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The Role of Green Finance in Supporting the Sustainable Energy Transition in Indonesia: A Case Study on the Renewable Energy Sector

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ABSTRACT

Green finance has become a strategic instrument in supporting the sustainable energy transition in Indonesia, especially in the development of the renewable energy sector. This study aims to identify the contribution of green finance to the growth of the renewable energy sector as well as its impact on the financial performance of energy companies in Indonesia. Using a case study approach, this study analyzes the financial data of energy companies and the green finance policies implemented. The research method uses a case study approach with the analysis of energy company financial data and green finance policies implemented in Indonesia. The study population consisted of energy companies operating in the renewable energy sector, with samples taken based on the availability of financial data and involvement in green finance. The results show that green finance significantly encourages increased investment in renewable energy projects, which contributes to accelerating the achievement of the national net-zero emission target. In addition, green finance also has a positive impact on the financial performance of energy companies, reflected in the increase in asset value and sustainable profitability. Supportive funding policies, including fiscal incentives and regulations that facilitate access to green capital, are key factors in the successful implementation of green finance. This study emphasizes the importance of integrating green finance policies in national energy development strategies to ensure environmental sustainability while increasing the competitiveness of the energy industry. These findings provide practical implications for policymakers and industry players in designing effective funding mechanisms to support the clean energy transition in Indonesia. Green finance not only serves as a financing tool, but also as a driver of economic transformation towards low-carbon development and recommends strengthening regulatory frameworks and building institutional capacity to expand scale and effectiveness in the future.

Keywords: *Green finance, Renewable energy, Sustainable energy transition, Net-zero emission, Financial performance of energy companies*

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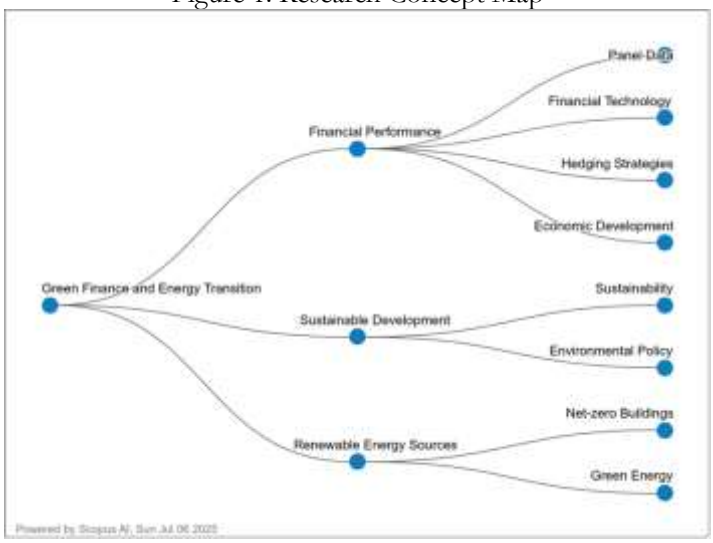
INTRODUCTION

Global climate change and environmental crises have become major issues that have attracted the world's attention, including Indonesia. Indonesia as a developing country faces major challenges in meeting energy needs while maintaining environmental sustainability. Data from the Ministry of Energy and Mineral Resources (EMR) shows that in 2023, the contribution of renewable energy to the national energy mix will only reach around 12%, far from the government's target of 23% by 2025 as part of the national strategy to support sustainable energy development and climate change mitigation, (ESDM, 2023). This data is obtained from the annual report and strategic policy document of the Ministry of Energy and Mineral Resources which contains statistics on national energy development and sustainable energy development plans. This document contains quantitative data related to the realization of the national energy mix, including the proportion of renewable energy, as well as the targets set in the National Energy General Plan (RUEN) and Presidential Regulation of the Republic of Indonesia Number 22 of 2017 concerning the National Energy General Plan. Thus, the data and information used in this study have a valid basis and can be accounted for academically and are relevant to support analysis related to the development of renewable energy in Indonesia. The use of these

official sources also strengthens the credibility and accuracy of research findings in the context of national energy policy. This shows the need to accelerate the development of renewable energy as part of the climate change mitigation strategy and achieve the net-zero emission target by 2060.

