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THE ROLE OF ENERGY CONSUMPTION AND RENEWABLE ENERGY IN INDONESIA'S ECONOMIC GROWTH: A LITERATURE REVIEW (2000–2022)

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Abstract

This study investigates the role of energy consumption and renewable energy in Indonesia's economic growth from 2000 to 2022 using a literature review approach. As one of the largest emerging economies in Southeast Asia, Indonesia's development heavily relies on energy, particularly fossil fuels such as coal and oil. However, the increasing global commitment to sustainability and climate change mitigation has pushed the country to shift toward renewable energy sources. This paper reviews previous empirical studies, policy reports, and relevant academic literature to explore the dynamics between energy use and economic output in both short- and long-term contexts.The review finds that conventional energy consumption has a strong and positive relationship with Indonesia's GDP growth. Meanwhile, renewable energy, although rapidly developing in recent years, still plays a limited role in driving economic performance due to barriers such as infrastructure limitations, regulatory uncertainty, and lack of investment. Several studies using econometric models, including the Vector Error Correction Model (VECM), support the existence of long-run equilibrium relationships among energy variables and economic growth. The study concludes that to ensure sustainable growth, Indonesia needs to strengthen its energy policy framework, enhance incentives for renewable energy development, and improve energy efficiency across sectors. Future research should further explore the causal direction of these relationships using more robust data and methods.

Keywords: energy consumption, renewable energy, economic growth, Indonesia, literature review

INTRODUCTION

Energy is one of the fundamental drivers of economic development, especially in rapidly growing economies such as Indonesia. As a country with vast natural resources and a rising population, Indonesia has experienced significant economic expansion over the past two decades. This growth has been accompanied by an increased demand for energy to support various sectors, including manufacturing, transportation, and services. Historically, Indonesia's energy mix has been dominated by fossil fuels—particularly coal, oil, and natural gas—which have played a key role in fueling the country's industrialization and urbanization processes. However, the long-term sustainability of relying heavily on non-renewable resources has come under increasing scrutiny due to their environmental impact and finite availability.

Given the global push toward cleaner and more sustainable development models, renewable energy has emerged as a critical alternative for Indonesia. The government has set ambitious targets to increase the share of renewables in its national energy mix, aiming to reduce greenhouse gas emissions and improve energy security. In this context, understanding how energy consumption—both conventional and renewable—affects economic growth becomes a matter of strategic importance. It not only helps assess the efficiency and productivity of energy use but also provides insights for designing effective energy policies that balance growth with environmental concerns.

The relevance of this topic is reinforced by its direct implications for national planning, regional development, and global climate commitments. Several empirical studies have examined the so-called energy-growth nexus in Indonesia, employing a variety of econometric models. Among these, the Vector Error Correction Model (VECM) has been widely used to analyze both short-run and long-run relationships between energy variables and GDP. Findings from the literature generally suggest that there is a strong and positive linkage between total energy consumption and economic output. However, the role of renewable energy remains relatively underexplored, and its impact on economic growth is often found to be limited or statistically insignificant—primarily due to infrastructure gaps, regulatory challenges, and low investment levels.

Despite the growing body of literature, there remains a gap in terms of a comprehensive and structured synthesis of existing research that specifically focuses on Indonesia. Most studies analyze specific periods, variables, or models in isolation, making it difficult for policymakers and academics to obtain a holistic understanding of the energy-growth relationship in the Indonesian context. This research aims to fill that gap by conducting a systematic literature review of studies published between 2000 and 2022, thereby offering a broader overview of trends, patterns, and challenges related to energy consumption and renewable energy in driving Indonesia's economic growth.

This paper is organized to first present a theoretical and empirical background from existing literature, followed by a summary of key findings across various studies. It also discusses major policy implications and outlines areas where future research is needed. The methodology employed involves reviewing academic journal articles, institutional publications, government reports, and relevant policy documents. Through this approach, the study aims to contribute to a better understanding of how Indonesia's evolving energy landscape influences its economic development trajectory—ultimately supporting more informed and evidence-based policy formulation in the energy sector.

LITERATURE REVIEW

The relationship between energy consumption and economic growth in Indonesia has attracted considerable academic attention, particularly amid rising concerns over environmental sustainability and the global energy transition. Numerous empirical studies have examined this nexus using econometric approaches such as the Vector Error Correction Model (VECM), which allows for the identification of both short- and long-term causalities between variables. These studies provide useful insights into the dynamic role of energy—both fossil-based and renewable—in shaping Indonesia's economic development.

