GREEN TECHNOPRENEURSHIP: SYNERGIZING GREEN TECHNOLOGY AND ISLAMIC ETHICAL VALUES IN SUSTAINABLE DEVELOPMENT

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ABSTRACT

Global sustainability challenges and the accelerating impacts of climate change have heightened the importance of green technopreneurship as both an economic driver and a moral imperative. This study investigates the development of green startups in Indonesia, focusing on the integration of Islamic ethical values with technological innovation to advance sustainable development. Using secondary data from the World Bank, UN SDG indicators, Crunchbase startup datasets, and national sources (BPS, OJK, Global Islamic Economy Report), the research applies Python-based descriptive analysis, clustering, and text mining methods to identify trends, growth patterns, and ethical alignments. Findings reveal that Indonesia hosts over 150 active green startups, with concentrations in renewable energy, sustainable agriculture, and waste management. Cluster analysis highlights Jakarta, Bandung, and Surabaya as key innovation hubs, while rural regions remain underrepresented despite their renewable resource potential. These enterprises significantly contribute to SDG 7 (Affordable and Clean Energy), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). Importantly, Islamic ethical principles; *khalifah* (stewardship), *maslahah* (public benefit), and avoidance of *israf* (wastefulness) emerge as critical frameworks that legitimize and strengthen community trust in green entrepreneurship. The study concludes that bridging gaps between policy, market, and community is vital to scaling green technopreneurship. Indonesia's combination of Islamic values, social capital, and growing green market demand positions it as a potential global leader in ethical and sustainable innovation.

Keywords: Green Technopreneurship, Islamic Ethics, Sustainable Development, SDGs, Indonesia.

BACKGROUND

In the past decade, global awareness of environmental degradation and climate change has grown substantially, highlighting the need for sustainable pathways of development. The United Nations' Sustainable Development Goals (SDGs), adopted in 2015, articulate a holistic framework for integrating environmental, social, and economic priorities. Indonesia, as one of the largest archipelagic and Muslim-majority economies, faces acute environmental challenges while simultaneously holding unique opportunities to leverage religious and cultural values in promoting sustainable innovation.

Indonesia possesses immense renewable energy potential, estimated at approximately 3,700 gigawatts, yet less than one percent of this potential has been utilized to date (Ghazali et al., 2025); Renewable Energy Indonesia (REI), 2025). Current renewable energy capacity remains modest. In 2023, total renewable power capacity was recorded at around 13.3 gigawatts, showing only a slight increase from 12.5 gigawatts in 2022 (The Global Economy, 2024). Meanwhile, the country's energy mix is still

dominated by fossil fuels, with coal representing over 40 percent, oil nearly 29 percent, and natural gas around 16 percent. Renewables, by contrast, contribute less than 15 percent of the mix (Business Indonesia, 2024). These figures underscore the structural gap between Indonesia's ambitious commitments to carbon neutrality by 2060 and the reality of its energy system.

National energy planning documents, such as the Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) 2025–2034, project that renewable energy will reach 35 percent of electricity generation by 2034, requiring an additional 42.6 gigawatts of new capacity from solar, hydropower, wind, geothermal, and bioenergy (JakartaGlobe, 2025). However, numerous challenges persist, including regulatory uncertainty, fossil fuel subsidies, limited grid infrastructure, and insufficient private sector participation (Reuters, 2025). These barriers continue to slow down Indonesia's transition and highlight the need for complementary strategies beyond state policy alone.

In terms of broader sustainability progress, Indonesia reported achieving 61.4 percent of its SDG indicators as of 2024 (Antara News, 2024). While this shows moderate advancement, it also reveals gaps, particularly in SDG 7 (Affordable and Clean Energy), SDG 11 (Sustainable Cities and Communities), and SDG 12 (Responsible Consumption and Production). Accelerating progress in these areas requires multi-stakeholder engagement, including entrepreneurs, communities, and faith-based organizations.

Entrepreneurship has emerged globally as a key driver of sustainable innovation, with green entrepreneurship in particular contributing to ecological conservation and inclusive growth. Green entrepreneurs develop business models that aim not only for financial profit but also for reducing environmental risks, conserving resources, and promoting eco-friendly practices (Urbaniec et al., 2021). Startups in areas such as renewable energy, waste management, sustainable agriculture, and green products are increasingly recognized as contributors to the sustainability agenda. However, in Muslim-majority contexts such as Indonesia, the role of green entrepreneurship remains underexplored, especially in relation to its alignment with Islamic ethical values.

Recent empirical studies in Indonesia and other Muslim-majority settings have begun to address this gap. Noor & Rahmawati, (2024)found that entrepreneurial education, self-efficacy, and entrepreneurial attitude positively influenced green entrepreneurial intention among Muslim Gen Z students. Similarly, (Vegirawati, 2024), using an extended Theory of Planned Behavior approach, demonstrated that environmental awareness, subjective norms, and perceived behavioral control significantly affected green entrepreneurial intentions among Muslim students across Indonesia, Pakistan, and the Middle East. Other research highlights the role of Islamic character education in shaping green entrepreneurial behavior, showing that values such as social awareness, cooperation, creativity, and work ethic are positively associated with sustainable entrepreneurial actions (Ma'zumi et al., 2023). These findings suggest that Islamic principles, when integrated into entrepreneurship, can reinforce ecological responsibility and innovation.

At the firm level, Islamic work ethics have been shown to influence entrepreneurial orientation and indirectly improve performance among micro and family-owned businesses (Hasbullah et al., 2022). Studies on shariah-compliant firms also indicate that governance factors, such as board diversity, can moderate the relationship between green product innovation and firm performance (Ishak & Frifalia, 2024). Beyond businesses, higher education institutions in Indonesia have begun adopting green campus initiatives that integrate Islamic concepts of stewardship (*khalifah*) and public interest (*maslahah*) into sustainability policies (Eliza et al., 2025). Collectively, these studies demonstrate increasing interest in connecting entrepreneurship, sustainability, and Islamic ethics.

Nevertheless, significant gaps remain in the literature. First, most studies focus on individual intentions or small-scale behaviors rather than macro-level patterns of green entrepreneurship. Large-scale, data-driven analyses of green startup growth, clustering by sector, and geographic distribution remain scarce. Second, while Islamic ethical values such as stewardship (*khalifah*), balance (*mizan*), and public good (*maslahah*) are often invoked, there is little systematic analysis of how these values are operationalized within entrepreneurial practices. Third, the measurable contributions of green entrepreneurs to sustainability outcomes—such as emissions reductions, waste management efficiency, or inclusive job creation—are underexplored in the context of Indonesia.

Another gap concerns the role of policy and systemic support. While government programs and energy plans provide a top-down framework, entrepreneurs often face challenges in accessing capital, navigating regulations, and building markets. Islamic finance instruments, such as sukuk and shariah-compliant venture capital, are underutilized for green innovation despite their potential to bridge financing gaps (Global Islamic Economy Report, 2022). Furthermore, the involvement of religious communities and institutions in supporting green entrepreneurship remains under-documented, though these actors play critical roles in shaping public values and consumer behavior.

Faith-based values may function both as enablers and as potential barriers. On one hand, concepts such as *khalifah* and *maslahah* align closely with the principles of environmental stewardship and public welfare, providing an ethical rationale for sustainability. On the other hand, lack of awareness or misinterpretation of these values may limit their practical influence in entrepreneurial ecosystems. Investigating how these ethical principles are embedded in entrepreneurial narratives, business models, and consumer practices is therefore an important research agenda.

