Jurnal Ekonomi Bisnis dan Kewirausahaan (JEBIK)
2026, Vol. 15, No. 1, 1-24

DOES RENEWABLE ENERGY REDUCE ESG RISK? EVIDENCE FROM ENERGY-INTENSIVE INDONESIAN FIRMS

Siti Rokhaniyah[1], Alex Johanes Simamora[*2], Siti Afidatul Khotijah[3]
[1, 2, 3]Tidar University, Indonesia

ABSTRACT

The main objective is to determine whether renewable energy adoption effectively reduces ESG risk and whether this effect varies depending on the level of energy intensity. Using a purposive sample of 180 firm-year observations from companies included in the ESG Leader Index during 2021–2023, the research applies fixed-effect regression analysis, supplemented by robustness tests that classify firms into low and high energy intensity groups. The findings indicate that companies adopting renewable energy experience significantly lower ESG risk compared to those that do not, with the effect being more pronounced in energy-intensive industries. In addition, the role of independent commissioners is shown to strengthen ESG risk reduction in high energy intensity firms, while institutional ownership has no significant impact. These results confirm stakeholder theory, legitimacy theory, and risk management theory, as renewable energy adoption simultaneously enhances stakeholder trust, secures social legitimacy, and mitigates sustainability-related risks. The novelty of this study lies in providing empirical evidence from an emerging market and in emphasizing the moderating role of energy intensity.

JEL: G32, Q42, Q56.

Keywords: *renewable energy, ESG risk, energy intensity.*

1. INTRODUCTION

Climate change is an urgent and crucial issue globally since it has a significant impact on human life and ecosystems. Carbon emissions from industrial events, transportation, and fossil-based energy consumption bring higher temperatures of the earth, overflowing seas and oceans, and intense natural disasters (Bolan, Padhye, Jasemizad, Govarthanan, Karmegam, Wijesekara, Amarasiri, Hou, Zhou, Biswal, Balasubramanian, Wang, Siddique, Rinklebe, Kirkham, & Bolan, 2024). Global gives higher awareness and concern to these damages by promoting energy transition that has characteristics of clean and eco-friendly energy (Bakhsh, Zhang, Ali, & Oláh, 2024; Rahman, Lipu, Shovon, Alsaduni, Karim, & Ansari, 2025). In this case, renewable energy is perceived as one of the strategic solutions to mitigate greenhouse and carbon emissions, while also improving sustainable development.

As a response, the global community has arranged a global agenda to accelerate the energy transition. It is initiated by the 2015 Paris Agreement, which aims to keep the temperature increasing benchmark of below 2°C while mitigating the temperature level up to 1.5°C compared to the pre-industrial era (Delbecq, Fontane, Gourdain, Planès, & Simatos, 2023). The 2015 Paris Agreement brings countries' commitment to reduce carbon emissions progressively, while implementing renewable energy rapidly. Furthermore, the United Nations promotes the Sustainable Development Goals (SDGs) to establish access to affordable and clean energy (SDG 7) and climate change reduction (SDG 13). The global agenda of renewable energy and climate change contributes to giving a normative framework for government and companies to shift the

[*]Corresponding Author: alexjohanessimamora@untidar.ac.id
Received: 20-02-2026, Accepted: 05-04-2026, Published: 06-04-2026
P-ISSN: 2087-9954, E-ISSN: 2550-0066. DOI: http://dx.doi.org/10.26418/jebik.v15i1.105141

current system into sustainable energy production and consumption systems (Voulvoulis, Giakoumis, Hunt, Kioupi, Petrou, Souliotis, Vaghela, & binti Wan Rosely, 2022).

Global investors, financial institutions, and regulators also give higher awareness to sustainability aspects when they evaluate the companies' performance (Chau, Anh, & Duc, 2025). Investors ask for transparency of environmental, social, and governance (ESG) aspects (Aydoğmuş, Gülay, & Ergun, 2022). Financial institutions also begin to assess funding based on companies' commitment to clean energy (Downie & Peterson, 2025). Regulators also push companies to implement sustainability reporting and climate risk management. Global pressures lead companies to enter new dynamics of business strategy where renewable energy implementation can give investors trust, affordable funding costs, and a positive reputation for companies (Arhinful, Mensah, Amin, Obeng, & Gyamfi, 2025; Hardi, Idroes, Hamaguchi, Can, Noviandy, & Idroes, 2025; Qadir, Al-Motairi, Tahir, & Al-Fagih, 2021). On the other hand, companies that ignore the issue of energy transition will face an increase in ESG risk that can decline market value and business and sustainability (Bagh, Fuwei, & Khan, 2024; Naseer, Guo, & Zhu, 2025).

Indonesia has a regulation of PP No. 22 of 2017 about the National Energy General Plan (*Rencana Umum Energi Nasional* or RUEN), which determines the target of energy fusion where renewable energy implementation can reach up to 23% by 2025 and 31% by 2050. The regulation is part of a long-term strategy to reduce fossil-based energy dependence, since fossil-based energy dominates the national energy consumption (Muzayanah, Lean, Hartono, Indraswari, & Partama, 2022). This commitment not only aligns with the global agenda to reduce carbon emissions but also serves as a national instrument for maintaining energy security, mitigating environmental impacts, and creating new investment opportunities in the clean energy sector (Institute for Essential Services Reform, 2025; Institute for Essential Services Reform, Lappeenranta University of Technology, & Agora Energiewende, 2021; International Energy Agency, 2023; Massagony, Pandit, & White, 2025). However, achieving this target requires synergy between the government, the business world, and the public, particularly in terms of investment in technology, infrastructure, and green financing (Qamruzzaman & Karim, 2023; Wen, He, Jing, & Haroon, 2025).

In line with this energy policy, regulations related to ESG aspects are also being strengthened in Indonesia. The Indonesian Financial Services Authority (*Otoritas Jasa Keuangan* or OJK) issues the regulation of POJK No. 51/POJK.03/2017 about Sustainable Finance Implementation. The regulation requires companies to make a sustainability report that aims to provide transparency of non-financial aspects, including carbon footprints, energy, and sustainable development implementation. The regulations lead companies to be evaluated based on both financial and non-financial aspects. Non-financial aspects are required to assess companies' ability to mitigate ESG risk, including risks of reputation, compliance, and competitiveness.

The Indonesia Stock Exchange (IDX) also has a critical role in supporting business sustainability. The IDX issues the stock index that can facilitate investors who are concerned about ESG aspects, such as the ESG Leader index. The ESG Leader index consists of companies with superior sustainability performance. The IDX also promotes green bonds as one of the alternatives to green financing. Investors see the IDX efforts as a positive signal where business sustainability becomes an important consideration in investment decisions and leads Indonesia to have a strong position to face global climate change (Purnamasari, Lazuarni, & Maleha, 2024).

However, renewable energy implementation in Indonesia still faces some challenges. The data shows that renewable energy fusion has not yet achieved the target of RUEN (Institute for Essential Services Reform, 2025). Indonesia still depends on fossil-based energy, especially coal, as the main power resource to run electricity production since coal is a domestic commodity and affordable (Febriyanti, Murtadho, & Almattushyva, 2023). Limited technology, costly investment, and insufficient infrastructure also become obstacles to implementing renewable energy (Massagony *et al.*, 2025). The gap between policy target and current condition leads to the important question of Indonesian readiness to run renewable energy as a strategic move to mitigate ESG risk.

The environmental aspect in ESG refers to the role of companies in managing the ecological impact of their operations. Renewable energy, including solar, wind, hydro, and biomass, can significantly reduce carbon footprints (Justice, Nyantakyi, & Isaac, 2024; Li, Wang, & lejia, 2023). Renewable energy leads companies to lower greenhouse emissions, which is the main factor in climate change. Furthermore, the transition to renewable energy can also reduce environmental risks such as air pollution, water contamination, and ecosystem damage (Jaiswal, Chowdhury, Yadav, Verma, Dutta, Jaiswal, SangmeshB, & Karuppasamy, 2022). In the long term, companies that integrate clean energy into their production chains will be perceived as more responsible by investors, regulators, and the wider public (Almaskati, 2023).

From a social perspective, the adoption of renewable energy not only contributes to environmental sustainability but also positively impacts society. Companies that use clean energy can support public health (Badreddine & Cherif, 2024) by reducing harmful pollutant emissions (Bo, You, Sang, Wang, Chen, Xu, Shan, Yang, Bessagnet, Li, & Xiao, 2023). Furthermore, the energy transition gives opportunities for green jobs in the technology, installation, and maintenance of renewable energy systems (Ma & Wang, 2025). In the context of energy security, diversifying energy sources through renewable energy also reduces dependence on imported fossil fuels, thereby strengthening national economic stability (Yadav & Mahalik, 2024). Thus, the social aspects of renewable energy not only improve community welfare but also strengthen the company's social legitimacy in the eyes of stakeholders (Ahmed, Ali, & D'Angola, 2024).

Governance also plays a crucial role in relation to renewable energy. Companies that adopt sustainable energy strategies generally demonstrate a higher level of transparency, both in reporting environmental performance and in responding to stakeholder expectations (Khatri & Kjærland, 2023; Sulemana, Cheng, Agyemang, Osei, & Nagriwum 2025). Corporate governance leads companies to avoid regulatory risks, especially governance mechanisms that monitor the benchmark of emission and sustainability reporting (Chen, Xie, & He, 2024; Handoyo, 2024). The implementation of sustainability-oriented governance gives companies the ability to manage long-term risk and business sustainability (Chen, Song, & Gao, 2023).

