

Integration of Education and Social Acceptance in Encouraging the Adoption of Green Energy Technologies in Indonesia

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ABSTRACT

The transition to green energy is a strategic agenda for Indonesia in responding to climate change and high dependence on fossil fuels. Although Indonesia has significant renewable energy potential, its utilization rate remains relatively low. This situation indicates that the challenges of the green energy transition are not only technical and economic, but also influenced by social factors, particularly education, social acceptance, and technology adoption. This study aims to analyze the relationship between education level, social acceptance, and the adoption of green energy technology in Indonesia. The study focuses on the role of education in shaping energy literacy and awareness, the dynamics of social acceptance of renewable energy technology, and the factors that hinder and encourage the adoption of green energy technology within the context of national policy. The research method used is a systematic literature review. Data were collected from scientific articles indexed by Scopus, Web of Science, and SINTA, as well as government policy reports and publications from relevant international institutions, covering the last five years. The analysis was conducted descriptively and analytically by grouping the literature findings into themes of education, social acceptance, and technology adoption. The results show that education level has a significant influence on increasing energy literacy and positive public attitudes toward green energy. Social acceptance has been shown to be a key factor influencing the successful implementation of renewable energy technologies, particularly through perceptions of benefits, risks, and distributive equity. However, the adoption of green energy technologies still faces obstacles such as high initial investment costs, limited infrastructure, and inconsistent policies. This research confirms that accelerating the green energy transition in Indonesia requires a holistic and integrated policy approach, combining strengthening education, increasing social acceptance, and sustainable institutional support.

Keywords: Green Energy, Education, Social Acceptance, Technology Adoption, Energy Transition

ABSTRAK

Transisi ke energi hijau adalah agenda strategis bagi Indonesia dalam menanggapi perubahan iklim dan ketergantungan tinggi pada bahan bakar fosil. Meskipun Indonesia memiliki potensi energi terbarukan yang signifikan, tingkat pemanfaatannya tetap relatif rendah. Situasi ini menunjukkan bahwa tantangan transisi energi hijau tidak hanya bersifat teknis dan ekonomi, tetapi juga dipengaruhi oleh faktor sosial, terutama pendidikan, penerimaan sosial, dan adopsi teknologi. Studi ini bertujuan untuk menganalisis hubungan antara tingkat pendidikan, penerimaan sosial, dan adopsi teknologi energi hijau di Indonesia. Studi ini berfokus pada peran pendidikan dalam membentuk literasi dan kesadaran energi, dinamika penerimaan sosial terhadap teknologi energi terbarukan, serta faktor-faktor yang menghambat dan mendorong adopsi teknologi energi hijau dalam konteks kebijakan nasional. Metode penelitian yang digunakan adalah tinjauan pustaka sistematis. Data dikumpulkan dari artikel ilmiah yang terindeks oleh Scopus, Web of

Science, dan SINTA, serta laporan kebijakan pemerintah dan publikasi dari lembaga internasional terkait, yang mencakup lima tahun terakhir. Analisis dilakukan secara deskriptif dan analitis dengan mengelompokkan temuan literatur ke dalam tema pendidikan, penerimaan sosial, dan adopsi teknologi. Hasilnya menunjukkan bahwa tingkat pendidikan memiliki pengaruh signifikan terhadap peningkatan literasi energi dan sikap positif masyarakat terhadap energi hijau. Penerimaan sosial telah terbukti menjadi faktor kunci yang mempengaruhi keberhasilan penerapan teknologi energi terbarukan, terutama melalui persepsi manfaat, risiko, dan keadilan distributif. Namun, adopsi teknologi energi hijau masih menghadapi hambatan seperti biaya investasi awal yang tinggi, infrastruktur yang terbatas, dan kebijakan yang tidak konsisten. Penelitian ini mengonfirmasi bahwa percepatan transisi energi hijau di Indonesia memerlukan pendekatan kebijakan yang holistik dan terintegrasi, yang menggabungkan penguatan pendidikan, peningkatan penerimaan sosial, dan dukungan kelembagaan yang berkelanjutan.