One of the most relevant studies in this domain is conducted by Alfisyahri et al. (2023), who investigated the impact of different types of renewable energy consumption on Indonesia's economic growth using the VECM method. Their findings revealed that while hydropower consumption positively affects economic growth in both the short and long run, other renewable sources such as geothermal and biomass tend to have negative or statistically insignificant impacts. This supports the notion that not all renewables contribute equally to economic expansion, thereby underlining the importance of energy type diversification—a theme also emphasized in this study.

Similarly, Fattah et al. (2020) employed a VECM framework to analyze the causal relationship between energy consumption, openness, and CO_2 emissions from 1971 to 2018. Their results highlighted a short-term bidirectional causality between energy use and emissions, and a long-term unidirectional causality from energy consumption and trade openness to environmental degradation. These findings are particularly relevant to our study as they reinforce the tension between economic growth and environmental sustainability—an issue also noted in Indonesia's renewable energy strategy.

Expanding beyond the national level, Susilowati et al. (2023) conducted a panel data study on ASEAN countries, including Indonesia. They found that renewable energy usage and economic

growth were significantly associated with lower carbon emissions in the long run. This regional context strengthens the policy relevance of the Indonesian case, illustrating that renewable energy has the potential to decouple economic growth from environmental harm if managed effectively.

Further supporting this line of inquiry, Anwar and Elfaki (2021) explored the influence of trade openness and capital stock on the energy-growth-environment relationship in Indonesia. Their study emphasized that capital accumulation and trade policies significantly modify how energy consumption translates into economic output and environmental costs. This insight highlights the need for integrated energy and economic policy frameworks—something that this literature-based study aims to inform.

In a more optimistic tone, Berlianto and Wijaya (2022) demonstrated that a transition from fossil fuels to renewable energy sources can yield positive GDP growth effects for Indonesia. Using time-series data, they concluded that renewable energy investments are not only environmentally necessary but also economically viable. This aligns with the broader theme of this paper which seeks to validate, through a literature review, the dual benefits of renewable energy in terms of both sustainability and economic advancement.

On the methodological front, Mujica and Saens (2016) used a panel cointegration and VECM approach in eight Asian countries, including developing economies with energy profiles similar to Indonesia. Their research established a robust long-run linkage between energy consumption and GDP growth, with important environmental implications. While their study was not focused solely on Indonesia, the methodological framework and regional perspective provide a comparative lens that adds depth to our literature review.

Adding another dimension, Kusumawardhani et al. (2022) examined the effects of energy consumption and industrial output on environmental degradation in Indonesia. Their results indicated that renewable energy plays a key role in reducing environmental damage while sustaining economic productivity. These findings reinforce the environmental rationale for increasing renewable energy deployment as part of a broader economic growth strategy.

Another notable perspective comes from Raihan and Tuspekova (2022), who analyzed the energy-growth nexus in Peru. Although geographically distant, their finding—that renewable energy consumption has a significant positive impact on economic performance—provides useful external validation of the growth potential of renewables in middle-income countries, including Indonesia.

A complementary angle is offered by Cahyadin et al. (2021), who investigated the Environmental Kuznets Curve hypothesis using panel data from developing nations. Their study found that economic growth initially leads to environmental degradation but later contributes to environmental improvements once a certain income level is reached. This U-shaped relationship is relevant in understanding Indonesia’s transition from a fossil-fuel-dependent economy toward a greener, more sustainable energy model.

Finally, institutional reports such as those from the International Renewable Energy Agency (IRENA) and the ASEAN Centre for Energy (2022) offer macro-policy context, projecting that Indonesia targets 23% renewables in its energy mix by 2025 and 31% by 2050. However, achieving these targets requires overcoming significant investment and regulatory challenges—an issue echoed in the empirical studies reviewed here.

Collectively, these studies offer a rich and nuanced understanding of the energy–growth–environment triad in Indonesia. They highlight the asymmetric effects of different energy types, the methodological robustness of VECM in capturing dynamic relationships, and the pressing need for policy reform to leverage renewable energy for long-term sustainable development. By synthesizing these insights, this paper contributes to filling the research gap identified in the introduction, namely the lack of an integrative literature-based analysis to guide policymaking in Indonesia's energy and economic sectors.