When companies fail to implement renewable energy in operational activities, companies will bear more ESG risk, including reputation risk that comes from public criticism and environmental activist pressure (Ahmed *et al.*, 2024), compliance risk that comes from regulation violation (Hamm, Wolfe, Cavanagh, & Lee 2022), and financial risk that comes from expense inefficiency, funding limitation, and stock market crash (Aydoğmuş *et al.,* 2022; Simamora, 2025). Companies that cannot follow the energy transition tend to lose market trust and competitive advantages (Simamora, 2025). On the other hand, companies that proactively pursue renewable energy can reduce ESG risk by improving investor trust, competitive advantages, reputation,

energy efficiency, and green finance access (Sitompul, Saifi, Hutahayan, & Sunarti, 2024; Wen *et al*., 2025).

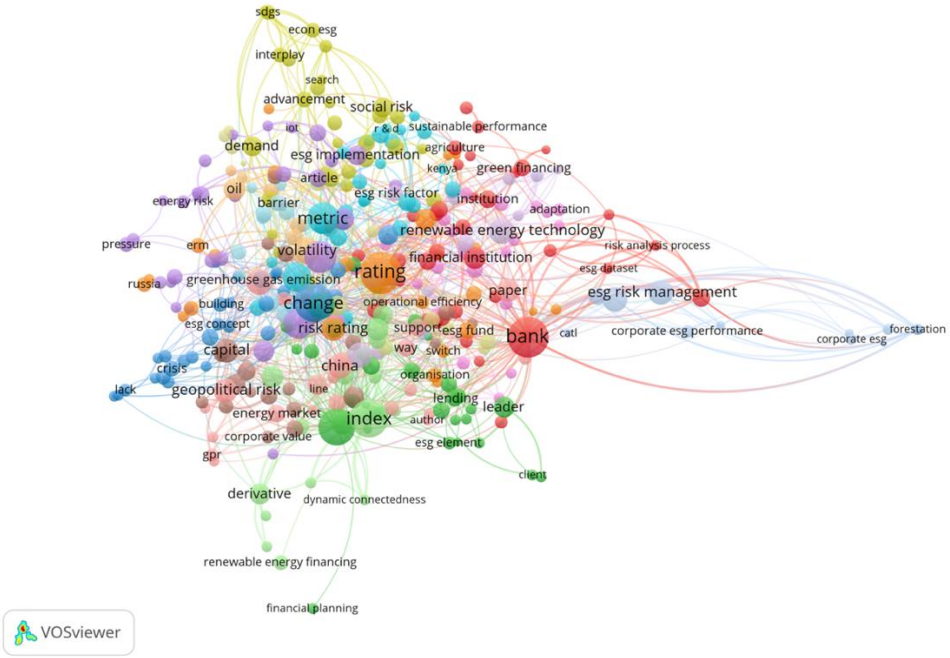
The urgency of examining renewable energy in relation to ESG risk lies in its direct role as a fundamental driver of sustainability risk mitigation. ESG risk emerges when companies unsuccessfully manage the environmental impact, social expectations, and governance responsibility (Urbizu, Ortas, & Etxeberria, 2025). In this context, energy consumption is one of the main sources of critical ESG risk, especially when the energy usage leads to carbon emissions, environmental degradation, and regulatory violations. Renewable energy adoption is not only operational decision, but also strategical mechanism for companies to manage ESG risk. By reducing fossil energy reliance, companies can reduce carbon emissions and pollution, avoid regulatory violations, achieve business sustainability, and build a reputation (Zhang, 2024). Since non-renewable energy is sensitive to increasing ESG risk, companies can experience regulatory penalties and sanctions, investor distrust, and negative public perception. It is important to examine how renewable energy implementation can reduce ESG risk, especially in emerging markets such as Indonesia, where the energy transition is still in progress, and companies face pressure to adjust their business to global sustainability standards.

Investors now assess not only financial performance but also the extent to which a company can manage ESG risks (Simamora, 2025). Companies committed to the energy transition, particularly by using renewable energy, send a positive signal to the market that they have a long-term, sustainability-oriented strategy (Zhang & Kong, 2022). This can increase the company's attractiveness to investors who are increasingly stringent in implementing responsible investment principles.

For companies, adopting renewable energy serves as both a risk mitigation strategy and an opportunity to create added value (Sitompul *et al.,* 2024). By reducing reliance on fossil fuels, companies not only mitigate potential ESG risks but also improve long-term operational cost efficiency. Clean energy brings companies to gain access to green financing, including green bonds or green index in the Indonesian capital market (Aransyah, 2023). This demonstrates that the energy transition is not only a form of compliance but also a strategic instrument for strengthening a company's competitive position.

Furthermore, investors are increasingly aware that a company's failure to adopt environmentally friendly practices can pose significant financial risks (Cardillo & Basso, 2025; Cosma, Rimo, & Schwizer, 2025). Reputational risk from public criticism, regulatory risk from non-compliance with emissions standards, and market risk from declining investor confidence can directly impact a company's stock value (Tran, Phan, Tee, & Nguyen, 2024). Therefore, companies that proactively implement renewable energy can strengthen their positive image, maintain investor loyalty, and attract new capital focused on sustainable portfolios (Elarabi & Khalifa, 2025; Ruan, Yang, & Dong, 2024; Sitompul *et al.,* 2024). In this regard, renewable energy becomes a strategic factor that connects corporate interests with investor expectations in the era of the global energy transition.

Although the issues of energy transition and sustainability have been widely discussed in the global literature, research on the relationship between renewable energy use and ESG risk remains relatively limited, particularly in the context of developing countries like Indonesia. Previous research on renewable energy and ESG risk can be seen in Figure 1.



Source: Ouput of VOS Viewer

Figure 1. Previous Research

Figure 1 shows that studies on ESG risk and renewable energy have developed within several interconnected thematic clusters. The first cluster highlights ESG risk management and the banking sector, including ESG risk management, banks, financial institutions, and renewable energy technology (Alsagr, Belkhaoui, & Ullah 2025; Chen, Umar, Su, & Mirza, 2023; Murtaza & Luqman, 2025; Sunio, Mendejar, & Nery, 2021). The studies focus more on the role of financial institutions in managing ESG risk by supporting the funding for renewable energy projects. In this case, energy transition does not only relate to technical aspects but also interacts with financial policy and risk governance of financial institutions.

The second cluster focuses more on ESG risk measurement, including index- and rating-based measurements (Nocoń, 2024; Park, Hahn, Lee, Kim, & Back, 2024; Pomè & Ciaramella, 2025). The studies show that ESG rating becomes an important factor for investors to assess companies' risk, including how risk can be reduced by implementing renewable energy. In this case, the ESG index and rating serve as both an evaluation tool of sustainable performance and a market mechanism to lead companies to use clean energy resources.

The third cluster focuses on risks of geopolitics, the energy market, and companies' value (Chen, He, & Ali, 2025; Tiwari, Abakah, Shao, Le, & Gyamfi, 2023). The studies explain that the use of fossil-based energy leads companies to be vulnerable to fluctuations in global geopolitics and the market. In this case, renewable energy plays the role of risk mitigation for market and external condition uncertainty.

Fourth cluster investigates the relationship between ESG and SDGs agenda (Işık, Ongan, & Islam, 2024; Işık, Ongan, Islam, & Menegaki, 2024). The literature in this cluster demonstrates that the adoption of renewable energy not only mitigates environmental risks but also provides social benefits in the form of public health, green job creation, and supports the achievement of sustainable development goals. Thus, the academic literature confirms that renewable energy

serves as a strategic instrument in strengthening the comprehensive integration of environmental, social, and governance aspects.

Despite the growing body of literature on renewable energy and ESG, several important gaps remain. First, prior studies predominantly focus on developed countries, where regulatory frameworks, technological readiness, and sustainability awareness are more advanced. This limits the generalizability of findings to emerging markets such as Indonesia, which face different structural challenges, including high dependence on fossil fuels and limited renewable energy infrastructure. Second, existing research tends to examine renewable energy in relation to ESG performance or firm value, rather than explicitly focusing on ESG risk as a distinct construct. As a result, the role of renewable energy as a risk mitigation mechanism remains underexplored. Third, prior studies often assume a homogeneous effect of renewable energy across firms, without considering firm-specific characteristics. In particular, the role of energy intensity as a condition that may strengthen or weaken the relationship between renewable energy and ESG risk has received limited attention. Therefore, this study aims to address these gaps by examining the effect of renewable energy on ESG risk in Indonesia, while incorporating energy intensity as a moderating or conditioning factor.

Overall, Figure 1 shows that renewable energy is positioned as a critical factor in ESG risk management, both through financing channels, rating mechanisms, and the global sustainability agenda. However, literature focusing on the context of developing countries, including Indonesia, remains limited. This gap gives space for research that empirically examines how renewable energy adoption affects the ESG risk of public companies listed on the Indonesia Stock Exchange, while expanding academic contributions from an emerging market perspective.

It is important to examine renewable energy and ESG risk in Indonesia. First, in terms of energy, Indonesia remains heavily dependent on fossil fuels, particularly coal, as its primary source of electricity generation (Muzayanah *et al*., 2022). This dependence makes the transition to renewable energy sources an urgent agenda, but it is fraught with obstacles, such as limited infrastructure, high investment costs, and suboptimal technological support (Massagony *et al.*, 2025). Under these conditions, public companies in Indonesia are in a crucial position to demonstrate their commitment to supporting the national energy transition targets set out in the RUEN.