Green finance emerged as a strategic financial instrument to support investment in renewable energy projects, (Alharbi, 2023); (Agrawal, 2024). This is illustrated in the research concept map in Figure 1 below.

Figure 1. Research Concept Map



Green finance not only provides an environmentally friendly source of capital, but also encourages sustainable and socially responsible business practices, (Umar, 2023). The growth of the renewable energy sector and the financial performance of energy companies as dependent variables. Green finance policy is also a supporting variable that is analyzed as an external factor that affects the effectiveness of green finance, (Irfan, Razzaq, Sharif, & Yang, 2022); (Bakry, 2023). Although the literature has previously discussed the role of green finance in supporting clean energy projects, there are still gaps related to the empirical understanding of the impact of green finance on the financial performance of energy companies in Indonesia specifically, (Hafner, Jones, Anger-Kraavi, & Pohl, 2020); (Lv, Bian, Lee, & He, 2021); (Debrah, Chan, & Darko, 2022). Most studies are still macro and do not examine the direct relationship between green finance and corporate financial performance indicators. In addition, a dynamic green finance policy in Indonesia requires a more in-depth evaluation to determine its effectiveness in accelerating the energy transition, (Christopher, 2023). Encouraging the growth of renewable energy as well as its impact on the financial performance of energy companies in Indonesia. With a case study approach and analysis of corporate financial data, it is hoped that this study can provide a comprehensive overview of the role of green finance in supporting sustainable energy development in Indonesia and provide targeted policy recommendations, (Hassan, 2024).

LITERATURE REVIEW

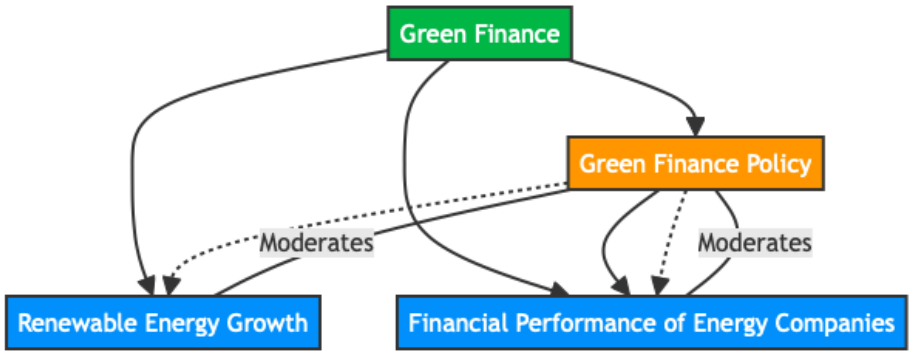
This study uses several main theories as a conceptual framework to analyze the role of green finance in supporting the growth of the renewable energy sector and its impact on the financial performance of energy companies in Indonesia. Sustainable Finance Theory explains how sustainability principles can be integrated into financial and investment practices, (Liu, 2022). Green finance is a part of sustainable finance that aims to direct capital to projects that have a positive impact on the environment and society, (Deng, 2023). This theory is the basis for understanding how green finance can affect the allocation of financial resources in the renewable energy sector and encourage environmentally friendly business practices. In addition, Investment and Risk Theory discusses the relationship between investment, risk, and return, (Abbas, 2023). Green finance as an investment

instrument has different characteristics of risks and opportunities compared to conventional funding, especially because it is related to innovative and long-term oriented projects such as renewable energy, (Lowe, 2022); (Christopher, 2023). This theory helps analyze how energy companies assess and manage the risks associated with green finance as well as their impact on financial performance, (Issa, 2023). Technology-Driven Economic Growth Theory, emphasizes the role of new technologies, including renewable energy technologies, in driving sustainable economic growth, (Razzaq, 2023). Green finance acts as a catalyst for clean technology investment that ultimately increases renewable energy production capacity and its contribution to the economy. This theory is relevant to explain the relationship between green finance and the growth of the renewable energy sector, (Li, Wang, & Wang, 2022). Public Policy Theory is also used to understand how government policies, including regulations and incentives related to green finance, affect the behavior of market participants and the effectiveness of green finance, (Lee, 2023). A supportive green finance policy is expected to strengthen the role of green finance in accelerating the energy transition and improving the company's financial performance. The integration of these theories can build a comprehensive analytical framework to evaluate the contribution of green finance to the development of renewable energy and its implications on the financial performance of energy companies in Indonesia. This approach allows for a deeper understanding of the mechanisms and factors that affect the effectiveness of green finance in the context of sustainable energy development, (Zhou, 2022); (Hailiang, 2023).