Kata kunci: Energi Hijau, Pendidikan, Penerimaan Sosial, Adopsi Teknologi, Transisi Energi

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1. INTRODUCTION

Global climate change and environmental degradation are serious challenges facing the world in the 21st century. High dependence on fossil fuels has led to increased greenhouse gas emissions, environmental pollution, and the vulnerability of national energy security. In this context, the transition to green or renewable energy has become a global strategic agenda to support sustainable development. Green energy, sourced from solar, wind, biomass, hydro, and geothermal energy, is considered capable of reducing environmental impacts while ensuring long-term energy availability.

Indonesia has enormous and diverse renewable energy potential, given its geographical location and abundant natural resources. The potential for solar, geothermal, hydro, and biomass energy makes Indonesia one of the countries with significant opportunities for green energy development. However, the realization of

renewable energy utilization in Indonesia remains relatively low compared to the available potential. To date, the national energy mix is still dominated by fossil fuels, particularly coal and oil. This situation highlights the structural, social, and institutional challenges in the transition to a more sustainable energy system.

The success of the green energy transition is not only determined by technological and economic aspects, but is also greatly influenced by human and social factors. Education plays a crucial role in shaping public awareness, knowledge, and attitudes toward environmental issues and sustainable energy. Higher levels of education tend to correlate with a better understanding of the benefits of green energy, the negative impacts of fossil fuels, and the urgency of behavioral change toward environmentally friendly energy consumption patterns. Education, both formal and informal, is a strategic instrument in building public energy literacy.

In addition to education, social acceptance is a crucial factor in determining the successful adoption of green energy technologies. New technologies often face social resistance due to perceived high costs, uncertain benefits, technological risks, and incompatibility with local values and culture. In the context of Indonesia's highly diverse social, economic, and cultural society, the level of acceptance of green energy technologies can vary significantly across regions. Therefore, understanding the dynamics of social acceptance is crucial in designing effective renewable energy policies and implementation strategies.

The adoption of green energy technologies also faces various practical challenges, such as high initial investment costs, limited infrastructure, unequal access to technology, and inconsistent policies. Although the government has issued various regulations and incentives to promote renewable energy, their implementation still faces obstacles at the community and business levels. This shows that technology adoption cannot be separated from educational factors and social acceptance as the main prerequisites.

Several previous studies have tended to discuss green energy from a technical, economic, or policy perspective in isolation. Other studies have also highlighted the role of education or social acceptance individually, without comprehensively examining the interrelationships between these variables, particularly in the Indonesian context. Thus, a research gap exists regarding the

need for studies that integrate aspects of education, social acceptance, and adoption of green energy technology within a single, coherent analytical framework.

Against this backdrop, the novelty of this article lies in its integrative approach, which examines the relationship between education levels, social acceptance, and adoption of green energy technology in Indonesia through a systematic literature review. This article not only maps the challenges and opportunities of the green energy transition but also emphasizes the importance of social and educational factors as foundations for the successful implementation of renewable energy technologies. With this approach, the research is expected to provide theoretical and practical contributions to the formulation of policies and strategies for accelerating a more inclusive and sustainable green energy transition in Indonesia.

2. METHOD

This study uses a systematic literature review approach to analyze the relationship between education level, social acceptance, and the adoption of green energy technology in Indonesia. This approach was chosen because it provides a comprehensive and structured understanding of current research developments and identifies patterns, gaps, and key findings in previous studies.

The research data sources were obtained from scientific articles indexed in reputable databases, such as Scopus, Web of Science (WoS), and the Science and Technology Index (SINTA). Furthermore, this study utilized government policy reports, official documents from ministries related to energy and education, and publications from international institutions relevant to renewable energy issues. The literature search was conducted using keywords such as renewable energy, green energy, education, social acceptance, and technology adoption, both in Indonesian and English.

The inclusion criteria for this study included publications published within the last five years, directly relevant to the research topic, and published in academically credible sources. Meanwhile, exclusion criteria included publications that were opinion pieces, not peer-reviewed, or not substantially related to the research variables.