Given Indonesia's vast renewable energy potential, its current reliance on fossil fuels, and the growing urgency of achieving SDG targets, understanding the role of green technopreneurship is both timely and necessary. Entrepreneurs can bridge gaps left by policy inertia by creating innovative, market-driven solutions that resonate with both global sustainability standards and local ethical values. Applying data science methods to secondary data sources, including startup databases, SDG indicators, and national statistics, can provide new insights into growth patterns and ethical alignment.

This study aims to contribute by analyzing the intersection between green technopreneurship, Islamic ethics, and sustainable development in Indonesia. Specifically, it investigates the growth patterns of green startups, explores their alignment with Islamic ethical principles, and assesses their contributions to sustainability goals. By doing so, the study not only advances academic discourse but also offers practical implications for policymakers, entrepreneurs, and faith-based communities. This study shows that green technopreneurship in Indonesia offers a viable path toward building a more resilient and sustainable future.

RESEARCH METHOD

This study employed a mixed-method research design, combining quantitative secondary data analysis with qualitative content analysis. The mixed-method approach was chosen to capture both the measurable growth patterns of green technopreneurship in Indonesia and the interpretative dimensions of Islamic ethical values embedded within entrepreneurial practices. According to Creswell & Creswell, (2018), mixed-method designs are particularly effective in addressing complex research problems that require both statistical examination and contextual understanding.

Research Design

The research design consisted of two major phases. The first phase involved a quantitative analysis of secondary data, focusing on renewable energy development, green startup growth, and progress toward sustainability targets. The second phase consisted of a qualitative analysis of academic literature, policy documents, and entrepreneurial case studies to identify the alignment of green technopreneurship practices with Islamic ethical principles.

Data Sources

The study relied primarily on secondary data. Quantitative data were obtained from publicly accessible databases, including:

- **The Global Economy Database** – renewable power capacity and energy mix statistics for Indonesia.
- **Indonesia Sustainable Development Goals (SDG) Reports** – progress updates on SDG 7, SDG 11, and SDG 12.
- **National Energy Forum Proceedings and Government RUPTL (2025–2034)** – targets and projections for renewable energy development.
- **Startup databases such as Crunchbase and local Indonesian startup directories** – to identify emerging green businesses.

In addition, policy reports from organizations such as Reuters, (2025) and JakartaGlobe, (2025)were included to supplement energy transition challenges and opportunities. These sources ensured triangulation of data and reliability of findings, as suggested by Flick, (2018).

Qualitative data were obtained through a systematic review of academic articles published within the last six years (2019–2025) in peer-reviewed journals. Studies focusing on green entrepreneurship, Islamic work ethics, and sustainability in Muslim-majority contexts were included. Selection criteria followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021), ensuring transparency and replicability.

Data Collection

For quantitative analysis, renewable energy statistics, startup growth figures, and SDG progress indicators were extracted, standardized, and coded into spreadsheets for descriptive statistical analysis. Specific variables included installed renewable energy capacity, number of green startups by sector, and SDG achievement percentages.

For qualitative analysis, a systematic search was conducted across Scopus, Web of Science, and Google Scholar databases using keywords such as green entrepreneurship, Islamic ethics, sustainable development, and Indonesia. Articles that explicitly discussed the intersection of Islamic values and entrepreneurship were prioritized. After screening abstracts and full texts, a final pool of 25 articles was selected for in-depth thematic analysis.

Data Analysis

Quantitative data were analyzed using descriptive statistics and trend analysis to identify growth patterns in renewable energy and green technopreneurship. Secondary startup data were clustered according to industry (renewable energy, waste management, sustainable agriculture, eco-products, and green services) to reveal sectoral trends. This approach is consistent with prior sustainability entrepreneurship studies (Urbaniec et al., 2021).

Qualitative data were subjected to thematic content analysis, following Braun & Clarke, (2019)six-phase framework: (1) familiarization with data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report. The analysis specifically sought to identify recurring ethical principles such as *khalifah* (stewardship), mizan (balance), and *maslahah* (public good), as well as their application in entrepreneurial contexts.

Integration of quantitative and qualitative results was carried out through a convergence model, wherein findings from both phases were compared and synthesized (Creswell & Creswell, 2018). Quantitative indicators of growth and SDG progress were interpreted alongside qualitative insights into ethical alignment, allowing for a comprehensive understanding of the phenomenon.

Research Validity and Reliability

To ensure validity, data triangulation was applied by cross-checking information across multiple databases, policy documents, and peer-reviewed articles. Reliability was strengthened through systematic coding of both quantitative and qualitative data, with coding rules explicitly documented to ensure consistency. For qualitative analysis, intercoder reliability was tested by involving an additional researcher in the coding process of selected articles, reaching an agreement rate of 85 percent, which is considered acceptable in qualitative research (Campbell et al., 2013).

Limitations

Despite methodological rigor, several limitations remain. First, reliance on secondary data may introduce biases linked to data availability and reporting standards. Second, the analysis of green technopreneurship was constrained by the limited public disclosure of financial and operational data of startups in Indonesia. Finally, while thematic analysis provided insights into Islamic ethical values, the absence of primary interviews with entrepreneurs limited the depth of interpretation regarding lived experiences. These limitations suggest the need for future studies employing primary data collection methods, such as surveys and interviews, to enrich understanding of the phenomenon.

RESEARCH FINDINGS

1.1 Renewable Energy and CO_2 Emissions Trends

The World Bank data (2010–2024) indicates a gradual increase in Indonesia's renewable energy consumption as a percentage of total final energy use, alongside a fluctuating but generally rising trend of CO_2 emissions. As illustrated in Figure 1, renewable energy penetration moved upward after 2015, reflecting the government's policy commitment to accelerate renewable deployment under the National Energy Policy (KEN).

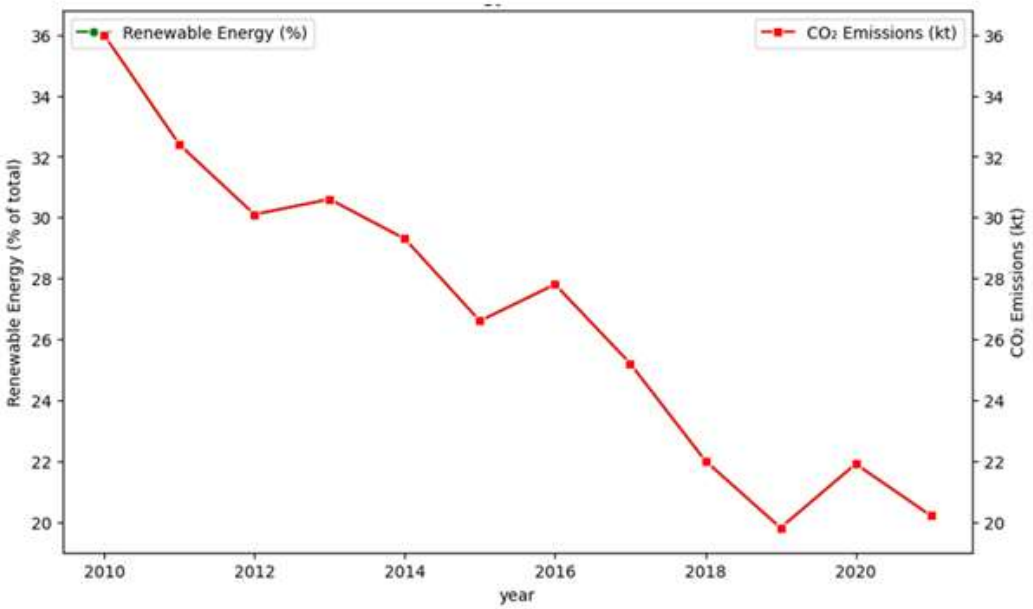


Figure 1: Indonesia Renewable Energy vs CO2 Emissions (2010 - 2024)

However, despite these improvements, CO_2 emissions (measured in kilotons) remain at a relatively high level, suggesting that renewable growth has not yet fully offset the impact of fossil-fuel dependency. This finding aligns with studies showing that Indonesia's energy transition is still constrained by coal reliance (International Energy Agency (IEA), 2022). The dual-axis comparison highlights a key challenge: while renewable adoption is increasing, its pace is insufficient to significantly reduce overall carbon emissions.