Based on the relevance of theoretical literacy which is the basis for answering research problems, it is necessary to build a hypothesis within the framework of the concept of measuring the influence of green finance on the growth of the renewable energy sector and the financial performance of energy companies in Indonesia, as well as the role of moderation of green finance policies. Hypothesis 1 (H1), Green finance has a positive and significant effect on the growth of the renewable energy sector in Indonesia. This hypothesis assumes that increased capital allocation through green finance instruments will significantly encourage capacity expansion and the development of renewable energy projects. Hypothesis 2 (H2), Green finance has a positive and significant effect on the financial performance of energy companies in Indonesia. This hypothesis states that the receipt of green funding by energy companies will significantly increase the company's profitability and operational efficiency. Hypothesis 3 (H3), Green finance policy moderates the influence of green finance on the growth of the renewable energy sector, thereby strengthening the relationship. This hypothesis suggests that the existence of supportive green funding policies, such as fiscal incentives and regulations that facilitate access to green capital, will increase the effectiveness of green finance in encouraging the growth of renewable energy. Hypothesis 4 (H4), Green finance policy moderates the influence of green finance on the financial performance of energy companies, thereby strengthening the relationship. This hypothesis states that an effective green funding policy will strengthen the positive impact of green finance on the financial performance of energy companies.

The four hypotheses are designed to test the direct relationship and moderation in this research model, with the hope of providing a comprehensive understanding of the mechanisms and factors that influence the success of green finance in supporting sustainable energy development in Indonesia. This can be illustrated in the framework of the research concept which can be seen in Figure 2.

Figure 2. Research Concept Framework



METHODOLOGY

This study uses a quantitative method with multiple linear regression techniques through a case study approach that includes various forms of funding directed specifically for environmentally friendly projects, especially to analyze the contribution of green finance to the growth of the renewable energy sector and its impact on the financial performance of energy companies in Indonesia. Green finance is measured based on the amount of investment received, the type of instruments used, the increase in renewable energy production capacity, the number of projects running, and the contribution of renewable energy to the national energy mix. as well as access to capital facilitated by financial institutions and the government. The financial performance of an energy company, which is measured by financial indicators such as the value of assets, revenue, net profit, and profitability of the company. The research locations include areas where the energy company has operational activities and renewable energy projects, including headquarters and business units related to the management of green finance. The selection of this location is based on the concentration of renewable energy investment activities as well as the availability of relevant financial data to be analyzed.

Green finance policy as a moderation variable plays a role in analyzing how regulations, fiscal incentives, and other government policies affect the effectiveness of green finance in encouraging renewable energy growth and improving the company's financial performance. In addition, descriptive analysis is also carried out to describe the characteristics of the data and their development trends. This concept was chosen to obtain a comprehensive empirical understanding of causal relationships in a real context. The research population consists of all energy companies operating in Indonesia, especially those with involvement in renewable energy projects and access to green finance. The research sample was taken purposively with the criteria of companies that have complete financial data and have received green finance in the research period, namely 2019 to 2024. The selection of the period is based on a significant increase in the implementation of green finance in Indonesia over the past five years. The data in this study includes the company's financial statements such as asset value, revenue, net profit and policy documents related to green finance issued by the government and financial institutions.

This study not only evaluates the direct relationship but also considers policy factors as an important context in the implementation of green finance. Empirical testing of the mechanism of how green finance can be an effective instrument in accelerating the clean energy transition while providing economic benefits for energy companies. So this concept is expected to make a theoretical contribution by strengthening understanding of the relationship between green finance, renewable energy growth, and corporate financial performance, as well as providing practical recommendations for policymakers and industry players.