Second, in terms of regulation and capital markets, Indonesia is in the early phase of strengthening sustainability practices. The OJK has mandated sustainability reporting through POJK No. 51/POJK.03/2017, that is just implemented fully in 2022. This makes Indonesia an important laboratory for assessing how regulations and market mechanisms can encourage companies to adapt to global demands regarding ESG risk management.

Third, from a global sustainability perspective, developing countries play a vital role because most of the future carbon emissions growth is projected to originate from these countries (Lu, Chen, & Cai, 2022). As one of the developing countries, Indonesia contributes to emissions, and at the same time, has significant potential for developing renewable energy sources such as solar, wind, hydro, and biomass. Therefore, how Indonesian companies manage the energy transition will have a significant impact on achieving global targets such as the Paris Agreement and the SDGs.

This research aims to examine the effect of renewable energy implementation on ESG risk. The novelty of this research lies in its focus on linking renewable energy to ESG risk in the Indonesian capital market, which is categorized as an emerging market. Most international literature focuses on developed countries, while studies in Indonesia are still very limited. Therefore, this research presents a new perspective on how green energy strategies can play a role in mitigating ESG risk in a business environment still grappling with structural barriers and dependence on fossil fuels.

This research makes an important contribution. First, in the theoretical perspective, this research extends ESG risks literature by integrating renewable energy into the framework of legitimacy, stakeholder, and risk management theories at the same time. Second, in the empirical perspective, this research provides evidence from emerging markets such as the Indonesian market, where the renewable energy implementation and ESG regulation are still in the developing stage. It contributes to filling the literature gap where most studies are conducted in developed countries. Third, this research introduces energy intensity as a conditioning factor to explain that renewable energy effectiveness can reduce ESG based on companies' characteristics of energy usage. Fourth, this research contributes to managers, investors, and regulators in formulating an effective strategy to reduce ESG risk by implementing renewable energy.

2. THEORETICAL FRAMEWORK AND EMPIRICAL STUDIES

Theoretical Foundation

This study integrates three main theoretical perspectives, namely legitimacy theory, stakeholder theory, and risk management theory, as the primary foundation to explain the relationship between renewable energy and ESG risk. Legitimacy theory explains that companies must run business activities based on social value, norms, and expectations since companies need society and stakeholders' legitimacy (Velte, 2023). In the context of ESG risk, renewable energy implementation is one of the strategic moves by companies to prove that they have commitments to environmental responsibility. By shifting to green energy, companies can reduce carbon emissions, improve their reputation, and minimize regulation and social risks. In Indonesia, the pressure of renewable energy implementation comes from the policy of RUEN (PP No. 22 of 2017) and the sustainability regulation (POJK No. 51/POJK.03/2017). Renewable energy is an important legitimacy tool for companies in front of regulators, investors, and the public.

Stakeholder theory explains that companies do not only fulfill shareholders' interests but also all stakeholders' interests, including society, government, suppliers, and customers (Mahajan, Lim, Sareen, Kumar, & Panwar, 2023). Higher ESG risk shows that companies fail to fulfill stakeholders' interests, including environmental aspects and transparency. Renewable energy becomes an important symbol of the fulfillment of stakeholders' expectations. By implementing clean energy, companies maintain their relationship with green investors, regulators, and society. Clean energy becomes important performance information for investors (Sitompul *et al.,* 2024), regulation compliance behavior assessed by regulators (Burch, Loraamm, & Nsude, 2025), and green job providers for the community (Ma & Wang, 2025).

Risk management theory shows the companies' effort to identify, evaluate, and manage risks to protect companies' value and sustainability (Aksana, Sayar, Elena, & Elena, 2025). In the context of ESG risk, renewable energy becomes a strategic way to mitigate specific risks.

Investment in green energy can reduce environmental risk (environmental damage and carbon emission), regulation risk (sanctions and penalties), and reputation risk (bad reputation). Therefore, adopting renewable energy is not merely fulfilling a moral or social obligation but also an integral part of corporate risk management. By combining these three theories, this study argues that renewable energy adoption is not only a compliance mechanism but also a strategic tool to reduce ESG risk, maintain stakeholder trust, and ensure business sustainability.

Renewable Energy and ESG Risk

Renewable energy is a source of energy derived from sustainable natural processes, such as sunlight, wind, water, biomass, and geothermal energy (Ang, Salem, Kamarol, Das, Nazari, & Prabaharan, 2022). Unlike fossil fuels, which are limited and produce high carbon emissions, renewable energy is considered more environmentally friendly because it is naturally renewable and contributes to reducing greenhouse gas emissions (Voumik, Ridwan, Rahman, & Raihan, 2023; Zhang, 2024). Globally, renewable energy plays a central role in supporting the transition to a low-carbon economy. The energy transition has become a key global agenda item in addressing climate change (Bakhsh *et al.,* 2024). Renewable energy is seen as key to reducing dependence on fossil fuels, which carry high risks of pollution, price fluctuations, and regulatory pressures. Implementing renewable energy in companies not only supports operational sustainability but also strengthens the company's position in the global supply chain, which increasingly demands environmentally friendly practices (Cheng, Chaudhry, Kazi, & Umar, 2024; Hmouda, Orzes, & Sauer, 2024; Runtuk, Ng, & Ooi, 2024). In Indonesia, renewable energy is regulated in PP No. 22 of 2017.

ESG risk refers to companies' risk that occurs when companies cannot manage aspects of environmental, social, and governance risk (Adisti, Novianti, & Suwarsinah, 2024). ESG risk includes financial risk, bad reputation, and regulatory sanctions and penalties, especially when companies perform business activities that are not aligned with sustainability principles (Cardillo & Basso, 2025; Handoyo & Anas, 2024). ESG risk becomes an important indicator of sustainability performance, especially for green investors in investment decision-making. Environmental risk shows the negative impact of companies' business on environmental damage, including carbon emissions, pollution, and nature exploitation (Wang, Zhang, & Li, 2024). Social risk refers to the negative impact on society, including labor safety, public health, and the local community (Borbor, Cranenburgh, & Luca, 2021). Governance risk comes from weak governance mechanisms, including lower transparency, conflict of interest, and regulation violation (Areneke, Adegbite, & Tunyi, 2022). For public companies that are listed on the IDX, ESG implementation is regulated in POJK No. 51/POJK.03/2017.

When companies use renewable energy for business activities, they will generate a lower carbon footprint, pollution, and potential conflict with communities (Lulek, Sadowska, Walasek, & Brabec, 2024; Pan, Xu, & Zaidi, 2024; Sitompul *et al*., 2024). Companies that use renewable energy can also increase their reputation through compliance with environmental regulations and reduce financial risk by avoiding sanctions and penalty costs (Elarabi & Khalifa, 2025). Renewable energy is not just a tool for emission reduction but also a business strategy for companies to achieve business sustainability by reducing risks.

Renewable energy allows companies to reduce carbon emissions and environmental damage by quitting to use fossil-based energy since fossil-based energy brings more environmental

risk (Gentile & Gupta, 2025; Shahveran & Yousefi, 2025). Renewable energy also helps companies to fulfill the global standard of environmental responsibility, including the Paris Agreement and the SDGs. Renewable implementation is a symbol of companies' commitment to fulfill stakeholders' interests (Sulemana *et al.,* 2025). In this case, renewable energy promotes stakeholder trust and social legitimacy that can reduce social risk, including reputational risk. In the context of governance, renewable energy is a strategy to meet sustainability principles (Li, Wang, & Sun, 2025), including transparency of renewable energy reporting (Hoang, Przychodzen, Przychodzen, & Segbotangni, 2021). In this case, renewable energy implementation is a form of green-based governance to fulfill RUEN and avoid regulation violations.

Based on legitimacy theory, companies need legitimacy for business activities, while renewable energy implementation is a strategy to align companies' business with environmental and regulatory demands (Velte, 2023). Stakeholder theory explains that companies need to fulfill the stakeholders' interests to reduce risks (Mahajan *et al.,* 2023). By implementing renewable energy, companies meet the environmental and social responsibility demands of investors, governments, and the public. Renewable energy is a signal of regulation compliance and business sustainability that can increase stakeholder trust and reduce ESG risk. Based on risk management theory, renewable energy is part of strategic risk mitigation to reduce ESG risk.

Previous research finds that renewable energy helps companies to reduce environmental risk (Sompolska-Rzechuła, Bąk, Becker, Marjak, & Perzyńska, 2024) and increase positive perception from investors (Almaskati, 2023). Alyahya, Agag, Aliedan, & Abdelmoety (2023) and Li., Li., Tan, & Mahmood (2025) also find that renewable energy implementation can increase ESG performance, minimize financial risks, and mitigate regulatory pressures and market boycotts. Khalid, Sun, Guo, & Srivastava (2024) show that the renewable energy implementation can reduce reputational risk.

Ha: Renewable energy reduces ESG risk.