Data analysis was conducted descriptively and analytically by grouping literature findings into main themes: the role of education, social acceptance, and

adoption of green energy technology. This approach allowed researchers to synthesize various perspectives and draw systematic conclusions to address the research questions.

3. RESULTS AND DISCUSSION

This discussion section presents the results of a systematic literature review synthesis to address the research objectives and research problem formulation. The discussion focuses on three key determinants of green energy adoption in Indonesia: education, social acceptance, and technology adoption, positioning them within the framework of a sustainable energy transition. Using a descriptive-analytical approach, findings from various studies are comparatively reviewed to identify patterns, gaps, and interrelationships between variables that influence the success of green energy implementation.

a) Green Energy Concept

The concept of green energy places renewable energy sources such as solar, wind, biomass, hydro, and geothermal at the heart of the energy transition, aiming to minimize environmental impacts throughout the technology's life cycle. According to Ellis et al. (2023), green energy not only serves as a substitute for fossil fuels, but represents a systemic shift in energy production and consumption that emphasizes efficiency, decarbonization, and long-term sustainability. Recent life-cycle assessment (LCA) studies have shown that greenhouse gas emissions per kWh of electricity from solar photovoltaic and wind technologies are consistently lower than those from coal-based generation, even when accounting for the manufacturing and decommissioning stages (Smith et al., 2024). These findings reinforce the claim that green energy has significant environmental advantages over conventional energy sources.

In addition to contributing to climate change mitigation, green energy also plays a strategic role in enhancing national energy security. Energy policy literature confirms that diversifying the energy mix through the use of domestic renewable resources can reduce dependence on fossil fuel imports and mitigate risks from global energy price volatility (IRENA, 2022). In the Indonesian context, several studies indicate that the technical potential of solar and geothermal energy is enormous, but their utilization rate remains relatively

low compared to available capacity (Pambudi et al., 2023). This situation indicates that green energy development requires proactive policies, infrastructure investment, and a regulatory framework that supports accelerated implementation.

However, a technical-ecological approach alone is insufficient to explain the dynamics of green energy implementation on the ground. A socio-technical perspective emphasizes that the energy transition is a complex process involving interactions between technology, institutions, and society (Geels, 2022). Energy transition studies indicate that renewable energy technologies will only be widely adopted if they gain social legitimacy, are supported by institutional capacity, and are accompanied by consistent economic incentives (Sovacool et al., 2023). Therefore, the concept of green energy needs to be understood as part of a systemic transformation that encompasses changes in values, social norms, and energy governance.

From an environmental perspective, quantitative evidence based on LCA further strengthens the advantages of green energy. Recent research shows that despite variations in emissions between technologies, the average emissions intensity of solar and wind power plants remains significantly lower than that of fossil fuel power plants, with energy payback periods shortening as technology advances (Portillo et al., 2024). This finding is crucial for refuting the argument that renewable energy has high “hidden environmental costs.” However, some researchers caution that green energy policies must still consider downstream impacts, such as solar panel waste management and critical material supply chains, to achieve comprehensive sustainability (UNECE, 2021).

In the context of developing countries like Indonesia, green energy needs to be understood as a combination of technical achievements and social processes. Policy literature emphasizes that the success of the energy transition depends heavily on improving public energy literacy, societal acceptance, and access to inclusive financing schemes (Wüstenhagen et al., 2022). The latest energy outlook also highlights the importance of integrating education policies, fiscal incentives, and strengthening governance to ensure that the environmental benefits of green energy are not achieved at the

expense of social equity (IRENA, 2022). Thus, a comprehensive green energy concept demands a cross-disciplinary approach that simultaneously integrates technical, economic, social, and policy aspects.

b) The Role of Education in Green Energy Awareness

First, empirical evidence shows that education level is positively correlated with energy literacy that is, basic technical knowledge about energy sources, understanding of environmental impacts, and the ability to evaluate the cost-benefit of renewable technologies. Survey studies of university students in Indonesia found that university students had a higher understanding of renewable energy concepts than vocational high school students or the general public, confirming the influence of education level on renewable energy awareness (Pambudi et al., 2024).

