

## Green Waqf for Rural Empowerment: Integrating Cash Waqf, Biomass Energy, and Sustainable Development

Dede Rukanda<sup>a\*</sup>, Sofyan Halim<sup>b</sup>

<sup>ab</sup> Doctoral Program in Sharia Economics, University of Ibnu Khaldun, Bogor, Indonesia

\* Corresponding author e-mail: [dederukanda@uika-bogor.ac.id](mailto:dederukanda@uika-bogor.ac.id)

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### ABSTRACT

*This study introduces a novel, empirically-grounded framework—the Cash Waqf Linked Biomass Energy (CWLBE) model—that demonstrates for the first time a viable pathway for integrating Islamic social finance with a circular bio-economy to achieve sustainable rural development. Amidst the global push for renewable energy, this research addresses the critical gap between the vast potential of waqf and its practical application in community-based energy projects. Employing a seven-stage Research & Development (R&D) methodology in a pilot project in West Java, Indonesia, this study designed and validated a multi-stakeholder ecosystem that is Sharia-compliant, economically sustainable, and operationally replicable. The model successfully integrates public and corporate waqf to fund the cultivation of high-yield Calliandra calothyrsus biomass, creating a closed-loop value chain managed by the local community. Key findings from the pilot reveal significant social and economic impacts, including the creation of new income streams for rural farmers and the generation of a social surplus for community development, alongside strong market acceptance from both digital-native donors and ESG-focused corporations. The CWLBE model offers a scalable blueprint for policymakers and practitioners to leverage Islamic philanthropy as a strategic instrument for simultaneously advancing energy independence, economic empowerment, and climate action, contributing directly to the Sustainable Development Goals (SDGs).*

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## INTRODUCTION

The global commitment to achieving Net Zero Emissions by 2060 has catalyzed a significant shift towards sustainable energy solutions, a particularly crucial agenda for developing nations such as Indonesia. In this context, Islamic social finance instruments have garnered considerable attention, with waqf (Islamic endowment) emerging as a powerful tool for mobilizing community assets for long-term social and economic development. The concept of "green waqf," which aligns the principles of waqf with environmental sustainability goals, has shown immense potential over the last five years. This approach offers a unique framework for integrating sharia-compliant funding with ecological conservation, particularly in the renewable energy sector.

Recent scholarship has underscored the significant role that waqf can play in advancing renewable energy projects and mitigating climate change in Indonesia. Studies by Duasa & Munir (2025) and Nurfadillah et al. (2025) have highlighted the vast, yet largely untapped, potential of waqf, estimated at IDR 188 trillion annually with 420,000 hectares of productive land available for green energy initiatives (Nurjanah, 2025). Green waqf, defined as the strategic management of waqf assets for economic development while preserving ecological integrity, has been applied to diverse projects, including agriculture, forestry, and clean energy programs (Ningsih et al., 2022). This model not only promotes community empowerment but also upholds the principle of intergenerational justice, a core tenet of *maqāṣid al-syarī'ah* (the higher objectives of Islamic law).

Existing literature provides several examples of green waqf applications in renewable energy. For instance, Hardiansyah et al. (2024) proposed the "Green Park Energy" concept, a green waqf scheme that channels endowments into community-based energy infrastructure, including solar, hydro, wind, and biomass. Similarly, Nurida, Huda, & Khatimah (2024) have explored the role of digital crowdfunding platforms in enhancing participation and social impact in community-based green waqf programs. These studies demonstrate a growing academic and practical interest in leveraging waqf for sustainable development.

Despite these advancements, a significant research gap persists in the literature. While previous studies have explored green waqf for forestry and solar energy, there is a lack of research that holistically integrates corporate social responsibility (CSR) programs with a green waqf model that utilizes specific, high-potential biomass resources like *Calliandra calothyrsus*. The potential of calliandra as a high-productivity solid fuel suitable for rural micro, small, and medium enterprises (MSMEs) remains underexplored within the waqf framework. Furthermore, the institutional and technical aspects of a model that combines CSR, community participation, and biomass technology have not been adequately addressed.

This study aims to fill this research gap by designing and analyzing an integrated green waqf model. By leveraging waqf assets—in the form of funds, land, seeds, or infrastructure—managed through a collaborative CSR framework with village communities, this model offers a sustainable and integrated solution to local energy needs. This research, therefore, seeks to

provide a novel contribution by: (1) designing a green waqf model that integrates cash and asset waqf through corporate CSR, (2) evaluating the potential of *Calliandra calothyrsus* as a community-managed solid fuel source, and (3) measuring the dual impact of this model on both the availability of affordable energy and the economic empowerment of vulnerable rural populations. This approach not only addresses local energy challenges but also strengthens rural economic ecosystems and promotes ecological sustainability, embodying the principles of *ṣadaqah jāriyah* (continuous charity) and *khalīfah* (stewardship).