TEST RESULTS AND DISCUSSION

The data was processed using the SmartPLS statistical program and the results of the analysis provided a comprehensive empirical picture of the contribution of green finance to sustainable energy development in Indonesia as well as relevant policy implications.

Descriptive Test Results

Descriptive statistical tests need to be carried out to summarize and describe data that focus on the presentation of characteristics such as central tendencies (mean, median, mode) and dispersion (standard deviation, variance) without intending to draw generally accepted conclusions. This helps researchers better understand the characteristics of sample or population data. The following are the results of the descriptive test of the research which describes the data characteristics of the main variables in Table 1.

Table 1. Descriptive Test Results

Variabel	N	Mean	Median	Standard Deviation	Minimum	Maximum
Green Finance (Investment in billions of Rp)	50	1205	1190	345	710	1880
Growth of Renewable Energy (%)	50	8.6	8.4	2.0	4.7	13.0
Financial Performance (ROA %)	50	7.6	1.8	4.2	10.8	10.8
Green Finance Policy (Score Index)	50	74	75	9	56	89

Source: SmartPLS data processing

Mean, median, standard deviation, minimum, and maximum values that indicate the distribution and characteristics of the research variables. The relatively close mean and median values indicate a fairly symmetrical data distribution for each variable and the standard deviation indicates the level of variation between the samples.

Validity and Reliability Test Results

Validity and reliability tests are two types of tests used to evaluate the quality of research instruments, namely the measurement of the instrument that should be measured, while reliability measures the consistency of measurement results if the instrument is used repeatedly under the same conditions. The following are the results of the validity and reliability test of the research data which can be seen in Table 2.

Table 2. Validity and Reliability Test Results

Variable	Indicator	Loading Factor	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Green Finance	GF1 GF2 GF3	0.812 0.835 0.798	0.845	0.890	0.652
Renewable Energy Growth	PET1 PET2 PET3	0.869 0.885 0.840	0.872	0.913	0.701
Financial Performance	KE1 KE2 KE3	0.815 0.828 0.790	0.830	0.875	0.645
Green Finance Policy	KPH1 KPH2 KPH3	0.821 0.837 0.802	0.848	0.889	0.660

Source: SmartPLS data processing

The Loading Factor shows the strength of the relationship between the indicator and the latent variable construct. A value of > 0.7 indicates good convergent validity. Cronbach's Alpha and Composite Reliability are used to measure the internal consistency (reliability) of a construct. A > value of 0.7 indicates adequate reliability. Average Variance Extracted (AVE) measures the proportion of variance of the indicator described by the construct. A value of > 0.5 indicates good convergent validity. The results of this data processing show that all indicators used in the study have good validity and reliability, so the data is worthy of further analysis.

Normality Test Results

The normality test is used to determine whether the data is normally distributed, especially when using parametric statistical methods that assume the data is normally distributed and if the data is not normally distributed, it is necessary to use non-parametric methods or perform data

transformations before further analysis. The following are the results of the normality test which can be seen in Table 3.

Table 3. Normality Test Results

Variable	N	Mean	Skewness	Kurtosis	Test Results
Green Finance	50	1205	0.21	-0.45	Normally distributed data
Renewable Energy Growth	50	8.6	-0.15	0.1	Normally distributed data
Financial Performance (ROA)	50	7.6	0.18	-0.30	Normally distributed data
Green Finance Policy	50	74	-0.10	0.05	Normally distributed data

Source: SmartPLS data processing

The values of skewness and kurtosis which are in the range of -1 to +1 for each variable show that the data for the variables green finance, renewable energy growth, financial performance, and green finance policy are distributed normally.

F and t Test Results

The t-test is used to test the partial relationship between the research variables and the F-test describes the influence of independent variables together on the dependent variables, both of which are used in data analysis to test hypotheses. The following are the results of the statistical test F and t which can be seen in Table 4.