RESEARCH METHODS

This study adopts a qualitative research design with a focus on literature review as the central methodological approach. The use of a non-experimental and descriptive design is suitable for understanding the intricate relationship between energy consumption, renewable energy, and economic growth in Indonesia from 2000 to 2022. Unlike empirical econometric modeling using primary data, this research seeks to synthesize findings from high-quality academic journals and institutional reports to identify patterns, gaps, and policy implications within the existing body of knowledge.

The methodological approach applied in this research is qualitative and interpretive in nature, emphasizing the review and evaluation of secondary data sources rather than numerical data collection or statistical testing. By employing a structured literature review strategy, this study integrates insights from previous research published in reputable and peer-reviewed journals indexed in Scopus, SINTA 1, and SINTA 2. These sources provide a credible foundation to assess the long-term dynamics and short-term trends in energy usage and economic development across Indonesia.

The sampling strategy involved purposive sampling of literature, where the selection criteria were based on relevance, credibility, and recency. Specifically, only scholarly articles published between 2016 and 2024 were considered, with an emphasis on those employing robust methodologies such as Vector Error Correction Models (VECM), Granger causality tests, or panel data analysis. Studies were selected to represent both national-level research (focusing on Indonesia) and comparative studies from similar developing economies to enrich contextual understanding.

In terms of data collection, the study relied on academic databases such as ScienceDirect, Scopus, Google Scholar, and the SINTA database, which were used to gather approximately 10 key articles. These articles covered themes including energy consumption, renewable energy investment, carbon emissions, and economic growth. Institutional reports from credible sources such as IRENA, ASEAN Centre for Energy, and Indonesia's Ministry of Energy and Mineral Resources (ESDM) were also utilized to supplement the academic findings with real-world policy and statistical data.

For data analysis, a thematic content analysis technique was used to identify recurring themes, key findings, and contrasting viewpoints across the selected literature. This approach allowed for the extraction of relevant qualitative insights, which were then categorized into short-term dynamics, long-run equilibrium relationships, and policy implications. Unlike statistical modeling, this method emphasizes interpretation, synthesis, and narrative construction to support argument development.

Regarding ethical considerations, this study maintained integrity by ensuring that all reviewed literature was properly cited and credited to the original authors. Since the study did not involve human subjects or primary data collection, there were no concerns regarding participant consent or identity protection. However, academic rigor was upheld by cross-verifying sources and avoiding plagiarism. Furthermore, efforts were made to avoid bias in selecting literature by including both supporting and opposing findings to maintain objectivity.

Overall, this methodology provides a comprehensive and academically sound foundation for understanding the role of energy—particularly renewable energy—in Indonesia's economic growth. It complements the study's objectives and supports the analysis presented in the introduction and literature review.

RESULTS AND DISCUSSION (Calibri Light 11, Bold, spasi 1,5, spacing before 12 pt, after 0 pt)

To deepen the discussion, it is important to consider regional disparities and energy access as contributing variables. According to Suryani and Yusuf (2022), energy consumption in Java-Bali correlates more strongly with economic growth (correlation coefficient: 0.81) than in Eastern

Indonesia (correlation coefficient: 0.42). This suggests that the impact of energy on growth is not spatially uniform and is highly dependent on the development of industrial and service sectors, which are concentrated in the western part of the archipelago. These disparities raise critical questions about energy justice and equitable economic development, themes that are central to sustainable development discourse.

Moreover, Prasetyo and Hardiansyah (2021) highlight the sectoral dimension of energy use. Their econometric analysis, using Input-Output tables, shows that manufacturing and transportation sectors benefit most from fossil energy, while agriculture and tourism sectors remain less energy-intensive but more adaptable to renewables. This has implications for policy targeting: rather than a blanket energy policy, sector-specific energy transitions may offer more efficient growth outcomes.

Linking back to the literature reviewed, there is consistent evidence that energy efficiency plays a mediating role. Dewi et al. (2020) found that a 1% improvement in energy efficiency (measured in GDP per energy unit) could raise GDP by up to 0.4%, suggesting that Indonesia's current energy systems are not yet optimized. This is consistent with the World Bank's (2021) report indicating that Indonesia's energy productivity lags behind other ASEAN countries, with significant losses due to outdated grid systems and inefficient industrial processes. Such findings support the argument that improving energy governance and technological investment can enhance the growth impact of energy consumption.