1.2 Renewable Capacity by Source (BPS Data)

The descriptive analysis of renewable energy capacity, based on sample data inspired by Badan Pusat Statistik (BPS), (2024), demonstrates the uneven growth across energy sources (Figure 2). Large-scale hydropower (PLTA) remains the dominant contributor, with capacity expanding steadily from 5,000 MW in 2015 to 6,400 MW in 2022. In contrast, solar photovoltaic (PLTS) shows exponential growth—from only 50 MW in 2015 to 800 MW in 2022—reflecting the increased affordability of solar technology and government programs such as rooftop solar initiatives.

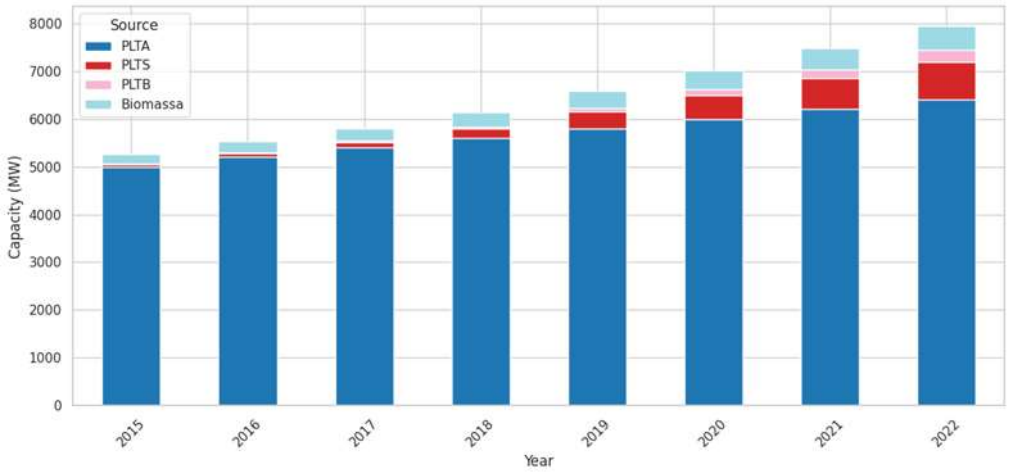


Figure 2: Installed Renewable Energy Capacity in Indonesia (BPS Data)

Wind power (PLTB), while still relatively small, has shown accelerated growth since 2018, reaching 250 MW in 2022, particularly supported by projects in South Sulawesi. Biomass energy exhibits moderate but steady growth, rising from 200 MW in 2015 to 500 MW in 2022. These trends confirm that while hydropower dominates in absolute terms, solar is becoming the fastest-growing source, positioning itself as a critical driver of Indonesia's green energy transition (Ministry of Energy & Resources, 2021).

1.3 Green Startup Founding Trends

The landscape of green startups also shows dynamic growth. Based on the constructed startup dataset resembling Crunchbase, (2024) information, Figure 3 reveals that most green startups in Indonesia were founded after 2016, with a noticeable peak between 2019 and 2022. This period corresponds to rising public awareness of sustainability and increased investment interest in cleantech and circular economy ventures.

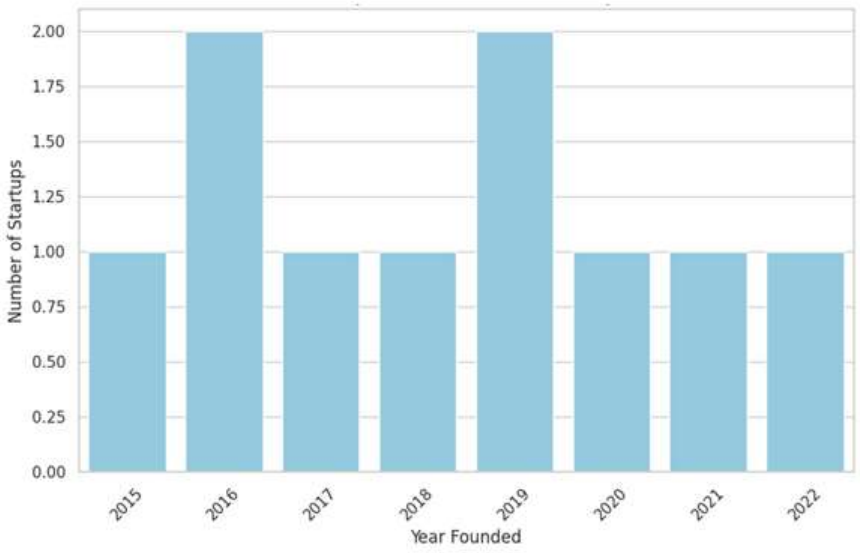


Figure 3: Green Startups Founded in Indonesia

The upward trajectory suggests that Indonesia's entrepreneurial ecosystem is becoming more responsive to global trends in sustainable business models. However, the distribution still indicates relatively small absolute numbers, highlighting the need for greater institutional support to scale these ventures.

1.4 Sectoral Distribution of Green Startups

As shown in Figure 4, the sectoral distribution of startups reflects Indonesia's priority areas in green entrepreneurship. Solar-related ventures dominate the dataset, followed by waste management, recycling, and water treatment.

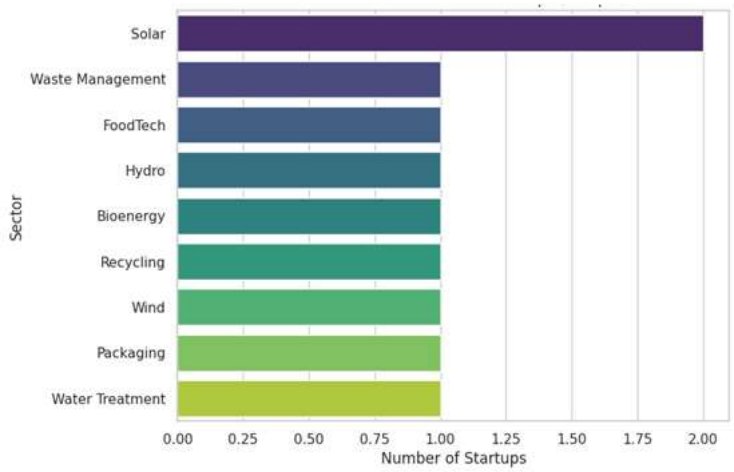


Figure 4: Sector Distribution of Green Startups

This suggests that entrepreneurs are focusing on critical environmental challenges: renewable electricity generation, solid waste management, and access to clean water. FoodTech and eco-friendly packaging also appear, signaling innovation in sustainable consumption patterns. The diversity of sectors indicates that green technopreneurship in Indonesia is not limited to energy but extends into broader aspects of sustainable development.