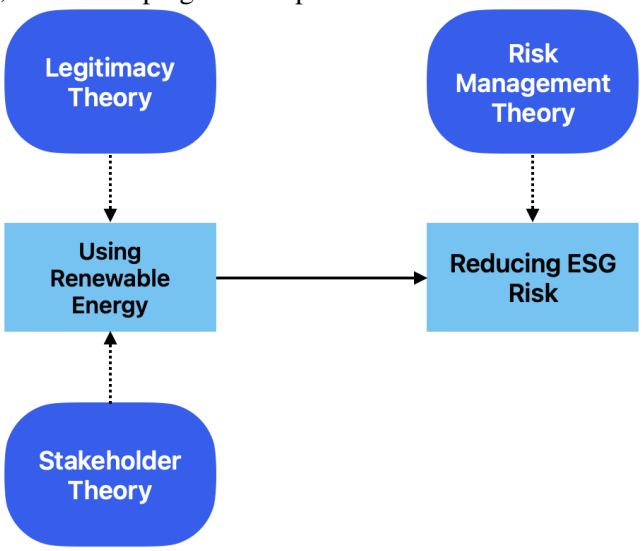
Theoretical Framework

Figure 2 explains how renewable energy can impact ESG risk in public companies in Indonesia. The underlying principle is that renewable energy serves as a strategic instrument that can help companies reduce their carbon footprint, improve stakeholder relationships, and enhance governance.

Based on legitimacy theory, companies seek to gain social and regulatory legitimacy by aligning their business practices with sustainability values. The use of green energy is an important way to maintain this legitimacy, thereby mitigating ESG risks. Stakeholder theory emphasizes that companies must consider the interests of all stakeholders. The adoption of renewable energy is a positive signal that a company is committed to stakeholder expectations, which in turn reduces reputational and social risks. Meanwhile, risk management theory positions renewable energy as part of a risk mitigation strategy, through which companies can mitigate regulatory threats, financial losses, and negative imagery resulting from environmental management failures.

This research makes some contributions to the existing literature. First, this research extends the ESG literature by putting renewable energy as an environmental strategy and a comprehensive risk mitigation mechanism that can solve risks of environmental, social, and governance aspects. Second, this research integrates three main theories, including legitimacy

theory, stakeholder theory, and risk management theory, to explain how renewable energy implementation affects ESG risk. Previous studies examine legitimacy theory, stakeholder theory, and risk management theory separately, while this research provides a more comprehensive framework. Third, this research is aware of companies' characteristics of energy intensity that determine the effectiveness of renewable energy in reducing ESG risk. Fourth, this research focuses on Indonesia as an emerging market. This research provides contextual insight into how renewable energy adoption is implemented in conditions where regulation is still in progress, high fossil energy reliance, and developing ESG implementation.



Source: Elaboration of Theory, Previous Research, and Research Context

Figure 2. Theoretical Framework

3. RESEARCH METHODS

Sample

This research uses purposive sampling as a sampling method. Purposive sampling refers to the sample selection that is based on relevant criteria. First, samples are companies that are listed on the IDX. Second, samples are also listed on the ESG Leader index. The ESG Leader index includes companies that have the highest ESG performance in each sector. In this case, the ESG Leader index provides a score of ESG risk. Third, companies are listed in 2021-2023 since the ESG Leader index was issued in 2021. The selection of 2023 as the final observation year is based on data availability and completeness. ESG risk data and renewable energy-related disclosures are not fully available for all firms beyond 2023 at the time of data collection. In addition, using data up to 2023 ensures consistency and comparability across firms, as ESG reporting standards and renewable energy disclosures in Indonesia are still evolving. Including incomplete or inconsistent data from subsequent periods may introduce bias and reduce the reliability of the analysis. Therefore, the study limits the observation period to 2023 to maintain data accuracy and robustness of the results. This research uses samples of 180, as in Table 1.

Table 1. Research Sample

Period of ESG Leader Assessment	Companies
Maret 2021	30
September 2021	30
Maret 2022	30
September 2022	30
Maret 2023	30
September 2023	30
Total Sample	180

Source: www.idx.co.id

Data Resource

This research uses secondary data that has been collected by other parties. Data, including renewable energy implementation and ESG risk score. Renewable energy implementation is accessed from the annual report and sustainability report that are provided by www.idx.co.id and the company's web page. The ESG risk score is accessed from the ESG Leader index assessment that is provided by www.idx.co.id and www.sustainalytics.com.

Research Variables

Research variables include the dependent variable, independent variable, and control variables. The dependent variable is ESG risk. ESG risk is measured by the ESG risk score, where the lower the ESG risk score, the lower the companies' risk that is covered by ESG activities (Rokhaniyah, Simamora, & Khotijah, 2025; Yudhanto & Simamora, 2023).

The independent variable is renewable energy implementation. The energy use by companies is regulated by SEOJK No. 16 /SEOJK.04/2021 about Annual Report Form and Content. In this case, companies can use energy resources from renewable sources. Renewable energy includes solar, water, wind, geothermal, and bio energy (Ang *et al*., 2022). This research measures renewable energy as a dummy variable where score 1 if companies use renewable energy resources and score 0 if otherwise (Doğan, Söylemez, Doğan, & Akça, 2025).

Control variables include independent commissioners and institutional ownership. In this case, control variables aim to control the corporate governance that can affect ESG risk (Abdelkader, Gao, & Elamer, 2024; Abdelkefi & Jarboui, 2026; Liu, Zhang, & He, 2025). Independent commissioners are members of the commissioner board that has no conflict of interest with owners and management. Independent commissioners represent public interests, including the implementation of ESG activities (Jafar, Basuki, Windijarto, Setiawan, & Yaacob, 2024). An independent commissioner is measured by the proportion of independent commissioners relative to the total members of the commissioner board (Jafar *et al*., 2024). Institutional ownership is a company's stock ownership by institutions. Institutional shareholders have more knowledge of business and can lead companies to have higher quality ESG (Sun & Zhao, 2024). Institutional ownership is measured by the ownership proportion held by institutions (Sun & Zhao, 2024).

Data Analysis

This research uses fixed-effect regression to test the hypothesis. Fixed-effect regression aims to control for different ESG and energy strategies in each company. This research also uses a preliminary test to ensure that the regression model is not biased. The regression model can be seen in equation 1.

$$ESG = a + b1\ Energy + b2\ Independent + b3\ Institution + e \quad \text{.....(1)}$$

ESG is ESG risk. Energy is the implementation of renewable energy. Independent is an independent commissioner. Institution is institutional ownership. The hypothesis is accepted if the coefficient of b1 is negative and significant.

4. DATA ANALYSIS AND DISCUSSIONS

Descriptive Statistics

Table 2. Descriptive Statistics

Category	Sample	Statistics	ESG Risk	Independent Commissioner	Institutional Ownership
Companies implement renewable energy	96	Minimum	11.310	0.333	0.000
		Maximum	29.000	0.750	0.891
		Mean	20.801	0.470	0.543
		Std. Deviation	4.948	0.109	0.200
Companies do not implement renewable energy	84	Minimum	14.080	0.300	0.000
		Maximum	29.710	0.833	0.927
		Mean	23.479	0.488	0.439
		Std. Deviation	4.230	0.143	0.335
Total	180	Minimum	11.310	0.300	0.000
		Maximum	29.710	0.833	0.927
		Mean	22.229	0.480	0.487
		Std. Deviation	4.759	0.128	0.284

Source: Processed Data (2026)

Table 2 provides descriptive statistics of ESG risk, the independent commissioner, and institutional ownership. There are 180 samples that consist of 96 companies that implement renewable energy and 84 companies that do not implement renewable energy.

ESG risk for companies that implement renewable energy has an average value of 20.801 with a deviation of 4.948. The range of ESG risk for companies that implement renewable energy is 11.310 – 29.000. ESG risk for companies that do not implement renewable energy has an average value of 23.479 with a deviation of 4.230. The range of ESG risk for companies that do not implement renewable energy is 14.080 – 29.710. ESG risk for all companies has an average value of 22.229 with a deviation of 4.759. In this case, ESG risk for companies that implement renewable energy is lower than for companies that do not implement renewable energy.

The independent commissioner for companies that implement renewable energy has an average value of 0.470 with a deviation of 0.109. The range of independent commissioners for companies that implement renewable energy is 0.333 – 0.750. The independent commissioner for companies that do not implement renewable energy has an average value of 0.488 with a deviation of 0.143. The range of independent commissioners for companies that do not implement renewable energy is 0.300 – 0.833. The independent commissioner for all companies has an average value of 0.480 with a deviation of 0.128.

Institutional ownership for companies that implement renewable energy has an average value of 0.543 with a deviation of 0.200. The range of institutional ownership for companies that

implement renewable energy is 0.000 – 0.891. Institutional ownership for companies that do not implement renewable energy has an average value of 0.493 with a deviation of 0.335. The range of Institutional ownership for companies that do not implement renewable energy is 0.000 – 0.927. Institutional ownership for all companies has an average value of 0.487 with a deviation of 0.284.

Preliminary Test

Table 3. Preliminary Test

Test	Result
Kolmogorov-Smirnov	Significance Value = 0.201
Glejser	Significance Value > 0.05
VIF	VIF <10
Run	Significance Value = 0.186

Source: Processed Data (2026)

Based on Table 3, the significance value of Kolmogorov-Smirnov is 0.201, which is bigger than 0.05, indicating that residuals have a normal distribution (Kittaneh & El-Kafrawy, 2026). Significance value of Glejser is more than 0.05, which shows that there is no heteroscedasticity problem (Ilori & Tanimowo, 2022). The Variance Inflation Factor (VIF) is less than 10, which indicates that there is no multicollinearity problem (Kermarrec, Lösler, Guerrier, & Schön, 2022). Significance value of the Run Test is 0.186, which is bigger than 0.05, which indicates that there is no autocorrelation problem (Kumar, 2023). The result of the preliminary test shows that the regression model in this research is not biased.