Second, cross-national research shows that increasing energy literacy fosters positive attitudes and pro-environmental behavioral intentions. Large-scale analyses of youth populations indicate that psychosocial factors (e.g., energy values, norms, and literacy) moderate the relationship between knowledge and action with energy literacy being a significant predictor of learning intentions and energy-saving practices (Khuc et al., 2023; Appiah et al., 2023). This provides a theoretical basis for why investments in curricula and educational programs can lead to attitudinal changes that lead to support for green energy.

Third, formal and non-formal educational interventions have demonstrated varying but complementary effectiveness: curricular programs (e.g., STEAM/project-based learning) improve students' conceptual understanding and technical skills, while public campaigns and community programs (including university CSR initiatives) are effective in increasing public awareness and social legitimacy for local renewable energy projects (Heliyon study on learning effectiveness 2023; university-CSR community programs 2024). Both approaches are necessary for knowledge to spread from schools to communities and facilitate technology adoption at the household level.

Fourth, systematic reviews and meta-analyses on energy literacy confirm that educational effects are strongest when combined with direct experience

(e.g., PV demonstrators, project visits), locally contextualized materials, and policy reinforcement (e.g., financial support for rooftop PV). LCA/implementation reviews also caution that without literacy and access to finance, technology adoption remains slow even when communities are aware of its benefits therefore, curricula must be balanced with policy programs that reduce practical barriers (Santillán et al., 2023; Portillo, 2024).

Fifth, the policy implications for the Indonesian context are clear: strengthening energy education at all levels (elementary, junior high, senior high, college, and vocational education), encouraging university-community collaboration (CSR) for practice-based literacy, and integrating education with fiscal incentives can accelerate the transition. Empirical studies in East Asian and Latin American contexts show that policy packages of education and economic incentives increase behavioral intentions and actual adoption more effectively than single programs (Sun, 2023; Espinoza et al., 2024). Therefore, a practical recommendation is to develop contextual (local) curricula and applied training programs synergized with microfinance schemes and subsidies to reduce initial barriers to adoption.

c) Social Acceptance of Green Energy

Social acceptance of green energy projects is influenced by a combination of economic, cultural, and risk perception factors where “relative benefits” and technological “compatibility” influence communities’ decisions to accept or reject new projects. Case study analyses of solar power projects show that community benefit schemes such as financial compensation, local employment, and public infrastructure investments significantly increase local acceptance (van den Berg, 2022).

Rogers’ Diffusion of Innovations Theory remains relevant for explaining green energy technology adoption patterns particularly the dimensions of perceived relative benefits, compatibility with local practices, and the complexity of technology use but recent literature emphasizes the need to enhance this model with energy justice and participatory governance approaches. Empirical studies show that when renewable energy projects are designed with public participation mechanisms and equitable benefit

distribution, local resistance decreases and social legitimacy increases (Romero-Lankao et al., 2023).

Risk perception (environmental, health, socio-economic) also plays a key role: citizens tend to reject projects perceived as risky or detrimental to the local landscape/identity, even if the economic benefits are perceived as positive. Contemporary literature combines procedural justice and distributive justice perspectives to assess acceptability, finding that clarity in decision-making processes and perceived fair compensation increase public support (Shyu et al., 2025).

Recent meta-analyses and reviews demonstrate spatial and temporal variation in acceptance levels: technology type (solar vs. wind vs. biomass), project scale (utility-scale vs. rooftop), and socio-economic context determine levels of public support. For example, the public is generally more accepting of rooftop PV installations and small-scale projects that provide immediate benefits than large-scale solar farms or wind turbines that alter the local landscape. Systematic reviews also point to the need for stronger policy evidence on effective incentive and participation mechanisms (Görsch et al., 2025).