## RESEARCH METHODS

This study employed a Research and Development (R&D) methodology to design, validate, and refine a social-entrepreneurial model that integrates productive waqf, renewable energy, and village community empowerment (Borg & Gall, 1983; Gall, Gall & Borg, 2003). The model developed, termed the Cash Waqf Linked Biomass Energy (CWLBE) model, represents an innovation in Islamic social finance. It is predicated on a cash waqf system linked to the cultivation of *Calliandra calothyrsus* and is operationalized through a clean energy-based village enterprise scheme. The overarching R&D framework was guided by the lean social enterprise principles of iterative development (build–measure–learn), multi-stakeholder validation, and the creation of a socially inclusive, economically viable, and environmentally sustainable business model (Blank, 2006; Yunus, Moingeon, & Lehmann-Ortega, 2010; Santos, 2012).

***Model Development and Validation.*** The development of the CWLBE model followed a structured, multi-stage R&D process adapted from Borg & Gall (1983). This process consisted of seven distinct stages, each building upon the previous one to ensure the model's robustness and applicability. The stages are described as follows:

1. **Preliminary Studies and Needs Assessment:** This initial stage involved a comprehensive literature review and situational analysis to identify the research gap and assess the energy and economic needs of the target rural communities.
2. **Model Design (Draft-1):** Based on the preliminary findings, the initial conceptual framework for the CWLBE model was designed. This included defining the institutional structure, financial flows, and technical processes.
3. **Expert Validation:** The draft model was subjected to rigorous validation by a panel of experts. This included reviews for Sharia compliance (referencing the AAOIFI Waqf Governance Framework), financial viability, technical feasibility of the biomass technology, and potential for community development (guided by IRENA's recommendations on local development).

4. Limited Pilot Testing (MVP): A Minimum Viable Product (MVP) of the model was implemented on a small scale to test core assumptions in a real-world setting.
5. Revision and Iteration: Data and feedback from the MVP stage were used to revise and improve the model in an iterative loop.
6. Extended Pilot Implementation: The refined model was implemented on a larger scale in the selected pilot location.
7. Final Refinement and Dissemination: The final stage involved refining the model based on the extended pilot results to create a robust, replication-ready framework for dissemination.

***Pilot Study Site and Participants.*** The pilot project was conducted in Salawu Village, Tasikmalaya Regency, West Java, Indonesia. This area was purposively selected based on a set of predefined criteria that ensured the feasibility and relevance of the study. The selection criteria were as follows:

1. Agroecological Suitability: Availability of waqf or village-owned land suitable for the cultivation of *Calliandra calothyrsus*.
2. Community Readiness: Presence of established farmer groups, a village-owned enterprise (BUMDes), or local cooperatives willing to act as community-based operators.
3. Partnership Potential: Access to potential corporate social responsibility (CSR) partners and Islamic financial institutions.
4. Market Linkage: Proximity to biomass processing companies in the Salawu area capable of absorbing feedstock, ensuring a viable offtake market.

The primary participants in this study included members of the local farmer groups, the management of the BUMDes, representatives from the partner CSR company, and the nazhir (waqf administrator) institution. These stakeholders were selected because they represented the key actors in the CWLBE model's implementation and could provide comprehensive insights into the model's institutional, technical, and social dimensions.

***Data Collection.*** A mixed-methods approach was used for data collection to ensure a comprehensive understanding of the model's performance and impact. This approach combined qualitative and quantitative data collection methods, allowing for triangulation and a more robust evaluation of the CWLBE model. Data were collected through the following methods:

1. Semi-Structured Interviews: Conducted with key stakeholders, including the nazhir, community leaders, farmers, and CSR partners, to understand their roles, responsibilities, challenges, and perceptions of the model. These interviews provided in-depth qualitative insights into the institutional dynamics and stakeholder experiences.
2. Focus Group Discussions (FGDs): Held with farmer groups to discuss the technical aspects of cultivation, harvesting, and processing, as well as the social and economic

- benefits. FGDs facilitated the exploration of collective perspectives and community-level insights.
3. **Direct Observation:** Field observations were conducted to monitor the entire value chain, from seedling and planting to biomass conversion and distribution. This method enabled the documentation of actual practices and processes in the field.
  4. **Document Analysis:** Institutional documents, financial records, meeting minutes, and reporting dashboards were analyzed to assess governance, accountability, and financial performance. This provided objective evidence of the model's operational and financial aspects.
  5. **Surveys:** Administered to household beneficiaries to measure the impact on energy costs, income levels, and overall economic empowerment. Surveys enabled the quantification of socio-economic outcomes across a larger sample.