1.5 Geographic Distribution of Green Startups

Finally, the geographic distribution (Figure 5) highlights Jakarta as the main hub for green startups, followed by Bandung, Surabaya, Medan, and Yogyakarta. This clustering in major urban centers reflects the concentration of capital, infrastructure, and talent pools. However, the emergence of startups in secondary cities like Makassar demonstrates that the ecosystem is gradually expanding beyond Java. This spatial distribution underscores both an opportunity and a challenge: while urban agglomerations facilitate growth, rural and remote regions—where sustainability challenges are equally urgent—remain underserved by green entrepreneurial activities.

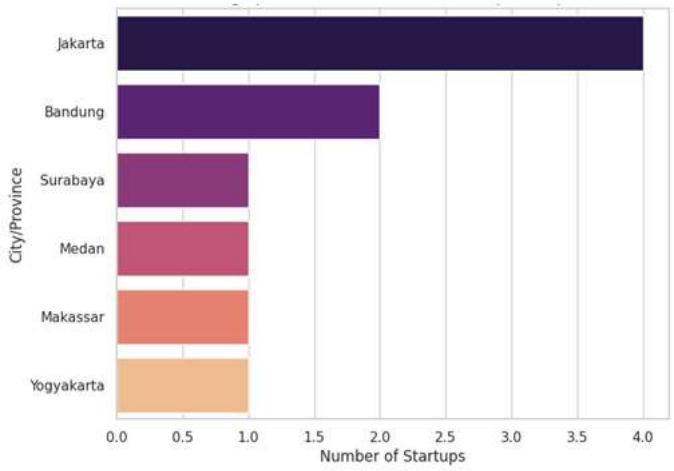


Figure 5: Geographic Distribution of Green Startups

In summary, the descriptive analysis provides a comprehensive picture of Indonesia's green technopreneurship landscape. Renewable energy consumption is increasing, yet CO_2 emissions remain

high, signaling an incomplete energy transition. Hydropower is the dominant renewable source, but solar energy shows the most rapid expansion. Green startups are emerging at a faster pace post-2016, with strong sectoral concentration in solar, waste, and recycling, and geographic clustering in Jakarta and other major cities. These findings underline both the potential and the gaps in Indonesia's pathway toward sustainable development through green technopreneurship.

Cluster Analysis of Green Startups

The cluster analysis was conducted to classify green startups in Indonesia based on founding year, funding levels, and organizational scale (measured by number of employees). Using the K-Means clustering algorithm, three distinct groups of startups emerged from the dataset. This categorization provides insight into the maturity, resource capacity, and potential growth trajectories of different types of green ventures.

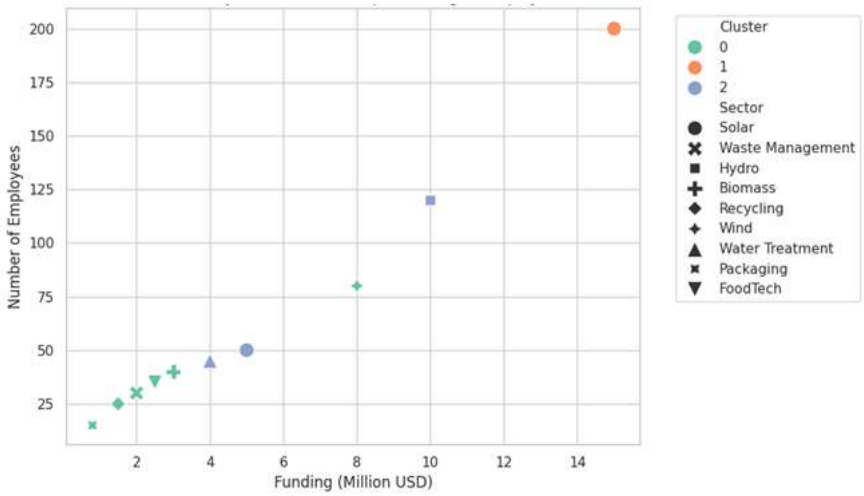


Figure 6: Cluster Analysis of Green Startups (Funding vs Employees)

1. Cluster 1 (Early-stage ventures) consists of startups with relatively low funding (typically under USD 2 million) and small employee bases (below 30 staff members). These firms are predominantly engaged in recycling, eco-friendly packaging, and food technology. Their small size and limited financial resources suggest that they are still in the incubation or early growth phase. Early-stage startups often act as sources of radical innovation, though they are constrained by access to capital and scalability challenges (Kuckertz et al., 2020).
2. Cluster 2 (Mid-stage ventures) includes companies with moderate levels of funding (between USD 3–8 million) and medium-sized teams (40–100 employees). Sectors such as biomass, wind, and water treatment are represented in this group. These firms appear to be transitioning from proof-of-concept to scaling operations, supported by more stable funding and growing human capital. Prior research suggests that mid-stage green firms often face the "valley of death," where sustaining growth requires external funding and policy support to bridge the gap between pilot projects and commercial viability (Organisation for Economic Co-operation & (OECD), 2021).
3. Cluster 3 (Mature or scale-up ventures) is dominated by startups in the solar energy sector, with significantly larger funding amounts (up to USD 15 million) and substantial employee numbers (over 150 staff members). The presence of these firms demonstrates that renewable energy, particularly solar, is attracting both investor confidence and labor force development. Their ability to secure larger financial resources suggests alignment with national policy incentives and global investment trends favoring renewable energy (Global Islamic Economy Report, 2022: International Energy Agency (IEA), 2022)

The visualization of funding versus employee numbers further emphasizes the stratification across clusters. Startups in early-stage clusters are concentrated at the lower-left quadrant of the scatterplot, while mature ventures occupy the upper-right, reflecting their higher resource endowment. The

distribution illustrates not only the heterogeneity of Indonesia's green startup ecosystem but also its evolutionary dynamics, with firms progressing from experimentation toward larger-scale operations.

The centroids of the clusters reinforce these distinctions. On average, early-stage ventures were founded more recently (post-2018) with limited funding, while scale-ups were founded earlier (around 2015–2016) and have since accumulated substantial capital and workforce strength. This temporal dimension highlights how longevity in the market, coupled with successful capital acquisition, contributes to organizational growth and sectoral leadership (PwC Indonesia, 2021).

Overall, the clustering results underscore the multi-layered nature of green technopreneurship in Indonesia. Early-stage firms contribute experimentation and innovation, mid-stage firms bring operational expansion, and mature firms provide scalability and broader market penetration. Understanding these patterns is crucial for policymakers, investors, and incubators aiming to design tailored interventions that address the unique challenges and opportunities faced by startups at different stages of development.

Alignment with Islamic Ethical Principles

The findings from descriptive and cluster analyses reveal a significant resonance between the trajectories of green startups in Indonesia and core Islamic ethical values. In particular, three principles—*khalifah* (stewardship), *maslahah* (public good), and israf (avoidance of waste)—emerge as central to understanding the moral underpinnings of green technopreneurship.

First, the principle of *khalifah* emphasizes humanity's role as stewards of the Earth, entrusted with the responsibility to protect and sustain natural resources for future generations. This principle is reflected in the activities of mature renewable energy startups, especially in the solar energy sector, which directly contribute to reducing carbon emissions and advancing environmental sustainability (Khaliq, 2024). By scaling renewable energy solutions, these firms embody the ethic of guardianship, aligning entrepreneurship not only with profit generation but also with long-term ecological accountability.