Comparison Analysis

Table 4. Comparison Analysis

Category	Mean of ESG Risk	t-Statistic	Significance
Companies implement renewable energy	20.801	3.914*	0.000
Companies do not implement renewable energy	23.479		
*Significant in 0.01			

Source: Processed Data (2026)

Table 4 shows the comparison analysis to compare the level of ESG risk between companies that implement and do not implement renewable energy. Companies that implement renewable energy have an ESG risk average value of 20.801, while companies that do not implement renewable energy have an ESG risk average value of 23.479. Value of t-statistic is 3.914 (significant in 0.01) with significance value of 0.000. The result shows that companies that do not implement renewable energy have higher ESG risk than companies that implement renewable energy. Adoption of renewable energy contributes to ESG performance.

Regression Analysis

Table 5 shows the regression analysis of renewable energy on ESG risk that is controlled by an independent commissioner and institutional ownership. Renewable energy has a coefficient value of -2.625 with a t-statistic of -3.780 (significant in 0.01) and a significance value of 0.000. The result shows that renewable energy has a negative effect on ESG risk. The research hypothesis is accepted where renewable energy reduces ESG risk.

Table 5. Regression Analysis

Variable	Coefficient	t-Statistic	Significance
Constant	23.448		
Renewable Energy	-2.625	-3.780*	0.000
Independent Commissioner	-4.228	-1.570	0.118
Institutional Ownership	-0.012	-0.986	0.325
Adjusted R-Squared		0.080	
F-Statistic		6.169*	
*Significant in 0.01			

Source: Processed Data (2026)

Robustness Test: Energy Intensity

Energy intensity refers to the level of energy consumption by companies to run their business activities (Li, Li, & Liao, 2022). Higher energy intensity shows that companies use more energy and lack energy efficiency (Chen, Alharthi, Zhang, & Khan, 2024). Since renewable energy promotes energy efficiency, renewable energy has a greater impact on companies that have higher energy consumption (Yu, Liu, Hu, & Tian, 2022). In Indonesia, companies that use energy intensively include those in the industrial, transportation, and household sectors (Center for Data and Information Technology on Energy Mineral Resources, 2023).

In this case, this research separates the analysis between the group of companies with higher energy intensity and the group of companies with lower energy intensity as a robustness test. This research argues that the benefit of renewable energy to reduce ESG risk occurs more in companies that use energy intensively. The result of the robustness test can be seen in Table 6.

Table 6. Robustness Test

Variable	Coeff.	t-Stat.	Sig.	Coeff.	t-Stat.	Sig.
		(1)			(2)	
Constant	23.738			24.320		
Renewable Energy	0.351	0.145	0.886	-2.912	-3.637*	0.000
Independent Commissioner	0.787	0.120	0.905	-6.422	-2.070**	0.040
Institutional Ownership	-0.014	-0.215	0.832	-0.014	-1.015	0.312
Adjusted R-Squared		0.003			0.097	
F-Statistic		0.025			6.341*	

*Significant in 0.01, **Significant in 0.05, (1) Group of companies with lower energy intensity (N=150), (2) Group of companies with higher energy intensity (N=30)

Source: Processed Data (2026)

Based on Table 6, the result in the group of companies with lower energy intensity shows that there are no independent variables significantly affecting ESG risk, especially renewable energy, which has a coefficient value of 0.351 with a t-statistic of 0.145 (insignificant) and a significance value of 0.886. The F-statistic is also insignificant. In this case, the model of companies with lower energy intensity fails to explain the level of ESG risk.

On the other hand, the group of companies with higher energy intensity has different results. Renewable energy has a coefficient value of -2.912 with a t-statistic of -3.637 (significant in 0.01) and a significance value of 0.000. The result shows that the effect of renewable energy on ESG risk only occurs in companies with higher energy intensity.

Discussion

This study examines the relationship between renewable energy and ESG risk. The results consistently show that renewable energy has a significant role in reducing ESG risk, particularly in firms with higher energy intensity. From the perspective of legitimacy theory, the findings indicate that companies adopt renewable energy to align with societal norms, environmental expectations, and regulatory requirements. This alignment helps firms maintain legitimacy and reduce ESG-related risks. From the stakeholder theory perspective, renewable energy serves as a signal that firms are committed to fulfilling stakeholder expectations, including those of investors, regulators, and the broader community. This reduces reputational risk and strengthens stakeholder trust. From the perspective of risk management theory, renewable energy functions as a strategic tool to mitigate environmental, regulatory, and financial risks. This is particularly relevant for firms with high energy consumption, where energy-related risks are more substantial.

Empirically, the findings from the comparison analysis and regression results consistently indicate that firms implementing renewable energy tend to have lower ESG risk compared to those that do not. This suggests that renewable energy is not only a sustainability initiative but also an effective risk mitigation mechanism. Furthermore, the heterogeneity analysis reveals that the effect of renewable energy is conditional on energy intensity. Renewable energy does not significantly affect ESG risk in firms with lower energy intensity, but it significantly reduces ESG risk in firms with higher energy intensity. This finding indicates that the effectiveness of renewable energy depends on the level of energy usage. Firms with higher energy intensity are more exposed to environmental risks, regulatory pressures, and energy cost volatility. Therefore, renewable energy adoption in these firms directly reduces their carbon footprint and lowers their ESG risk. In contrast, firms with lower energy intensity have relatively smaller environmental impacts, making the effect of renewable energy less pronounced.

In the context of Indonesia, this finding is particularly relevant, as many industries still rely heavily on fossil fuels. Energy-intensive sectors face greater pressure to comply with sustainability regulations, making renewable energy a more critical strategy for risk reduction. These findings provide important managerial implications. Managers, especially in energy-intensive firms, should consider investing in renewable energy not only for regulatory compliance but also as a strategic tool to reduce ESG risk and ensure long-term sustainability.

5. CONCLUSIONS, RECOMMENDATIONS, AND LIMITATIONS

This research concludes that the implementation of renewable energy plays a significant role in reducing ESG risks for companies listed on the Indonesia Stock Exchange. The analysis results show that companies using renewable energy have a lower ESG risk level compared to those that do not. The main regression proves that renewable energy has a significant negative impact on ESG risk; thus, the research hypothesis is accepted. Further robustness tests show that the impact of renewable energy on ESG risk is only significant for companies with high energy intensity, while it does not show meaningful results for companies with low energy intensity. This finding confirms the legitimacy theory, stakeholder theory, and risk management theory, which emphasize that clean energy is an instrument of social legitimacy, a signal of meeting stakeholder expectations, and a mechanism for mitigating sustainability risks.

The practical implication of this research is that companies, especially those in energy-intensive sectors, need to view investment in renewable energy not just as regulatory compliance but also as a business strategy that can reduce ESG risks while strengthening long-term competitiveness. For investors, the results of this study serve as a basis for considering that companies implementing renewable energy have lower ESG risks and are more sustainable. For regulators, these findings confirm the importance of strengthening energy transition policies, providing green incentives, and increasing ESG transparency to accelerate the shift toward a low-carbon economy.

Although it provides empirical contributions, this study has limitations. First, the renewable energy variable is measured using a dummy variable because of data limitations, so it is not yet able to capture the variation in the level of clean energy use in more detail. Second, the observation period is limited to 2021–2023, so it does not yet reflect the long-term impact of energy transition on ESG risk. Based on these limitations, future research is recommended to use more detailed measures regarding the proportion of renewable energy in the company's total energy consumption. The observation period also needs to be extended to capture the long-term impacts of the energy transition.

REFERENCES

Abdelkader, M. G., Gao, Y., & Elamer, A. A. (2024). Board Gender Diversity and ESG Performance: The Mediating Role of Temporal Orientation in South Africa Context. *Journal of Cleaner Production*, *440*, 140728. https://doi.org/10.1016/j.jclepro.2024.140728

Abdelkefi, S. N., & Jarboui, A. (2026). Does CEO Power Affect Operational Risk and ESG Disclosure in Islamic Banks? Evidence from the Banking Sector. *Management & Sustainability: An Arab Review*, *In Press*, 1–16. https://doi.org/10.1108/MSAR-04-2025-0124

Adisti, D., Novianti, T., & Suwarsinah, H. K. (2024). Environmental, Social, and Governance (ESG) Risk Management of PT XYZ Indonesia (ESG Disclosure Approach 2023). *Business Review and Case Studies*, *5*(3), 498. https://doi.org/10.17358/brcs.5.3.498

Ahmed, S., Ali, A., & D'Angola, A. (2024). A Review of Renewable Energy Communities: Concepts, Scope, Progress, Challenges, and Recommendations. *Sustainability*, *16*(5), 1749. https://doi.org/10.3390/su16051749

Aksana, T., Sayar, T., Elena, P., & Elena, S. (2025). Development of the Theory of Organizational Risk Management. *SHS Web of Conferences*, *212*, 04055. https://doi.org/10.1051/shsconf/202521204055

Almaskati, N. (2023). To Reward or Not to Reward? Investors' Response to Renewable Energy Investment by International Oil Companies. *Borsa Istanbul Review*, *23*(4), 845–851. https://doi.org/10.1016/j.bir.2023.02.004