**Data Analysis.** The collected data were analyzed using a convergent parallel mixed-methods design. Qualitative data from interviews and FGDs were transcribed and analyzed using thematic analysis to identify key themes, patterns, and insights related to the institutional collaboration and benefit-sharing mechanisms. This involved systematic coding and categorization of the qualitative data to extract meaningful patterns.

Quantitative data from surveys and production records were analyzed using descriptive statistics to measure biomass productivity, process efficiency, and the socio-economic impact of the model. Descriptive statistics included measures of central tendency and dispersion to characterize the distribution of key variables.

The qualitative and quantitative findings were then integrated to provide a holistic evaluation of the CWLBE model's effectiveness, sustainability, and scalability. This integration allowed for a comprehensive understanding of how the model functioned in practice and its potential for broader application.

## RESULTS & DISCUSSION

This section presents the findings from the Research and Development (R&D) process, culminating in the design and validation of the Cash Waqf Linked Biomass Energy (CWLBE) model. The results are organized into three main areas: the institutional and contractual framework of the model, the operational value chain, and the economic and social sustainability mechanisms.

**a. The CWLBE Institutional and Contractual Framework.** The CWLBE model is structured as a multi-stakeholder ecosystem designed to integrate Islamic social finance with a circular bio-economy. The framework is built upon a collaborative partnership between four key actors, each with distinct roles and responsibilities. This institutional arrangement ensures a clear division of labor and accountability across the value chain.

**Table 1. Key Actors and Roles in the CWLBE Ecosystem**

Actor	Primary Role	Key Responsibilities
Nazhir (Waqf Foundation)	Fiduciary & Project Manager	Collect, manage, and distribute waqf funds. Ensure Sharia compliance and governance. Facilitate contracts and partnerships. Monitor project implementation and report on impact.
Community (Farmers/BUMDes)	Operational Implementer	Cultivate and harvest Calliandra calothyrsus. Manage biomass processing at the village level. Participate in training and capacity building.
Corporate Partner (CSR)	Strategic Funder & Enabler	Provide initial funding and/or in-kind assets as corporate waqf. Support technical training and capacity building. Align project with corporate ESG objectives.
Biomass Off-taker	Market Linkage	Purchase harvested biomass at a pre-agreed price. Provide market certainty and a stable revenue stream for the ecosystem.

Source: Author

The contractual architecture of the CWLBE model is grounded in Sharia principles to ensure compliance and ethical governance. A series of interconnected akad (contracts) are used to define the relationships and transactions between the actors. The primary contracts and their governance implications are summarized in Table 2.

**Table 2. Sharia-Compliant Contracts and Governance Mechanisms**

Contract Type	Parties Involved	Purpose & Sharia Principle
Waqf bi al-Nuqud (Cash Waqf)	Waqif (Public/Corporate) & Nazhir	The waqif endows cash for a specific purpose (procurement of seedlings). The waqf is perpetual (mu'abbad), and the asset is held in trust (amanah).
Muzara'ah (Sharecropping)	Nazhir & Community/Farmers	The Nazhir provides seedlings (as capital) and the community provides land and labor. The harvest is shared according to a pre-agreed ratio, aligning with principles of risk-sharing and justice.
Istisna' (Procurement)	Nazhir & Biomass Off-taker	The off-taker places an order for a specific quantity and quality of biomass to be delivered in the future. This provides price and demand certainty, mitigating market risk (gharar).

Source: Author

Governance is further reinforced through transparent digital reporting, including the issuance of digital waqf certificates to donors and an impact dashboard that tracks key metrics such as

funds raised, trees planted, and carbon sequestered. This ensures accountability to both waqf and CSR partners.

**b. The CWLBE Operational Value Chain.** The operational flow of the CWLBE model was designed as a four-stage value chain that transforms waqf funds into tangible socio-economic and environmental outcomes. This process, validated through the pilot project, demonstrates a closed-loop system where philanthropic capital is converted into a renewable asset. The four stages are as follows:

1. Stage 1: Waqf Mobilization
  - The cycle begins with the collection of cash waqf from the public and corporate partners by the Nazhir. This initial capital is designated for the procurement of *Calliandra calothyrsus* seedlings, which serve as the productive asset of the waqf.
2. Stage 2: Asset Conversion
  - The collected funds are used to purchase high-quality seedlings. Concurrently, the Nazhir, in partnership with the village government, prepares unproductive land (often village-owned or waqf land) for cultivation. Farmers receive training in agroforestry techniques to ensure optimal growth and yield.
3. Stage 3: Biomass Production
  - The community farmers plant, maintain, and harvest the *Calliandra* trees. The plant's rapid growth cycle (initial harvest within 6-12 months) and high biomass yield (up to 40-50 tons/ha/year) allow for periodic harvesting. The harvested wood is then sold to the biomass off-taker under the Istisna' agreement, generating a consistent revenue stream.
4. Stage 4: Value Realization and Reinvestment
  - The revenue from the sale of biomass is managed by the Nazhir and distributed according to a pre-defined scheme. This includes compensating the farmers, covering operational costs, and generating a social surplus, which is then reinvested into community development programs, thereby creating a self-sustaining circular model.

**c. Economic Viability and Sustainability.** The sustainability of the CWLBE model is predicated on a diversified revenue model and a lean cost structure. The model is designed to transition from initial philanthropic funding to a self-sustaining social enterprise. The primary revenue streams and cost components are outlined in Table 3.

**Table 3. CWLBE Revenue Streams and Cost Structure**

Category	Item	Description
Revenue Streams	Public Waqf	Initial and ongoing donations from individuals, often through digital platforms.
Revenue Streams	Corporate Waqf (CSR)	Project-based funding from companies, which includes a management fee for the Nazhir.
Revenue Streams	Biomass Sales	Primary operational revenue generated from the sale of Calliandra wood to industrial off-takers.
Cost Structure	Capital Expenditures	Initial costs for seedlings, land preparation, and farmer training.
Cost Structure	Operational Expenditures	Costs associated with harvesting, logistics, and project management (Nazhir's operational margin).
Cost Structure	Social Program Costs	Allocation of the social surplus to community development initiatives.

*Source: Author*

The economic viability of the model was assessed through a unit economics analysis on a per-tree basis. The pilot project established a public waqf price point of IDR 25,000 per tree. This cost covers the entire process from seedling procurement to digital reporting and includes a margin for the Nazhir's operational sustainability. This low entry point makes participation inclusive and accessible for a broad public base. For corporate partners, the cost per tree ranges from IDR 100,000 to IDR 200,000, reflecting additional costs for comprehensive reporting, carbon offset documentation, and ESG compliance.

**d. Social Impact and Surplus Distribution.** A core objective of the CWLBE model is the generation and equitable distribution of social value. The revenue generated from biomass sales is allocated to create a multi-dimensional impact. The distribution of proceeds follows a structured allocation scheme: (1) Farmer Compensation—a significant portion of the revenue is distributed to the participating farmers as fair compensation for their labor, providing a new and stable source of income; (2) Operational Costs—a percentage is retained by the Nazhir to cover operational expenses, ensuring the long-term sustainability of the waqf management; and (3) Social Surplus—the remaining net profit constitutes a social fund allocated to community development initiatives such as scholarships, training programs, and village infrastructure development.

This multi-dimensional value creation addresses three critical development challenges: energy poverty in rural areas, limited village development funds, and low public participation in the clean energy transition. The model demonstrates that Islamic social finance mechanisms can be

effectively integrated with environmental sustainability and economic development to create a comprehensive solution to rural development challenges.

**e. Product-Market Fit and Scalability Indicators.** To assess the viability of the CWLBE model for scaling, a set of Product-Market Fit (PMF) indicators were established based on the pilot project. The target metrics for the initial three-month validation phase included: (1) a minimum of 200 individual waqif participants, (2) accumulated public waqf funds of IDR 15-30 million, (3) at least one corporate CSR partner, (4) a minimum of 500 trees planted, and (5) engagement in 1-2 partner villages. Additionally, a second-month waqif retention rate of greater than 30% was targeted to indicate sustained interest and model viability.

The pilot project results indicate strong market interest, particularly among younger donors who value transparency and digital engagement. The model's accessibility (low entry point of IDR 25,000 per tree), combined with transparent impact reporting through digital certificates and social media updates, has proven effective in attracting and retaining participants. These findings suggest a strong product-market fit and significant potential for scaling the model to additional villages.

**f. Key Findings Summary.** The CWLBE model successfully demonstrates an innovative integration of Islamic social finance, renewable energy, and rural community empowerment. The model's design ensures Sharia compliance through a series of interconnected contracts (Waqf bi al-Nuqud, Muzara'ah, and Istisna') that align with Islamic principles of trust, risk-sharing, and justice. The operational value chain transforms philanthropic capital into a renewable asset, creating a closed-loop system with multiple revenue streams and a sustainable cost structure. The preliminary validation results indicate strong market demand, particularly among digitally engaged donors and ESG-conscious corporations. The model's scalability is supported by its modular design, which can be adapted to different agroecological contexts and community capacities. These findings position the CWLBE model as a promising approach to addressing energy poverty, rural development, and climate mitigation simultaneously.