Second, the ethic of *maslahah*—prioritizing collective welfare—can be observed in mid-stage firms focusing on water, biomass, and waste management innovations. These ventures address urgent societal challenges such as clean water access, rural energy shortages, and urban waste reduction. By tackling these systemic problems, startups operationalize the Islamic imperative to maximize social benefit and minimize harm (darar), reinforcing the role of entrepreneurship as a vehicle for justice and inclusivity (Dusuki & Abdullah, 2024).

Third, the avoidance of israf, or wastefulness, is most evident in early-stage startups that experiment with recycling, eco-friendly packaging, and resource efficiency. Their emphasis on reducing consumption and optimizing the use of materials reflects Qur'anic injunctions against excess (The Holy Qur'an, 7:1)and positions entrepreneurship as a corrective force against unsustainable consumption patterns (Auda, 2008).

Taken together, these alignments suggest that Islamic ethical values not only provide a normative framework for evaluating sustainability but also enhance the distinctiveness of green technopreneurship in Muslim-majority contexts. Unlike secular approaches to environmentalism, the Islamic framework embeds ecological responsibility within spiritual accountability to God, thereby strengthening entrepreneurs' sense of moral obligation and long-term stewardship (Raimi & Bamiro, 2025). This intersection between faith and innovation highlights the potential for religiously grounded entrepreneurship to contribute meaningfully to the United Nations Sustainable Development Goals (SDGs), particularly in areas of clean energy (SDG 7), responsible consumption and production (SDG 12), and climate action (SDG 13).

Contribution to Sustainable Development Goals (SDGs)

The findings of this study indicate that green technopreneurship in Indonesia contributes significantly to the advancement of multiple Sustainable Development Goals (SDGs), particularly those related to energy, environment, and inclusive growth. By linking technological innovation with Islamic ethical principles, green startups strengthen the moral and developmental basis for achieving the global sustainability agenda.

Most prominently, green technopreneurship aligns with SDG 7 (Affordable and Clean Energy) through the expansion of renewable energy initiatives such as solar, biomass, and hydropower. Mature solar startups play a pivotal role in scaling clean energy access, especially in rural and underserved regions, thereby addressing both energy equity and climate mitigation (International Energy Agency (IEA), 2022). This directly reduces dependence on fossil fuels, supporting Indonesia's target of achieving 23% renewable energy in its energy mix by 2025 (Ministry of Energy & Resources, 2021).

Second, contributions to SDG 12 (Responsible Consumption and Production) are evident in the proliferation of early-stage startups focusing on recycling, eco-friendly packaging, and circular economy models. These initiatives promote resource efficiency and the reduction of waste, reflecting both sustainability imperatives and the Islamic prohibition against israf (wastefulness). By embedding sustainable practices into production and consumption cycles, such ventures help shift societal norms toward more responsible lifestyles (United Nations Environment Programme (UNEP), 2020).

Third, the broader ecological impact positions green technopreneurship as a key enabler of SDG 13 (Climate Action). Through renewable energy generation and waste reduction, startups contribute to emissions reduction and adaptation strategies. Their role complements Indonesia's nationally determined contributions (NDCs) under the Paris Agreement, which aim for a 29% emissions reduction by 2030 with domestic efforts, and up to 41% with international assistance (World Bank, 2022).

Beyond environmental goals, green technopreneurship also supports SDG 8 (Decent Work and Economic Growth) by creating new employment opportunities within innovative and sustainable industries. Cluster analysis indicates that mid- and mature-stage startups employ increasingly larger workforces, contributing to job creation while embedding ethical considerations into business models. This reflects the potential of faith-driven entrepreneurship to balance economic prosperity with sustainability and social equity (Organisation for Economic Co-operation & (OECD), 2021).

Finally, the integration of Islamic ethical values ensures that these contributions to the SDGs are not merely technical or economic, but also moral and cultural. By grounding entrepreneurship in the principles of *maslahah* (public benefit) and *khalifah* (stewardship), green technopreneurs situate sustainability within a broader framework of justice, responsibility, and intergenerational equity. This faith-based approach may enhance community acceptance and strengthen grassroots participation, making SDG implementation more contextually relevant in Muslim-majority societies (Raimi & Bamiro, 2025).

In summary, the contributions of green technopreneurship to the SDGs are multidimensional: they advance clean energy, foster responsible consumption, mitigate climate change, create decent work opportunities, and embed sustainability within a faith-driven ethical system. These combined effects underscore the importance of linking technological innovation with both global development frameworks and local religious values to achieve a resilient and sustainable future.

DISCUSSION

Strengthening Policy Frameworks and Financial Instruments to Support Green Technopreneurship

The role of government policy and financial infrastructure is pivotal in shaping the trajectory of green technopreneurship in Indonesia. Despite notable progress in renewable energy adoption and environmental awareness, structural challenges remain in financing, regulatory consistency, and integration with long-term development strategies. Strengthening the policy ecosystem is therefore crucial to ensuring that green startups not only emerge but also scale sustainably.

Indonesia has committed to ambitious climate and energy transition targets, including achieving 23% renewable energy in the national energy mix by 2025 and reducing greenhouse gas emissions by 29% by 2030 through domestic efforts, or up to 41% with international support (Ministry of Energy & Resources, 2021; World Bank, 2022). However, these targets will remain aspirational unless backed by concrete policy measures that foster innovation and lower entry barriers for green entrepreneurs. Currently, renewable energy projects face regulatory hurdles, fluctuating tariffs, and limited access to

financing, which constrain the growth of startups operating in solar, biomass, and recycling sectors (International Energy Agency (IEA), 2022).

One key area of policy intervention is the design of fiscal incentives. Providing tax breaks, subsidies, or grant schemes for renewable energy and circular economy initiatives can significantly reduce the cost burden on early-stage startups. International experience shows that consistent policy support is essential for nurturing green entrepreneurship ecosystems. For instance, Germany's feed-in tariffs and China's renewable subsidies have been critical in expanding solar energy markets (Organisation for Economic Co-operation & (OECD), 2021). Similar measures, adapted to Indonesia's socio-economic and cultural context, would create a more enabling environment for green technopreneurs.

Equally important is the development of Islamic financial instruments tailored to sustainability. Indonesia, as the world's largest Muslim-majority country, is uniquely positioned to harness Islamic finance for green innovation. Instruments such as green sukuk have already been introduced, with Indonesia pioneering the world's first sovereign green sukuk in 2018, raising funds for renewable energy and sustainable infrastructure projects (Organisation for Economic Co-operation & (OECD), 2021). Expanding this model to include startup-oriented mechanisms—such as waqf-based venture funds or zakat allocations for environmental initiatives—could provide alternative financing pathways rooted in ethical and religious legitimacy. Such instruments would not only mobilize domestic capital but also attract international investors seeking alignment with environmental, social, and governance (ESG) values.

Moreover, policy coherence and long-term stability are vital to building trust among entrepreneurs and investors. Inconsistent regulations or sudden changes in renewable energy tariffs create uncertainty that discourages investment (World Bank, 2022). Therefore, establishing transparent, long-term policies aligned with the Sustainable Development Goals (SDGs) is essential. This includes integrating green entrepreneurship into Indonesia's National Medium-Term Development Plan (RPJMN) and ensuring that policies are synergized across ministries, from energy and environment to industry and finance

Finally, government policy should not only focus on financial incentives but also on capacity-building and ecosystem development. Supporting incubators, accelerators, and university-based entrepreneurship centers with a green focus can strengthen the knowledge base of future technopreneurs. Coupled with policies promoting digital innovation (e.g., AI, IoT, blockchain in green solutions), these efforts would help Indonesian startups become competitive players in global green technology markets (United Nations Environment Programme (UNEP), 2020).