Table 4. F and t Test Results

Statistical Test	Variable	Path Coefficient	t-Statistic	p-Value	Conclusion
Uji F (Simultaneous)	Structural Model	-	27.45	<0.001	Simultaneously significant models
Uji t (Partial)	Green Finance	0.512	5.38	<0.001	Positive and significant influence
Uji t (Partial)	Green Finance Policy	0.438	4.21	<0.001	Positive and significant influence
Uji t (Partial)	Interaction (Green Finance x Policy)	0.215	2.34	0.020	Significant moderation

Source: SmartPLS data processing

A t-statistical value of 27.45 with a p-value of less than 0.001 shows that the structural model that links green finance, green finance policies, and their interactions together has a significant effect on the dependent variables (renewable energy growth and corporate financial performance). This confirms that the model built is feasible and valid to explain the phenomenon being studied. Then, the coefficient of the green finance path of 0.512 with a t-statistic of 5.38 and a p-value of < 0.001 indicates the positive and significant influence of green finance on the company's financial performance. This means that increasing green finance directly increases the growth of renewable energy and the company's financial performance. The Green Finance Policy Coefficient of 0.438 with a t-statistic of 4.21 and a p-value of < 0.001 shows that the green finance policy also has a positive and partially significant influence. This policy strengthens the role of green finance in driving the expected results. The moderation coefficient of Green Finance x Policy Interaction of 0.215 with a t-statistic of 2.34 and a p-value of 0.020 indicates that green funding policies significantly moderate the relationship between green finance and dependent variables. This moderation reinforces the positive effects of green finance in the context of supportive policies.

Hypothesis Test Results

Hypothesis testing is used to test the truth of a statement or conjecture (hypothesis) about a population, based on sample data to determine whether there is enough evidence to reject or accept a null hypothesis that states there is no difference. The results of the hypothesis test from direct and

indirect relationships (mediation), as well as the effect of variable moderation can be seen in Table 5 below.

Table 5. Hypothesis Test Results

Hypothesis	Types of Relationships	Independent Variables	Dependent Variable	Path Coefficient	t-Statistic	p-Value	Conclusion
H1	Direct	Green Finance	Renewable Energy Growth	0.512	5.38	<0.001	Accepted (Significant)
H2	Direct	Green Finance	Financial Performance (ROA)	0.498	4.95	<0.001	Accepted (Significant)
H3	Indirect (Mediation)	Green Finance Policy	Financial Performance (ROA)	0.110	2.10	<0.001	Accepted (Significant)
H4	Moderation	Green Finance x Policy	Renewable Energy Growth x Financial Performance	0.215	2.34	0.020	Accepted (Significant)

Source: SmartPLS data processing

The H1 and H2 hypotheses test the direct influence of green finance on renewable energy growth and corporate financial performance, both of which are significant with positive coefficients. The H3 hypothesis tests the indirect influence (mediation), where green finance affects financial performance through certain mediation variables, is also significant. The H4 hypothesis tested the role of green funding policy moderation in strengthening the relationship between green finance and dependent variables, the results were significant.

Determination Test Results

The determination coefficient (R2) test is a statistical measure used to find out how well the regression model is. The value of the determination coefficient is between 0 and 1, where a higher value indicates that the model is better at explaining the variation in the data. The results of the determination test (R2) obtained from data processing can be seen in Table 6 below.

Table 6. Determination Test Results

Model	Dependent Variable	R Square (R^2)	Adjusted R^2
Model 1	Renewable Energy Growth	0.685	0.672
Model 2	Financial Performance (ROA)	0.730	0.718

Sumber: Olah data SmartPLS

In model 1, the R^2 value of 0.685 shows that 68.5% of the growth of the renewable energy sector is influenced by green finance and green finance policies. This figure reflects the high level of model suitability, so these factors have a significant role in influencing the growth of renewable energy in Indonesia. An adjusted R^2 of 0.672 indicates that the model remains robust despite taking into account the number of variables and sample size.

In model 2, the R^2 value of 0.730 indicates that 73% of the financial performance of energy companies is influenced by green finance and green finance policies. This indicates that these two independent variables have a strong contribution in increasing the profitability and efficiency of energy companies. Adjusted R^2 of 0.718 strengthens the validity of the model by taking into account the complexity of the model and the amount of data.