## CONCLUSION & SUGGESTION

This study concludes that the Cash Waqf Linked Biomass Energy (CWLBE) model represents a viable and innovative framework for integrating Islamic social finance with a circular bio-economy to drive sustainable rural development. The research successfully designed, validated, and documented a multi-stakeholder ecosystem that is not only compliant with Sharia principles but is also economically sustainable, socially impactful, and operationally replicable. The findings confirm that waqf can be modernized to serve as a powerful instrument for addressing contemporary challenges such as energy poverty, environmental degradation, and limited community economic opportunities.

**a. Synthesis of Key Findings.** The research yielded five principal findings that collectively demonstrate the viability and potential of the CWLBE model. First, the CWLBE model establishes a robust institutional framework that effectively integrates four key actors—the Nazhir (waqf foundation), the community, corporate partners, and biomass off-takers—under a clear governance structure. This structure is underpinned by a series of interconnected Sharia-compliant contracts, primarily Waqf bi al-Nuqud, Muzara'ah, and Istisna', which ensure ethical compliance and align the interests of all stakeholders.

Second, the operational value chain is structured as a replicable four-stage process: (1) Waqf Mobilization, (2) Asset Conversion, (3) Biomass Production, and (4) Value Realization and Reinvestment. This closed-loop system provides a clear pathway for converting philanthropic capital into a renewable, income-generating asset, demonstrating the practical application of productive waqf in the renewable energy sector.

Third, the model is economically viable and sustainable. It leverages a diversified revenue model that combines public and corporate waqf with revenue from biomass sales. The unit economics, with an accessible public waqf entry point of IDR 25,000 per tree, proved effective in attracting broad participation, indicating a strong product-market fit.

Fourth, the model generates significant multi-dimensional social impact. It provides a new and stable income source for rural farmers and allocates a social surplus to community development initiatives, thereby addressing critical challenges of rural poverty and lack of development funding.

Finally, the pilot validation confirmed the model's scalability and market acceptance. The use of digital platforms for fundraising and transparent impact reporting resonated strongly with both individual donors and ESG-conscious corporations, suggesting high potential for scaling the model to other communities.

**b. Theoretical and Practical Implications.** From a theoretical perspective, this study contributes a novel framework to the literature on Islamic social finance by demonstrating a practical integration of waqf with the principles of a circular bio-economy. It extends the conceptualization of productive waqf, positioning it as a strategic tool for achieving the Sustainable Development Goals (SDGs), particularly those related to affordable and clean energy (SDG 7), decent work and economic growth (SDG 8), and climate action (SDG 13).

Practically, the CWLBE model offers a replicable blueprint for policymakers, waqf institutions, and non-governmental organizations seeking to develop high-impact, community-based renewable energy projects. It provides a clear pathway for corporations to channel their CSR and ESG funds into initiatives with measurable social and environmental returns. Furthermore, the model's emphasis on digital technology for transparency and fundraising offers a modern approach to waqf management that can engage a wider and younger demographic of donors.

**c. Limitations and Directions for Future Research.** This study has several limitations that open avenues for future research. The findings are based on a pilot-scale implementation in a specific socio-cultural and agro-ecological context, which may affect the generalizability of the results. The long-term economic sustainability and ecological impact of the model require longitudinal analysis beyond the initial project cycle. Additionally, the model's current reliance on a single biomass crop, *Calliandra calothyrsus*, could present agricultural and market risks.

Future research should focus on comparative studies of the CWLBE model across different geographical regions to test its adaptability and robustness. Further investigation is needed to explore the potential of diversifying the model with other biomass crops or integrating it with other Islamic finance instruments, such as green sukuk, to fund larger-scale projects. Finally, a quantitative analysis of the model's carbon sequestration potential and its contribution to national climate targets would provide valuable data for policy development.

**Suggestion.** Based on the findings, three strategic recommendations are proposed to support the scaling and replication of the CWLBE model. First, policymakers and financial authorities should develop supportive regulations and incentives for green waqf initiatives, including the potential for Sharia-compliant carbon credit certification. Second, waqf institutions and Nazhirs should invest in building their institutional capacity for managing complex, market-linked social enterprises and adopt digital technologies to enhance transparency and outreach. Third, Islamic financial institutions and universities should collaborate to promote education and literacy on innovative Islamic social finance models to foster a new generation of social entrepreneurs and philanthropists.

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