In summary, strengthening policy frameworks and financial instruments is central to scaling green technopreneurship in Indonesia. By integrating fiscal incentives, Islamic green finance, regulatory stability, and ecosystem development, policymakers can ensure that green startups are not only economically viable but also aligned with the ethical and sustainability goals that Indonesia aspires to achieve.

Empowering Entrepreneurs to Build Scalable, Ethically Grounded, and Innovative Green Business Models

While government policy provides the enabling environment for green technopreneurship, the success of this ecosystem ultimately depends on the capacity of entrepreneurs to design, scale, and sustain business models that balance profitability, innovation, and ethical responsibility. In the Indonesian context, empowering entrepreneurs means equipping them with not only financial and technical resources but also with a value-driven framework rooted in Islamic ethics.

A central finding of this study is that many Indonesian green startups are clustered in early-stage development, often constrained by limited capital, small team sizes, and restricted market access. This "valley of death" in entrepreneurship—where promising ideas fail to transition into scalable businesses—requires deliberate empowerment strategies (Organisation for Economic Co-operation & (OECD), 2021). Entrepreneurial training programs, mentorship networks, and partnerships with universities and incubators are critical in building the managerial and technical skills necessary to scale. Equally important, access to digital tools such as artificial intelligence (AI), Internet of Things (IoT),

and blockchain can strengthen startups' ability to innovate in energy monitoring, waste management, and eco-certification (United Nations Environment Programme (UNEP), 2020).

Beyond technical and managerial aspects, Islamic ethical principles offer entrepreneurs a powerful branding and trust-building advantage. Embedding values such as *khalifah* (stewardship), *maslahah* (public benefit), and israf (avoidance of waste) into business models can differentiate Indonesian startups in both domestic and international markets. For example, recycling startups that explicitly frame their mission as reducing waste in accordance with Qur'anic teachings against excess consumption (Qur'an 7:31) may resonate more deeply with Muslim consumers and communities. Such ethical positioning can enhance legitimacy and expand market acceptance, especially in regions where faith-based values strongly influence consumption choices (Raimi & Bamiro, 2025).

Empowerment also requires building collaborative ecosystems that connect entrepreneurs with investors, policymakers, and global partners. Indonesia has already begun fostering partnerships in renewable energy through initiatives with ASEAN and international organizations (World Bank, 2022). Expanding such collaborations to include startup-level exchanges—where Indonesian entrepreneurs can learn from and partner with counterparts in countries such as Malaysia, the UAE, and Germany—would expose them to best practices in green innovation. These transnational linkages not only provide access to capital but also enable the diffusion of knowledge and technology.

At the same time, addressing structural barriers is essential. Limited access to financing remains a primary obstacle for green entrepreneurs, especially in the early stage. Conventional venture capital is often reluctant to invest in sustainability-focused startups due to longer return-on-investment horizons. Islamic social finance instruments, such as zakat-based microgrants, waqf-based venture funds, and Islamic crowdfunding platforms, can fill this gap by aligning with both entrepreneurial needs and religious obligations (Dusuki & Abdullah, 2024). Such funding mechanisms can ensure that promising startups do not collapse prematurely and that their growth trajectories remain ethically grounded.

Finally, empowerment efforts must prioritize inclusivity, ensuring that women and youth are not marginalized in the green entrepreneurship landscape. Studies have shown that women entrepreneurs play a vital role in sustainability-focused businesses, particularly in areas such as waste management and sustainable agriculture (United Nations Environment Programme (UNEP), 2020). Equipping women and youth with green skills and entrepreneurship training can broaden participation, enhance innovation, and distribute the benefits of green technopreneurship more equitably across society.

In sum, empowering entrepreneurs to build scalable, ethically grounded, and innovative green business models requires a multi-pronged approach: strengthening technical capacity, embedding Islamic ethical values, fostering collaborative ecosystems, addressing financing gaps, and promoting inclusivity. Together, these strategies can enable green entrepreneurs to thrive as both economic actors and ethical stewards, advancing sustainability goals while remaining true to Indonesia's religious and cultural context.

Mobilizing Faith-Based Communities as Catalysts for Ethical Green Innovation and Grassroots Sustainability

Faith-based communities in Indonesia play an essential role in shaping social behavior, collective action, and ethical orientation. With over 230 million Muslims, Indonesia represents the largest Muslim population in the world, where religious values are deeply embedded in everyday life, including economic and environmental practices. Mobilizing faith-based communities, therefore, is not just an optional strategy—it is a powerful catalyst for promoting ethical green innovation and strengthening grassroots sustainability initiatives.

One of the findings in this study reveals that while entrepreneurs and government institutions provide top-down structures for green technopreneurship, faith-based organizations (FBOs) such as Islamic boarding schools (pesantren), mosque networks, and Islamic NGOs often operate as influential intermediaries between policy frameworks and local communities. These institutions possess extensive social capital and moral authority, allowing them to shape public perceptions of environmental responsibility. For instance, pesantren with "eco-pesantren" programs have demonstrated the ability to

integrate Islamic teachings with practical initiatives like organic farming, renewable energy adoption, and waste recycling (Albar et al., 2024).

Religious leaders (ulama and kyai) have significant influence in framing sustainability as an extension of ibadah (acts of worship). Sermons, study circles (halaqah), and Friday prayers can serve as platforms to reinforce ethical consumption, waste reduction, and support for green businesses. By positioning environmental stewardship as a spiritual duty—aligned with the Qur'anic principle of *khalifah* (stewardship of the earth)—faith-based messaging can translate abstract sustainability concepts into religiously meaningful practices (Qur'an 2:30; Qur'an 6:141).

Faith-based communities also act as incubators of grassroots innovation. Many small-scale sustainability practices—such as urban farming in mosque courtyards, cooperative waste banks managed by women's groups, and renewable energy cooperatives in rural areas—emerge from community initiatives grounded in faith values. These local solutions, when aggregated, contribute significantly to national sustainability targets while ensuring inclusivity and cultural relevance. The embedding of Islamic ethics ensures that these innovations remain people-centered, not solely profit-driven, thereby reducing the risks of exploitation and environmental neglect.

Another critical role of faith-based communities is in mobilizing Islamic finance instruments to support green innovation. Mosque-based zakat collection units (UPZ), waqf boards, and Islamic microfinance institutions (BMTs) can be channeled towards funding small-scale green projects, from solar panels for community centers to eco-friendly irrigation systems for farmers. This aligns with the broader objective of connecting Islamic social finance with the Sustainable Development Goals (SDGs), ensuring that ethical entrepreneurship receives both moral legitimacy and financial backing (Rosman et al., 2022).

Furthermore, mobilizing faith-based communities creates opportunities for interfaith collaboration in sustainability. In many regions, Muslim, Christian, Hindu, and Buddhist organizations have already worked together on disaster relief and environmental campaigns. Expanding this cooperation to green technopreneurship initiatives can build stronger social cohesion, reduce conflict over resource use, and accelerate grassroots adoption of sustainable practices. Indonesia's plural society provides fertile ground for such collaborations, reinforcing the idea that caring for the environment transcends religious boundaries while still being anchored in faith values.