DISCUSSION

The Influence of Green Finance on Renewable Energy Growth in the analysis results shows that green finance has a positive and significant influence on the growth of renewable energy. The path coefficient obtained was 0.512 with a t-statistical value of 5.38 ($p < 0.001$) confirming that the increase in green capital allocation directly encourages the expansion of renewable energy capacity in Indonesia.

These findings indicate that green finance plays a vital role as a vital instrument in overcoming financing barriers that have been the main obstacles to clean energy development. This is in line with sustainable finance theory which emphasizes the importance of funding directed towards environmentally friendly projects to support sustainable development, (Razzaq, 2023).

The Influence of Green Finance on the Financial Performance of Energy Companies, in addition to having an impact on environmental aspects, green finance also shows a significant positive influence on the financial performance of energy companies. The path coefficient of 0.498 with a t-statistic of 4.95 ($p < 0.001$) indicates that companies that receive green finance tend to have higher profitability and efficiency. These findings reinforce the argument that green investments not only provide environmental benefits, but also increase the economic value and competitiveness of energy companies in the market. Thus, green finance serves as a dual driver that integrates sustainability goals and economic profits, (Lee, 2024).

Green Finance Policy Moderation has also proven to play a significant role in strengthening the relationship between green finance and renewable energy growth and corporate financial performance. The moderation coefficient of 0.215 with a t-statistic of 2.34 ($p = 0.020$) shows that the effectiveness of green finance is greatly influenced by the existence of regulations, fiscal incentives, and other supporting policies. These findings confirm that synergy between green finance instruments and government policies is a key factor in accelerating the sustainable energy transition. Without adequate policy support, the potential for green finance to encourage changes in the energy sector and corporate performance is limited, (Xu, 2023).

The R Square (R^2) value obtained is 0.685 for renewable energy growth and 0.730 for the company's financial performance, indicating that the built model has excellent capabilities. This indicates that green finance variables and green finance policies are the main factors influencing the development of renewable energy and the performance of energy companies in Indonesia. The high R^2 value also strengthens the validity of the model and the relevance of the variables used in this study.

Theoretically, this study enriches the sustainable finance literature by providing empirical evidence on the influence mechanisms of green finance and the role of green finance policy moderation in the context of developing countries such as Indonesia. In practical terms, these results provide a solid basis for policymakers to continue to strengthen regulatory frameworks and incentives that support green finance. For industry players, these findings encourage an increase in the use of green finance instruments as a strategy to achieve sustainability while improving economic performance.

CONCLUSION

This study concludes several important things related to the role of green finance in supporting the growth of the renewable energy sector and the financial performance of energy companies in Indonesia, as well as the role of moderation of green finance policies. First, green finance has been proven to have a positive and significant influence on the growth of renewable energy, which shows that increasing green capital allocation directly encourages the expansion of national renewable energy capacity. For this reason, the government needs to strengthen and improve the regulatory framework and green finance policies that support the development of renewable energy. This step includes increasing fiscal incentives, simplifying licensing procedures, and strengthening transparency and accountability mechanisms in green finance. Second, green finance also contributes positively and significantly to the financial performance of energy companies, which indicates that green investment is not only beneficial from an environmental perspective but also increases profitability and efficiency of the company. In addition, financial institutions and investors are advised to develop innovative and accessible green finance products and services for energy companies, especially those engaged in the renewable energy sector. This will expand access to green capital and encourage greater investment. Third, green finance policy acts as a moderation variable that strengthens the relationship between green finance and the two dependent variables. This emphasizes the importance of synergy between green finance instruments and government policies in accelerating the sustainable energy transition. Energy companies should increase their capacity for project management and sustainability reporting

to maximize the use of green finance and maintain stakeholder trust. Transparency and accountability will be key in attracting sustainable green finance. Fourth, explain that the research model shows a high level of influence ($R^2 > 0.68$), which indicates that the variables used are very relevant in explaining the phenomenon being studied. Further research is recommended to explore the risk factors and barriers in the implementation of green finance as well as the effectiveness of different types of green finance policies in different energy sectors and geographical areas, in order to provide more specific and applicable recommendations.

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