Alsagr, N., Belkhaoui, S., & Ullah, S. (2025). How Do Financial Risk and Banking Globalization Affect Renewable Energy? A Nonlinear Analysis. *International Journal of Energy Economics and Policy*, *15*(5), 456–463. https://doi.org/10.32479/ijeep.20536

Alyahya, M., Agag, G., Aliedan, M., & Abdelmoety, Z. H. (2023). A Cross-Cultural Investigation of the Relationship between Eco-Innovation and Customers Boycott Behaviour. *Journal of Retailing and Consumer Services*, *72*, 103271. https://doi.org/10.1016/j.jretconser.2023.103271

Ang, T.-Z., Salem, M., Kamarol, M., Das, H. S., Nazari, M. A., & Prabaharan, N. (2022). A Comprehensive Study of Renewable Energy Sources: Classifications, Challenges and Suggestions. *Energy Strategy Reviews*, *43*, 100939. https://doi.org/10.1016/j.esr.2022.100939

Aransyah, M. F. (2023). How Effective is the Green Financing Framework for Renewable Energy? A Case Study of PT Pertamina Geothermal Energy in Indonesia. *International Journal of Energy Economics and Policy*, *13*(5), 165–170. https://doi.org/10.32479/ijeep.14729

Areneke, G., Adegbite, E., & Tunyi, A. (2022). Transfer of Corporate Governance Practices into Weak Emerging Market Environments by Foreign Institutional Investors. *International Business Review*, *31*(5), 101978. https://doi.org/10.1016/j.ibusrev.2022.101978

Arhinful, R., Mensah, L., Amin, H. I. M., Obeng, H. A., & Gyamfi, B. A. (2025). The Strategic Role of Sustainable Finance in Corporate Reputation: A Signaling Theory Perspective. *Sustainability*, *17*(11), 5002. https://doi.org/10.3390/su17115002

Aydoğmuş, M., Gülay, G., & Ergun, K. (2022). Impact of ESG Performance on Firm Value and Profitability. *Borsa Istanbul Review*, *22*, S119–S127. https://doi.org/10.1016/j.bir.2022.11.006

Badreddine, A., & Cherif, H, L. (2024). Public Health Improvement by Reducing Air Pollution: A Strategy for the Transition to Renewable Energy. *Health Economics and Management Review*, *5*(1), 1–14. https://doi.org/10.61093/hem.2024.1-01

Bagh, T., Fuwei, J., & Khan, M. A. (2024). From Risk to Resilience: Climate Change Risk, ESG Investments Engagement and Firm's Value. *Heliyon*, *10*(5), e26757. https://doi.org/10.1016/j.heliyon.2024.e26757

Bakhsh, S., Zhang, W., Ali, K., & Oláh, J. (2024). Strategy towards Sustainable Energy Transition: The Effect of Environmental Governance, Economic Complexity and Geopolitics. *Energy Strategy Reviews*, *52*, 101330. https://doi.org/10.1016/j.esr.2024.101330

Bo, X., You, Q., Sang, M., Wang, P., Chen, S., Xu, X., Shan, W., Yang, Y., Bessagnet, B., Li, H., & Xiao, Y. (2023). The Impacts of Clean Energy Policies on Air Pollutants and CO2 Emission Reduction in Shaanxi, China. *Atmospheric Pollution Research*, *14*(12), 101937. https://doi.org/10.1016/j.apr.2023.101937

Bolan, S., Padhye, L. P., Jasemizad, T., Govarthanan, M., Karmegam, N., Wijesekara, H., Amarasiri, D., Hou, D., Zhou, P., Biswal, B. K., Balasubramanian, R., Wang, H., Siddique, K. H. M., Rinklebe, J., Kirkham, M. B., & Bolan, N. (2024). Impacts of Climate Change on the Fate of Contaminants through Extreme Weather Events. *Science of The Total Environment*, *909*, 168388. https://doi.org/10.1016/j.scitotenv.2023.168388

Borbor, J. D., Cranenburgh, K. C. V, & Luca, C. W. F. (2021). Social Risk Management as a Response to Increasing International Pressure for Social Performance. *SPE Annual Technical Conference and Exhibition*. https://doi.org/10.2118/206240-MS

Burch, C., Loraamm, R., & Nsude, C. (2025). When Beyond Compliance is the Expectation: The Realities of Environmental Planning and Permitting for Renewable Energy Projects in the Great Plains of the United States. *Energy Research & Social Science*, *125*, 104108. https://doi.org/10.1016/j.erss.2025.104108

Cardillo, M. A. dos R., & Basso, L. F. C. (2025). Revisiting Knowledge on ESG/CSR and Financial Performance: A Bibliometric and Systematic Review of Moderating Variables. *Journal of Innovation & Knowledge*, *10*(1), 100648. https://doi.org/10.1016/j.jik.2024.100648

Chau, L., Anh, L., & Duc, V. (2025). Valuing ESG: How Financial Markets Respond to Corporate Sustainability. *International Business Review*, *34*(3), 102418. https://doi.org/10.1016/j.ibusrev.2025.102418

Chen, S., Song, Y., & Gao, P. (2023). Environmental, Social, and Governance (ESG) Performance and Financial Outcomes: Analyzing the Impact of ESG on Financial Performance. *Journal of Environmental Management*, *345*, 118829. https://doi.org/10.1016/j.jenvman.2023.118829

Chen, W., Alharthi, M., Zhang, J., & Khan, I. (2024). The Need for Energy Efficiency and Economic Prosperity in a Sustainable Environment. *Gondwana Research*, *127*, 22–35. https://doi.org/10.1016/j.gr.2023.03.025

Chen, W., Xie, Y., & He, K. (2024). Environmental, Social, and Governance Performance and Corporate Innovation Novelty. *International Journal of Innovation Studies*, *8*(2), 109–131. https://doi.org/10.1016/j.ijis.2024.01.003

Chen, Z., He, M., & Ali, M. (2025). Natural Resources and Geopolitical Risk Impact on Energy Security Risk: The Role of Renewable Energy Consumption and Foreign Direct Investment. *Natural Resources Forum*, *In Press*. https://doi.org/10.1111/1477-8947.70006

Chen, Z., Umar, M., Su, C.-W., & Mirza, N. (2023). Renewable Energy, Credit Portfolios and Intermediation Spread: Evidence from the Banking Sector in BRICS. *Renewable Energy*, *208*, 561–566. https://doi.org/10.1016/j.renene.2023.03.003

Cheng, H., Chaudhry, H. R., Kazi, I., & Umar, M. (2024). Unlocking Greener Supply Chains: A Global Innovative Perspective on the Role of Logistics Performance in Reducing Ecological Footprints. *Journal of Innovation & Knowledge*, *9*(4), 100612. https://doi.org/10.1016/j.jik.2024.100612

Cosma, S., Rimo, G., & Schwizer, P. (2025). Environmental Controversies, Environmental Fines and Firms' Default Risk. *Research in International Business and Finance*, *77*, 102910. https://doi.org/10.1016/j.ribaf.2025.102910

Delbecq, S., Fontane, J., Gourdain, N., Planès, T., & Simatos, F. (2023). Sustainable Aviation in the Context of the Paris Agreement: A Review of Prospective Scenarios and Their Technological Mitigation Levers. *Progress in Aerospace Sciences*, *141*, 100920. https://doi.org/10.1016/j.paerosci.2023.100920

Doğan, D., Söylemez, Y., Doğan, Ş., & Akça, N. (2025). The Impact of Financial Development on Renewable Energy Consumption: Evidence from RECAI Countries. *Sustainability*, *17*(14), 6381. https://doi.org/10.3390/su17146381

Downie, C., & Peterson, M. J. (2025). Public Financial Institutions in the Energy Transition: The Impact of Export Credit Agencies. *Climatic Change*, *178*(3), 40. https://doi.org/10.1007/s10584-025-03881-z

Elarabi, H. A. O., & Khalifa, W. (2025). Impact of Sustainable Finance on Business Financial Performance: Insight from London Stock Exchange Firms. *Sustainability*, *17*(11), 4898. https://doi.org/10.3390/su17114898

Febriyanti, A. H., Murtadho, S. Al, & Almattushyva, Y. (2023). Not So Ambitious? Indonesia's Coal Dependence Amidst the Era of Energy Transition. *Global South Review*, *5*(1), 47. https://doi.org/10.22146/globalsouth.81488

Gentile, G., & Gupta, J. (2025). Orchestrating the Narrative: The Role of Fossil Fuel Companies in Delaying the Energy Transition. *Renewable and Sustainable Energy Reviews*, *212*, 115359. https://doi.org/10.1016/j.rser.2025.115359

Hamm, J. A., Wolfe, S. E., Cavanagh, C., & Lee, S. (2022). (Re)Organizing Legitimacy Theory. *Legal and Criminological Psychology*, *27*(2), 129–146. https://doi.org/10.1111/lcrp.12199

Handoyo, S. (2024). Public Governance and National Environmental Performance Nexus: Evidence from Cross-Country Studies. *Heliyon*, *10*(23), e40637. https://doi.org/10.1016/j.heliyon.2024.e40637

Handoyo, S., & Anas, S. (2024). The Effect of Environmental, Social, and Governance (ESG) on Firm Performance: The Moderating Role of Country Regulatory Quality and Government Effectiveness in ASEAN. *Cogent Business & Management*, *11*(1), 2371071. https://doi.org/10.1080/23311975.2024.2371071