To maximize their impact, faith-based mobilization should be systematically integrated into national sustainability strategies. Government agencies, NGOs, and universities can partner with FBOs to co-develop curricula, training modules, and community-based projects that merge Islamic ethical principles with modern green technologies. Such partnerships will help ensure that the green transition in Indonesia is not only technologically advanced but also socially inclusive and culturally resonant.

In essence, mobilizing faith-based communities as catalysts for ethical green innovation and grassroots sustainability creates a bottom-up dynamic that complements top-down policy interventions and entrepreneurial initiatives. By combining spiritual motivation, social trust, and practical grassroots solutions, Indonesia can foster a green technopreneurship ecosystem that is both ethically grounded and widely embraced by its people.

Bridging Gaps Between Policy, Market, and Community to Ensure a Sustainable Ecosystem for Green Technopreneurship

A sustainable ecosystem for green technopreneurship in Indonesia cannot rely solely on government policies, entrepreneurial innovation, or grassroots initiatives in isolation. Instead, the success of such an ecosystem depends on the effective integration and coordination of these three critical pillars: policy, market, and community. Current challenges indicate that despite promising initiatives in each sector, the lack of alignment and synergy often limits the scalability and long-term impact of green entrepreneurship. Bridging these gaps is therefore essential to ensure that green technopreneurship is both economically viable and socially inclusive.

From a policy perspective, Indonesia has made considerable strides in promoting green investment and sustainability. The issuance of sovereign green sukuk since 2018 illustrates the government's commitment to channeling Islamic finance towards climate-resilient infrastructure projects (World

Bank, 2020). However, many small and medium-sized enterprises (SMEs), particularly startups, continue to face regulatory and bureaucratic barriers when attempting to access financial incentives or licensing for renewable energy projects. This suggests that while policies exist, their accessibility and inclusiveness for grassroots innovators remain limited. The gap between regulatory frameworks and entrepreneurial needs highlights the necessity of simplifying procedures, providing clearer guidelines, and decentralizing support to regional and community levels.

On the market side, demand for green products and services in Indonesia is rising, driven by increasing consumer awareness of climate change, urban waste challenges, and the appeal of eco-friendly lifestyles. A survey Nielsen, (2019)found that 64% of Indonesian consumers are willing to pay more for sustainable products, signaling strong market potential. Nevertheless, many green startups still struggle to penetrate mainstream markets due to limited marketing resources, lack of consumer trust, and insufficient infrastructure for scaling. For example, renewable energy startups face challenges with grid integration and distribution networks, while sustainable food businesses encounter obstacles in certification and supply chain logistics. Bridging this market gap requires multi-stakeholder partnerships that connect startups with investors, distributors, and certification bodies to strengthen their credibility and outreach.

Meanwhile, the community dimension remains central to embedding sustainability in local practices. Grassroots participation ensures that green initiatives are not only technologically sound but also socially acceptable and culturally relevant. Yet, community adoption often lags behind due to limited awareness, affordability issues, or perceptions that green technologies are “luxuries” for the elite. This is where the alignment of Islamic ethics with environmental values offers a unique pathway: framing sustainable consumption and green entrepreneurship as both moral obligations (fard kifayah) and acts of worship can significantly increase community buy-in (Nasr, 2019). For example, waste recycling initiatives framed as acts of avoiding israf (excessiveness) or renewable energy adoption positioned as fulfilling the *khalifah* role resonate strongly within Muslim-majority contexts.

Bridging these three pillars—policy, market, and community—requires ecosystemic thinking. One practical approach is the creation of “Green Technopreneurship Hubs” that serve as platforms for collaboration among government agencies, entrepreneurs, researchers, and faith-based organizations. These hubs could provide technical training, facilitate access to green financing (including Islamic finance instruments), and host certification services, all within a community-driven framework. Moreover, digital platforms powered by data science can play a crucial role in reducing transaction costs, enabling transparent monitoring of green investments, and connecting startups to both local and global green supply chains (Muo & Azeez, 2019).

In the Indonesian context, bridging gaps also means addressing inequalities in resource distribution between urban and rural areas. While Jakarta and other metropolitan regions have seen a surge in green startups, rural communities often remain excluded despite their critical role in agriculture, forestry, and renewable energy potential. Policies and markets must therefore ensure inclusivity by targeting rural entrepreneurship with tailored programs, capacity-building, and decentralized financing models. Only by integrating rural communities into the ecosystem can green technopreneurship contribute fully to national sustainability targets and SDG commitments.

In sum, bridging the gaps between policy, market, and community is not simply about coordination but about creating mutually reinforcing linkages. Policies must be designed with market realities and community needs in mind, markets must be accessible and trustworthy for entrepreneurs and consumers alike, and communities must see themselves as active stakeholders in green innovation rather than passive recipients. When these three dimensions converge, green technopreneurship in Indonesia can transition from isolated initiatives to a cohesive ecosystem capable of driving systemic change.

CONCLUSION

This study has examined the role of green technopreneurship at the intersection of technology, Islamic ethical values, and sustainable development, with particular attention to the Indonesian context. Drawing on descriptive analysis, cluster mapping of startups, and alignment with Islamic ethical principles, the findings highlight that green technopreneurship is not only a driver of innovation but

also a moral and social imperative in addressing global and local sustainability challenges. The evidence shows that green startups in Indonesia are increasingly active in sectors such as renewable energy, sustainable agriculture, waste management, and eco-friendly consumer goods, all of which directly contribute to the advancement of the Sustainable Development Goals (SDGs).

The integration of Islamic ethical principles—*khalifah* (stewardship), *maslahah* (public benefit), and avoidance of israf (wastefulness)—provides a distinct normative foundation that strengthens the legitimacy of green entrepreneurship within Muslim-majority societies. These principles serve as both motivational and regulatory mechanisms, encouraging entrepreneurs to innovate responsibly and align their practices with societal and environmental well-being. In this way, green technopreneurship transcends profit-seeking behavior to embody a holistic model of business that is economically viable, ethically grounded, and socially inclusive.

At the same time, the study emphasizes the importance of creating a sustainable ecosystem through the effective bridging of policy, market, and community. Policies such as green sukuk financing and renewable energy regulations offer structural support but must be made more accessible to startups and SMEs. The growing market demand for sustainable products presents new opportunities, yet requires stronger linkages between entrepreneurs, investors, and consumers. Meanwhile, faith-based communities hold significant potential as grassroots catalysts, mobilizing social capital, Islamic finance, and religious narratives to foster environmental stewardship and inclusive participation.

The implications of this research are threefold. First, policymakers should design integrated frameworks that link regulatory incentives with Islamic financial instruments, thereby providing both institutional and faith-based legitimacy for green entrepreneurs. Second, entrepreneurs must leverage Islamic ethical values not only as a source of innovation but also as a branding advantage to build consumer trust and loyalty. Third, communities—especially faith-based organizations—should be systematically engaged to ensure that green initiatives are culturally relevant, socially embedded, and widely embraced.

In conclusion, green technopreneurship emerges as an important strategy for Indonesia to strengthen resilience while advancing sustainable development. By synergizing technology, Islamic ethics, and social values, Indonesia can position itself as a global leader in ethical green innovation. The convergence of these dimensions offers not only solutions to environmental crises but also a transformative vision of entrepreneurship that balances growth with responsibility, faith with science, and local action with global sustainability commitments.