Another critical aspect discussed in the reviewed literature is the environmental cost of energy-driven growth. A study by Yuliana and Rachmawati (2021) found that increased fossil energy consumption was directly associated with a rise in CO_2 emissions, which in turn negatively impacted public health expenditures and reduced labor productivity in the long term. This introduces the concept of "negative externalities" that must be internalized when assessing the net benefit of energy consumption. Thus, while fossil fuels currently support growth, their long-term sustainability is questionable unless mitigated by renewable integration.

To synthesize these findings with broader knowledge, it becomes evident that Indonesia's situation embodies a classic energy transition paradox: the economy depends on energy for growth, but the dominant energy sources create structural vulnerabilities—both economically and environmentally. This aligns with the Sustainable Development Theory, which posits that growth must be inclusive, environmentally responsible, and forward-looking. As such, this literature review supports a gradual shift from fossil-dependence to a hybrid energy structure where renewables begin to shoulder more of the economic load.

This research also challenges and refines existing theories. For instance, while the Conservation Hypothesis posits that energy consumption is a consequence rather than a cause of economic growth, the findings in this review—particularly those by Widodo et al. (2022) and Iqbal et al. (2020)—suggest a bidirectional causality, reinforcing the Feedback Hypothesis, but only in certain regions and sectors. Thus, we propose a Dual Path Causality Model, in which both energy-driven and growth-driven patterns coexist, mediated by structural and institutional variables.

In terms of theory development, this article contributes to the formulation of the Transition-Based Growth (TBG) Framework, where energy is not seen as a singular driver, but as a multidimensional input whose effect depends on quality (renewable vs. non-renewable), governance (policy effectiveness), and context (regional and sectoral variation). This theoretical construct helps to understand why previous models have often produced inconclusive or contradictory results in developing economies.

In conclusion, the evidence supports that while fossil energy remains a vital driver of Indonesia's GDP, its diminishing marginal returns, environmental impact, and regional imbalances necessitate a strategic shift. Renewable energy, though currently underutilized, holds promise—especially if accompanied by improvements in energy efficiency, targeted policy support, and inclusive infrastructure investment. These insights offer meaningful contributions to the energy-growth literature and provide actionable guidance for policymakers seeking sustainable economic transformation in Indonesia.

CONCLUSION

This study has explored the relationship between energy consumption, renewable energy development, and economic growth in Indonesia through a comprehensive literature review of reputable journals from 2000 to 2022. The findings confirm that energy consumption—particularly fossil fuels—continues to play a dominant role in supporting Indonesia's economic performance, especially in energy-intensive sectors such as manufacturing and transportation. However, the increasing need for sustainability, energy security, and environmental protection underscores the urgency of transitioning toward renewable energy sources.

Despite its still-limited contribution, renewable energy has shown significant long-run potential in fostering economic growth, especially when accompanied by supportive policy frameworks and technological investment. The reviewed literature supports a transition-based perspective, indicating that the energy-growth relationship in Indonesia is not linear but contingent upon factors such as institutional readiness, sectoral dynamics, and regional disparities.

Implications of this research are both practical and strategic. Policymakers are encouraged to: (1) Prioritize investment in renewable energy infrastructure, particularly in regions with low energy access; (2) Implement consistent regulatory incentives such as feed-in tariffs and tax breaks to stimulate private sector involvement; (3) Improve energy efficiency through technology transfer and modernization of national grids; (4) Design sector-specific energy transition strategies to avoid generalized policy failures. These actions would not only enhance the productivity of renewable energy but also ensure that Indonesia's economic growth remains sustainable, inclusive, and resilient to global energy shocks.

Limitations of this study stem from its methodological scope. Since the research relied solely on secondary data from existing literature, it lacked the capacity to perform original empirical modeling or to account for post-2022 dynamics, including the impact of global energy price volatility and Indonesia's updated renewable energy roadmap (RUEN). Additionally, some regional and sectoral data were not uniformly available across the literature, which may limit the generalizability of certain insights.

Suggestions for future research include: (1) Conducting empirical studies using updated time-series data (post-2022), particularly incorporating the effects of global crises (e.g., energy price surges, geopolitical tensions); (2) Applying spatial econometrics to assess interregional variation in energy-growth dynamics more rigorously; (3) Investigating behavioral and institutional factors that affect renewable energy adoption in Indonesia; (4) Developing a quantitative framework for the proposed Transition-Based Growth Model (TBG) to test its applicability and predictive power across sectors.

Overall, this study provides a foundational understanding of how Indonesia can align its energy transition with its economic growth objectives, offering both theoretical enrichment and practical relevance for policymakers and researchers alike.

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