Hardi, I., Idroes, G. M., Hamaguchi, Y., Can, M., Noviandy, T. R., & Idroes, R. (2025). Business Confidence in the Shift to Renewable Energy: A Country-Specific Assessment in Major Asian Economies. *Journal of Economy and Technology*, *3*, 44–68. https://doi.org/10.1016/j.ject.2024.08.002

Hmouda, A. M. O., Orzes, G., & Sauer, P. C. (2024). Sustainable Supply Chain Management in Energy Production: A Literature Review. *Renewable and Sustainable Energy Reviews*, *191*, 114085. https://doi.org/10.1016/j.rser.2023.114085

Hoang, T. H. V, Przychodzen, W., Przychodzen, J., & Segbotangni, E. A. (2021). Environmental Transparency and Performance: Does the Corporate Governance Matter? *Environmental and Sustainability Indicators*, *10*, 100123. https://doi.org/10.1016/j.indic.2021.100123

Ilori, O. O., & Tanimowo, F. O. (2022). Heteroscedasticity Detection in Cross-Sectional Diabetes Pedigree Function: A Comparison of Breusch-Pagan-Godfrey, Harvey and Glejser Tests. *International Journal of Scientific and Management Research*, *05*(12), 150–163. https://doi.org/10.37502/IJSMR.2022.51211

Işık, C., Ongan, S., & Islam, H. (2024). A New Pathway to Sustainability: Integrating Economic Dimension (ECON) into ESG Factors as (ECON-ESG) and Aligned with Sustainable Development Goals (SDGs). *Journal of Ekonomi*, *6*(1), 34–39. https://doi.org/10.58251/ekonomi.1450860

Işık, C., Ongan, S., Islam, H., & Menegaki, A. N. (2024). A Roadmap for Sustainable Global Supply Chain Distribution: Exploring the Interplay of ECON-ESG Factors, Technological Advancement and SDGs on Natural Resources. *Resources Policy*, *95*, 105114. https://doi.org/10.1016/j.resourpol.2024.105114

Jafar, R., Basuki, B., Windijarto, W., Setiawan, R., & Yaacob, Z. (2024). Environmental, Social and Governance (ESG) Disclosure and Cost of Equity: The Moderating Effects of Board Structures. *Cogent Business & Management*, *11*(1), 2429794. https://doi.org/10.1080/23311975.2024.2429794

Jaiswal, K. K., Chowdhury, C. R., Yadav, D., Verma, R., Dutta, S., Jaiswal, K. S., SangmeshB, & Karuppasamy, K. S. K. (2022). Renewable and Sustainable Clean Energy Development and Impact on Social, Economic, and Environmental Health. *Energy Nexus*, *7*, 100118. https://doi.org/10.1016/j.nexus.2022.100118

Justice, G., Nyantakyi, G., & Isaac, S. H. (2024). The Effect of Renewable Energy on Carbon Emissions through Globalization. *Heliyon*, *10*(5), e26894. https://doi.org/10.1016/j.heliyon.2024.e26894

Kermarrec, G., Lösler, M., Guerrier, S., & Schön, S. (2022). The Variance Inflation Factor to Account for Correlations in Likelihood Ratio Tests: Deformation Analysis with Terrestrial Laser Scanners. *Journal of Geodesy*, *96*(11), 86. https://doi.org/10.1007/s00190-022-01654-5

Khalid, F., Sun, J., Guo, J., & Srivastava, M. (2024). Green Corporate Image: Assessing the Effects of Climate Change Management Practices on Corporate Reputation. *Corporate Social Responsibility and Environmental Management*, *31*(3), 1786–1801. https://doi.org/10.1002/csr.2663

Khatri, I., & Kjærland, F. (2023). Sustainability Reporting Practices and Environmental Performance Amongst Nordic Listed Firms. *Journal of Cleaner Production*, *418*, 138172. https://doi.org/10.1016/j.jclepro.2023.138172

Kittaneh, O., & El-Kafrawy, P. (2026). Quantitative Analytics Techniques. *Mathematical Modeling for Big Data Analytics* (75–89). https://doi.org/10.1016/B978-0-44-326735-2.00014-6

Kumar, N. K. (2023). Autocorrelation and Heteroscedasticity in Regression Analysis. *Journal of Business and Social Sciences*, *5*(1), 9–20. https://doi.org/10.3126/jbss.v5i1.72442

Li, D., Li, J., Tan, S., & Mahmood, T. (2025). Business, Finance, Energy Strategy, and Sustainability Integration: A Holistic Approach to Corporate Responsibility in the Green Era. *Energy Strategy Reviews*, *58*, 101656. https://doi.org/10.1016/j.esr.2025.101656

Li, R., Wang, Q., & lejia, L. (2023). Does Renewable Energy Reduce per Capita Carbon Emissions and per Capita Ecological Footprint? New Evidence from 130 Countries. *Energy Strategy Reviews*, *49*, 101121. https://doi.org/10.1016/j.esr.2023.101121

Li, R., Wang, Q., & Sun, J. (2025). Financial Risk and Renewable Energy: Exploring the Influence of Urbanization and Natural Resource Rents Across 112 Countries. *Humanities and Social Sciences Communications*, *12*(1), 170. https://doi.org/10.1057/s41599-025-04481-z

Li, T., Li, X., & Liao, G. (2022). Business Cycles and Energy Intensity. Evidence from Emerging Economies. *Borsa Istanbul Review*, *22*(3), 560–570. https://doi.org/10.1016/j.bir.2021.07.005

Liu, H., Zhang, X., & He, Y. (2025). Digital Transformation and ESG Performance—Empirical Evidence from Chinese Listed Companies. *Sustainability*, *17*(13), 6165. https://doi.org/10.3390/su17136165

Lu, J., Chen, H., & Cai, X. (2022). From Global to National Scenarios: Exploring Carbon Emissions to 2050. *Energy Strategy Reviews*, *41*, 100860. https://doi.org/10.1016/j.esr.2022.100860

Lulek, A., Sadowska, B., Walasek, R., & Brabec, Z. (2024). The Impact of Energy Companies on the Environment and Local Communities - Disclosures in Non-Financial Reports of Companies. *Economics and Environment*, *89*(2), 786. https://doi.org/10.34659/eis.2024.89.2.786

Ma, B., & Wang, A. (2025). Exploring the Role of Renewable Energy in Green Job Creation and Sustainable Economic Development: An Empirical Approach. *Energy Strategy Reviews*, *58*, 101642. https://doi.org/10.1016/j.esr.2025.101642

Mahajan, R., Lim, W. M., Sareen, M., Kumar, S., & Panwar, R. (2023). Stakeholder Theory. *Journal of Business Research*, *166*, 114104. https://doi.org/10.1016/j.jbusres.2023.114104

Massagony, A., Pandit, R., & White, B. (2025). Political Economy of Energy Policy in Indonesia Towards Net Zero Emissions by 2060. *Energy for Sustainable Development*, *88*, 101757. https://doi.org/10.1016/j.esd.2025.101757

Murtaza, G., & Luqman, M. (2025). Environmental Banking, Renewable Energy Projects, and Private Investments Crowd Out. In H. Dinçer, & S. Yüksel (Eds.), *Renewable Energy Projects and Investments: Interdisciplinary Knowledge, Analysis, Opportunities, and Outlook* (1 ed., pp. 177-200). Elsevier. https://doi.org/10.1016/B978-0-443-29869-1.00010-6

Muzayanah, I. F. U., Lean, H. H., Hartono, D., Indraswari, K. D., & Partama, R. (2022). Population Density and Energy Consumption: A Study in Indonesian Provinces. *Heliyon*, *8*(9), e10634. https://doi.org/10.1016/j.heliyon.2022.e10634

Naseer, M. M., Guo, Y., & Zhu, X. (2025). Short-Term Costs and Long-Term Gains of ESG Initiatives in High-Risk Environments: Evidence from UK Firms. *Development and Sustainability in Economics and Finance*, *7*, 100075. https://doi.org/10.1016/j.dsef.2025.100075

Nocoń, A. (2024). ESG Risk Management in Banks – towards its Measurement. *Economics and Environment*, *90*(3), 737. https://doi.org/10.34659/eis.2024.90.3.737

Pan, A., Xu, S., & Zaidi, S. A. H. (2024). Environmental Impact of Energy Imports: Natural Resources Income and Natural Gas Production Profitability in the Asia-Pacific Economic Cooperation Countries. *Geoscience Frontiers*, *15*(2), 101756. https://doi.org/10.1016/j.gsf.2023.101756

Park, Y.-N., Hahn, S. H., Lee, C.-K., Kim, J., & Back, K.-J. (2024). Developing an Integrated Resort's (IR) Environmental, Social, and Corporate Governance (ESG) Measurement Scale. *International Journal of Hospitality Management*, *123*, 103924. https://doi.org/10.1016/j.ijhm.2024.103924

Pomè, A. P., & Ciaramella, G. (2025). ESG Measurement Tool: An Approach to Measure the Sustainability Introduced in Real Estate Requalification Projects. In *Getting to Zero - Beyond Energy Transition Towards Carbon-Neutral Mediterranean Cities* (pp. 953–968). Springer Nature. https://doi.org/10.1007/978-3-031-82323-7_75