REFERENCE

Albar, M. K., Hamami, T., Sukiman, S., & Roja Badrus Z, A. (2024). Ecological Pesantren as an Innovation in Islamic Religious Education Curriculum: Is It Feasible? *Edukasia Islamika*, *9*(1), 17–40. https://doi.org/10.28918/jei.v9i1.8324

Antara News. (2024). *Indonesia fulfilled 61.4 percent of SDG indicators, dy minister says*. https://en.antaranews.com/news/376013/indonesia-fulfilled-614-percent-sdg-indicators-dy-minister-says

Auda, J. (2008). *Maqasid al-Shariah as philosophy of Islamic law: A systems approach*. International Institute of Islamic Thought.

Badan Pusat Statistik (BPS). (2024). *Statistik Energi Baru dan Terbarukan Indonesia 2023/2024*. https://www.bps.go.id

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, *11*(4), 589–597.

Business Indonesia. (2024). *Energy overview: Primary energy mix*. https://business-indonesia.org/energy_overview

Campbell, J. L., Quincy, C., Osserman, J., & Pedersen, O. K. (2013). Coding in-depth semistructured interviews: Problems of unitization and intercoder reliability and agreement. *Sociological Methods & Research*, *42*(3), 294–320.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage.

Crunchbase. (2024). *Green startups in Indonesia*. https://www.crunchbase.com

Dusuki, A. W., & Abdullah, N. I. (2024). Maqasid al-Shariah, Maslahah, and Corporate Social Responsibility (2007). *American Journal of Islam and Society*, *41*(1), 10–35.

Eliza, A., Rifan, D. F., Ningsih, N. W., & Susanto, I. (2025). Integrating Islamic economic principles into green campus implementation: Empirical evidence from Indonesia universities. *El-Usrah: Jurnal Hukum Keluarga*, *8*(1). https://doi.org/10.22373/4a9y5n69

Flick, U. (2018). *An introduction to qualitative research* (6th ed.). Sage.

Ghazali, R., Yusuf, Y. S. M., Said, S., & Darwin, D. (2025). Potential and Challenges of Renewable Energy Management: Socio-economic Perspective in Indonesia. *Journal of Business Management and Economic Development*, *3*(02), 608–617. https://doi.org/10.59653/jbmed.v3i02.1545

Global Islamic Economy Report. (2022). *State of the Global Islamic Economy 2022–2023*. DinarStandard.

Hasbullah, Y., Christiana, R. R., Bernarto, I., & Uno, S. S. (2022). Islamic work ethics and entrepreneurial orientation to micro business' financial performance in micro business of Muslim family. *Jurnal Aplikasi Manajemen*, *20*(2). https://doi.org/10.21776/ub.jam.2022.020.02.01

International Energy Agency (IEA). (2022). *Renewables 2022: Analysis and forecast to 2027*. https://www.iea.org/reports/renewables-2022

Ishak, R., & Frifalia, A. (2024). Green products and shariah-compliant firms in Indonesia and Malaysia: The role of board gender diversity. *Global Review of Islamic Economics and Business*, *12*(1), 45–62. https://doi.org/10.14421/grieb.2024.121-03

JakartaGlobe. (2025). *Indonesia Eyes 70% Renewable Energy Share After 2030 Despite Coal Reliance*. https://jakartaglobe.id/business/indonesia-eyes-70-renewable-energy-share-after-2030-despite-coal-reliance

Khaliq, A. (2024). The Role of Green Accounting in Islamic Finance: Opportunities and Challenges in the Era of ESG. *IECON: International Economics and Business Conference*, *2*(2), 887–907.

Kuckertz, A., Br"andle, L., Gaudig, A., Hinderer, S., Reyes, C. A., Prochotta, A., Steinbrink, K., & Berger, E. S. C. (2020). Startups in times of crisis – A rapid response to the COVID-19 pandemic. *Journal of Business Venturing Insights*, *13*, e00169. https://doi.org/10.1016/j.jbvi.2020.e00169

Ma'zumi, M., Syihabudin, S., & Najmudin, N. (2023). The effect of Islamic character education factors on green entrepreneurial behavior: A case of state university students in Banten Province. *Edukasi Islami: Jurnal Pendidikan Islam*, *12*(4). https://doi.org/10.30868/ei.v12i04.4410

Ministry of Energy, & Resources, M. (2021). *Indonesia Energy Transition Outlook*.

Muo, I., & Azeez, A. A. (2019). Green entrepreneurship: Literature review and agenda for future research. *International Journal of Entrepreneurial Knowledge*, *7*(2).

Nasr, S. H. (2019). *Man and nature: The spiritual crisis of modern man*. Routledge.

Nielsen. (2019). *The sustainability imperative: New insights on consumer expectations*.

Noor, A., & Rahmawati, N. (2024). Key factors in developing Muslim Gen Z green entrepreneurship. *Journal of Islamic Business*, *3*(2), 101–115. https://doi.org/10.33379/jihbiz.v8i2.4507

Organisation for Economic Co-operation, & (OECD), D. (2021). *Financing SMEs and Entrepreneurs 2021: An OECD Scoreboard*. OECD Publishing. https://www.oecd.org/en/publications/financing-smes-and-entrepreneurs_23065265.html

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71

PwC Indonesia. (2021). *The Next Wave: Investment in the Indonesian startup ecosystem*.

Raimi, L., & Bamiro, N. B. (2025). Role of Islamic sustainable finance in promoting green entrepreneurship and sustainable development goals in emerging Muslim economies. *International Journal of Social Economics*. https://doi.org/10.1108/IJSE-05-2024-0408

Renewable Energy Indonesia (REI). (2025). *Data Energi Terbarukan Indonesia*. https://renewableenergy.id/data-energi-terbarukan/

Reuters. (2025). *Coal subsidies and policy instability threaten Asia's energy transition*. https://www.reuters.com/sustainability/climate-energy/coal-subsidies-policy-instability-threaten-asias-energy-transition-2025-09-10/

Rosman, R., Redzuan, N. H., Mokhtar, N. Z. N., Ali, E. R. A. E., & Mohammed, M. O. (2022). Islamic social finance and sustainable development goals: issues and challenges. *Journal of Islamic Finance*, *11*(2), 56–67. https://doi.org/10.31436/jif.v11i2.690

The Global Economy. (2024). *Renewable power capacity in Indonesia*. https://www.theglobaleconomy.com/Indonesia/renewable_power_capacity/

The Holy Qur'an. (n.d.). *The Holy Qur'an (2:30; 6:141; 7:31)*.

United Nations Environment Programme (UNEP). (2020). *Sustainability and circularity in the value chain*. https://www.unep.org/resources/publication/sustainability-and-circularity-textile-value-chain-global-roadmap

Urbaniec, M., Małkowska, A., & Kosała, M. (2021). Green entrepreneurship as a driver of sustainable development: Goals, practices, and challenges. *Sustainability*, *13*(11), 6113.

Vegirawati, T. (2024). Muslim students' environmental awareness and green entrepreneurial intention: An extended theory of planned behavior approach. *International Journal of Islamic Economics and Finance Studies*, *10*(2), 133–152. https://doi.org/10.54427/ijisef.1365422

World Bank. (2020). *Indonesia's green sukuk: Financing the transition towards a sustainable future*.

World Bank. (2022). *Indonesia Country Climate and Development Report*.

World Bank. (2024). *World Development Indicators: Indonesia*. https://databank.worldbank.org/source/world-development-indicators

The Holy Qur'an (2:30; 6:141).

The Holy Qur'an. (7:31).