For the Indonesian and developing world contexts, the implications are clear: policy design must combine technical-economic policy packages with culturally sensitive communication and participation strategies. Contemporary surveys and case studies recommend practical steps such as deliberative early consultations, transparent benefit-sharing mechanisms, and local education programs that reduce misconceptions about technology risks all of which have been shown to increase project acceptance rates and sustainability (Chen et al., 2025).

d) Adoption of Green Energy Technology

The adoption of green energy technologies in Indonesia still faces significant structural barriers, primarily related to high initial investment costs for household and utility-scale installations and limited access to long-term financing at competitive interest rates. Financial studies indicate that long payback periods and limited liquidity are key determinants of decisions to adopt renewable energy technologies by households and small and medium-

sized enterprises (Tarigan, 2023). Halimatussadiah et al. (2024) assert that without innovative financing mechanisms, such as green credit, third-party ownership, or leasing schemes, the penetration of technologies like rooftop photovoltaic (PV) will remain low. This finding is reinforced by a sensitivity analysis of net-metering policies, which shows that even small changes in incentive structures can significantly impact the economic viability of rooftop PV projects in Indonesia.

In addition to financing constraints, limited electricity grid infrastructure is also a major barrier to green energy adoption. Uneven grid distribution and capacity, with investment concentrated in the Java-Bali system, limit renewable energy integration outside the main islands (Energy Transition Partnership, 2024). Furthermore, grid operators' technical readiness to manage the variability of renewable energy sources including the need for smart grids, system flexibility, and energy storage remains relatively limited. According to IRENA (2022), without significant investment in grid modernization and adaptive system planning, increasing renewable energy capacity risks grid congestion and limited power absorption.

Regulatory factors and policy inconsistencies contribute to increased investment risk perceptions for developers and financial institutions. Several studies have noted a lack of synchronization between renewable energy acceleration policies and fossil fuel policies, such as domestic coal obligations, electricity ceiling pricing, and repeated changes to rooftop PV net-metering schemes (Halimatussadiah et al., 2024; Kusuma et al., 2025). This regulatory uncertainty makes it difficult to obtain long-term contracts (power purchase agreements) and low-cost financing. The case of changes in net-metering policies in Indonesia demonstrates that regulatory instability can directly reduce investment appetite, both in the household and industrial sectors (Climate Transparency, 2024).

On the other hand, opportunities to accelerate green energy adoption are increasingly open with technological advances and the development of large-scale strategic projects. The development of floating solar, lowering solar module costs, and international financing initiatives through the Just Energy Transition Partnership (JETP) scheme offer opportunities to lower the levelized

cost of electricity (LCOE) in the medium term (IRENA, 2022). Empirical studies show that public-private collaboration and multilateral funding support can close the initial investment gap and increase investor confidence in renewable energy projects in developing countries (Aditya et al., 2025).

To encourage broader and more sustainable adoption of green energy technologies, public policies need to be designed holistically and integratedly. Recent literature emphasizes the importance of synergies between financing policies (green credit and risk guarantees), regulatory certainty (incentive stability and energy export mechanisms), increased grid capacity, and technical capacity-building and education programs for local actors (Kusuma et al., 2025; IRENA, 2022). Furthermore, streamlined licensing processes, transparent procurement mechanisms, and realistic adjustments to local content policies can reduce transaction costs and accelerate project implementation. This policy synergy is a prerequisite for Indonesia's green energy technical potential to be realized into real and sustainable installed capacity.

4. CONCLUSION

Based on the literature review and discussion outlined above, this study confirms that the transition to green energy in Indonesia is a process that cannot be understood in isolation. Unlike previous studies that tend to isolate technical, economic, or policy aspects, this article offers an integrative approach by highlighting the interrelationships between education, social acceptance, and technology adoption as key social determinants of green energy success. This approach is novel in this research because it broadens the perspective of the energy transition from a purely technological issue to a socio-technical process involving changes in knowledge, attitudes, and societal institutional structures.

By synthesizing findings across studies, this research provides a more comprehensive understanding of how education serves as a foundation for energy literacy, social acceptance as a legitimizing mechanism, and technology adoption policies as an implementation instrument. Thus, the following conclusions can be drawn:

First, the green energy transition in Indonesia is a strategic necessity that is not only technical but also social and institutional. Second, education plays a

fundamental role in improving energy literacy and shaping positive public attitudes toward green energy. Third, social acceptance is a determining factor in the successful implementation of green energy technology at the local level. Fourth, the adoption of green energy technology in Indonesia requires holistic, stable, and integrated policies across sectors.

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