Purnamasari, E. D., Lazuarni, S., & Maleha, N. Y. (2024). Impact of Green Finance on Market Value and Reputation of Financial Service Companies. *Jurnal Ilmiah Ekonomi Global Masa Kini*, *15*(2), 149–153. https://doi.org/10.36982/jiegmk.v15i2.4840

Qadir, S. A., Al-Motairi, H., Tahir, F., & Al-Fagih, L. (2021). Incentives and Strategies for Financing the Renewable Energy Transition: A Review. *Energy Reports*, *7*, 3590–3606. https://doi.org/10.1016/j.egyr.2021.06.041

Qamruzzaman, M., & Karim, S. (2023). Clarifying the Relationship between Green Investment, Technological Innovation, Financial Openness, and Renewable Energy Consumption in MINT. *Heliyon*, *9*(11), e21083. https://doi.org/10.1016/j.heliyon.2023.e21083

Rahman, T., Lipu, M. S. H., Shovon, M. M. A., Alsaduni, I., Karim, T. F., & Ansari, S. (2025). Unveiling the Impacts of Climate Change on the Resilience of Renewable Energy and Power Systems: Factors, Technological Advancements, Policies, Challenges, and Solutions. *Journal of Cleaner Production*, *493*, 144933. https://doi.org/10.1016/j.jclepro.2025.144933

Rokhaniyah, S., Simamora, A. J., & Khotijah, S. A. (2025). Corporate Governance of Board Independence towards ESG Risk. *Quality - Access To Success*, *In press*(208), 362–365. https://doi.org/10.47750/QAS/26.208.37

Ruan, L., Yang, L., & Dong, K. (2024). Corporate Green Innovation: The Influence of ESG Information Disclosure. *Journal of Innovation & Knowledge*, *9*(4), 100628. https://doi.org/10.1016/j.jik.2024.100628

Runtuk, J. K., Ng, P. K., & Ooi, S. Y. (2024). Challenges and Solutions in Working with Green Suppliers: Perspective from a Manufacturing Industry. *Sustainability*, *16*(20), 8744. https://doi.org/10.3390/su16208744

Shahveran, E., & Yousefi, H. (2025). Replacing Fossil Fuel-Based Power Plants with Renewables to Meet Iran's Environmental Commitments in the Electricity Sector. *Renewable and Sustainable Energy Transition*, *7*, 100102. https://doi.org/10.1016/j.rset.2024.100102

Simamora, A. J. (2025). Environmental, Social, and Governance (ESG) Risk towards Stock Market Reaction in Indonesia. *The International Journal of Financial Systems*, *3*(1), 1–20. https://doi.org/10.61459/ijfs.v3i1.45

Sitompul, H., Saifi, M., Hutahayan, B., & Sunarti. (2024). Use of Renewable Energy to Enhance Firm Performance: A Systematic Review. *Sustainability*, *16*(21), 9157. https://doi.org/10.3390/su16219157

Sompolska-Rzechuła, A., Bąk, I., Becker, A., Marjak, H., & Perzyńska, J. (2024). The Use of Renewable Energy Sources and Environmental Degradation in EU Countries. *Sustainability*, *16*(23), 10416. https://doi.org/10.3390/su162310416

Sulemana, I., Cheng, L., Agyemang, A. O., Osei, A., & Nagriwum, T. M. (2025). Stakeholders and Sustainability Disclosure: Evidence from an Emerging Market. *Sustainable Futures*, *9*, 100445. https://doi.org/10.1016/j.sftr.2025.100445

Sun, Y., & Zhao, Z. (2024). Responsible Investment: Institutional Shareholders and ESG Performance. *Pacific-Basin Finance Journal*, *85*, 102357. https://doi.org/10.1016/j.pacfin.2024.102357

Sunio, V., Mendejar, J., & Nery, J. R. (2021). Does the Greening of Banks Impact the Logics of Sustainable Financing? The Case of Bank Lending to Merchant Renewable Energy Projects in the Philippines. *Global Transitions*, *3*, 109–118. https://doi.org/10.1016/j.glt.2021.12.001

Tiwari, A. K., Abakah, E. J. A., Shao, X., Le, T.-L., & Gyamfi, M. N. (2023). Financial Technology Stocks, Green Financial Assets, and Energy Markets: A Quantile Causality and Dependence Analysis. *Energy Economics*, *118*, 106498. https://doi.org/10.1016/j.eneco.2022.106498

Tran, V. T., Phan, D. H. B., Tee, C.-M., & Nguyen, D. T. (2024). Unmasking the Carbon Conundrum: How Emissions Impact Stock Price Crash Risk. *Finance Research Letters*, *64*, 105443. https://doi.org/10.1016/j.frl.2024.105443

Urbizu, L. G., Ortas, E., & Etxeberria, I. A. (2025). ESG Risk Exposure, Management and Firm Risk: New Evidence from a Panel Quantile Regression Approach. *Cogent Business & Management*, *12*(1), 2585542. https://doi.org/10.1080/23311975.2025.2585542

Velte, P. (2023). Determinants and Financial Consequences of Environmental Performance and Reporting: A Literature Review of European Archival Research. *Journal of Environmental Management*, *340*, 117916. https://doi.org/10.1016/j.jenvman.2023.117916

Voulvoulis, N., Giakoumis, T., Hunt, C., Kioupi, V., Petrou, N., Souliotis, I., Vaghela, C., & binti Wan Rosely, WIH. (2022). Systems Thinking as a Paradigm Shift for Sustainability Transformation. *Global Environmental Change*, *75*, 102544. https://doi.org/10.1016/j.gloenvcha.2022.102544

Voumik, L. C., Ridwan, M., Rahman, Md. H, & Raihan, A. (2023). An Investigation into the Primary Causes of Carbon Dioxide Releases in Kenya: Does Renewable Energy Matter to Reduce Carbon Emission? *Renewable Energy Focus*, *47*, 100491. https://doi.org/10.1016/j.ref.2023.100491

Wang, Q., Zhang, S., & Li, R. (2024). Impact of Risk Factors on the Link between Natural Resources Rents and Carbon Emissions: Evidence from Economic, Financial, and Political Risks. *Humanities and Social Sciences Communications*, *11*(1), 1002. https://doi.org/10.1057/s41599-024-03414-6

Wen, B., He, Y., Jing, X., & Haroon, M. (2025). Advancing Renewable Energy and Green Finance for Economic Growth and Ecological Resilience. *Energy Strategy Reviews*, *59*, 101747. https://doi.org/10.1016/j.esr.2025.101747

Yadav, A., & Mahalik, M. K. (2024). Does Renewable Energy Development Reduce Energy Import Dependency in Emerging Economies? Evidence from CS-ARDL and Panel Causality Approach. *Energy Economics*, *131*, 107356. https://doi.org/10.1016/j.eneco.2024.107356

Yu, S., Liu, J., Hu, X., & Tian, P. (2022). Does Development of Renewable Energy Reduce Energy Intensity? Evidence from 82 Countries. *Technological Forecasting and Social Change*, *174*, 121254. https://doi.org/10.1016/j.techfore.2021.121254

Yudhanto, W., & Simamora, A. J. (2023). Environmental, Social, and Governance Risk on Firm Performance: The Mediating Role of Firm Risk. *Binus Business Review*, *14*(2), 223–234. https://doi.org/10.21512/bbr.v14i2.8935

Zhang, D., & Kong, Q. (2022). Green Energy Transition and Sustainable Development of Energy Firms: An Assessment of Renewable Energy Policy. *Energy Economics*, *111*, 106060. https://doi.org/10.1016/j.eneco.2022.106060

Zhang, J. (2024). Energy Access Challenge and the Role of Fossil Fuels in Meeting Electricity Demand: Promoting Renewable Energy Capacity for Sustainable Development. *Geoscience Frontiers*, *15*(5), 101873. https://doi.org/10.1016/j.gsf.2024.101873

Zhang, Y. (2024). Circular Economy Innovations: Balancing Fossil Fuel Impact on Green Economic Development. *Heliyon*, *10*(18), e36708. https://doi.org/10.1016/j.heliyon.2024.e36708

ADDITIONAL REFERENCES

Center for Data and Information Technology on Energy Mineral Resources. (2023). *Handbook of Energy & Economy Statistics of Indonesia*. Ministry of Energy and Mineral Resource. https://www.esdm.go.id/assets/media/content/content-handbook-of-energy-and-economic-statistics-of-indonesia-2023.pdf

Institute for Essential Services Reform. (2025). *Indonesia Energy Transition Outlook 2025, Navigating Indonesia's Energy Transition at the Crossroads: A Pivotal Moment for Redefining the Future*. Institute for Essential Services Reform. https://iesr.or.id/wp-content/uploads/2024/12/Indonesia-Energy-Transition-Outlook-2025-Digital-Version.pdf

Institute for Essential Services Reform, Lappeenranta University of Technology, & Agora Energiewende. (2021). *Deep Decarbonization of Indonesia's Energy System: A Pathway to Zero Emissions by 2050*. Institute for Essential Services Reform. https://iesr.or.id/wp-content/uploads/2022/06/IESR-Deep-Decarbonization-Updated-V7.pdf

International Energy Agency. (2023). *An Energy Sector Roadmap to Net Zero Emissions in Indonesia*. International Energi Agency. https://www.iea.org/reports/an-energy-sector-roadmap-to-net-zero-emissions-in-indonesia