of investors and the higher potential for project failure are disadvantages that must be reduced. Meanwhile, Venture Capital provides financial support and expertise for innovative projects with high growth potential (Kulanov et al., 2020). Its advantages include the flexibility of its funding structure, extensive network, and connections for business development. Finally, government grants and incentives provide financial support with no refund requirements (Pratiwi & Juerges, 2020). Its

advantages also include supporting innovative renewable energy technologies and projects and accelerating the sustainable energy transition. However, it also depends on government budgets, complex application processes, and intense competition for grants and incentives, which are challenges that must be reduced.

Recommendations for Stakeholders and Future Research Directions

Several recommendations are constructed for sustainable finance and renewable energy stakeholders. First, the government should continue to develop and refine policies that support investment in renewable energy, including tax incentives, subsidies, and mandatory ESG disclosure policies. Next, investors are advised to improve the integration of ESG analyses in the investment decision-making process, considering the higher potential returns and lower risks of renewable energy projects. Furthermore, Companies in the renewable energy sector must improve their ESG performance transparency and reporting to attract more sustainable investments. Lastly, Financial institutions should develop and offer more innovative financial products specifically designed for renewable energy to facilitate access to finance, such as green bonds and sustainable funds.

Future research should focus on long-term evaluations of the impact of sustainable investments in renewable energy on economic and environmental performance. Further studies are needed to identify factors influencing the success of different funding schemes and supporting policies in different geographic and economic contexts. In addition, research should explore new green technologies and renewable energy innovations to understand their potential to meet sustainable global energy needs. Through these analyses, it becomes clear that sustainable finance is crucial in accelerating the transition to renewable energy. With the right approach, existing challenges can be overcome, capitalizing on the significant opportunities renewable energy and green technologies offer for sustainable economic development and climate change mitigation.

Conclusion

This study provides a nuanced analysis of the role of sustainable finance in driving investment in renewable energy and green technologies. By integrating environmental, social, and governance (ESG) factors into investment decision-making, sustainable finance emerges as a critical tool to redirect capital flows toward projects that align with sustainable development objectives. The research contributes to the literature by offering a comprehensive synthesis of sustainable finance strategies and their intersection with renewable energy and green technology. It enhances understanding of sector-specific dynamics through methodological innovations and case studies. Furthermore, the study identifies practical ways to make sustainable finance more effective in

boosting investments in renewable energy, such as improving policies that align with ESG standards, developing new financial instruments like green bonds, and fostering cross-sector collaboration. These contributions provide valuable insights for policymakers, financial institutions, and industry practitioners in designing more effective strategies to overcome investment barriers and escalate investments in sustainable energy systems. Future research should expand on this foundation by evaluating the long-term economic, environmental, and social impacts of sustainable finance on renewable energy investment. In addition, it is also essentials to explore the scalability of successful policies and funding mechanisms in diverse contexts, and identifying pathways for enhancing the resilience of green energy systems in response to evolving market and environmental challenges.

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