ZAKAT FOR GREEN ENERGY: FINANCING SOLAR INFRASTRUCTURE IN ACEH'S FRONTIER REGIONS THROUGH BAITUL MAL

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ABSTRACT - Electricity access inequality persists in Aceh's underdeveloped, frontier, and outermost (3T) hamlets despite the state utility's target of full hamlet electrification by 2027. This study examines whether zakat funds administered by Baitul Mal Aceh (BMA), particularly the *fisabilillah* category, can serve as a financing instrument for off-grid solar (PLTS) infrastructure, and formulates a shariah- and regulation-compliant hybrid financing model. The study applies a descriptive qualitative approach with a case study design. It draws on document review of BMA disbursement records (2021–2024), electrification data from PLN UID Aceh and the Ministry of Energy and Mineral Resources, and the governing zakat and electricity regulations. Thematic analysis is combined with scenario-based gap estimation and SWOT analysis. Findings are triangulated across at least two independent sources for every reported figure. Three results emerge. First, the *fisabilillah* category received IDR 2.76 billion in 2024, only 4.3% of total zakat disbursement, sufficient to finance between one and three pilot hamlets annually under mid-range cost assumptions; broad juristic latitude does not translate into fiscal capacity. Second, IDR 89.2 billion remained undisbursed in 2024, almost equal to the IDR 89.46 billion actually distributed indicating an absorption rate near 50% and locating the binding constraint in regulation and governance rather than in fund availability. Third, the *tamlīk* requirement in zakat jurisprudence can be satisfied through collective mustahik ownership (*shirkah milk*) with Baitul Mal Gampong acting as agent under a *wakālah* contract, provided operation and maintenance costs are shifted to infaq endowment and community tariffs. The Islamic social finance literature on renewable energy relies almost exclusively on waqf, thereby avoiding rather than resolving the *tamlīk* problem. This study addresses that problem directly, and does so in a jurisdiction where zakat is classified as regional own-source revenue, a configuration that materially alters what financing designs are feasible.

Keywords: *productive zakat; renewable energy; off-grid solar; frontier regions; hybrid financing; Aceh*



INTRODUCTION

1. Context and urgency

Aggregate electrification statistics conceal the problem they are meant to describe. Indonesia's national electrification ratio exceeds 99%, yet the Ministry of Energy and Mineral Resources reported in early 2026 that approximately 5,700 villages and 4,400 hamlets still lacked electricity, with full coverage targeted for 2029–2030. The government tripled its Village Electrification (Lisdes) budget to IDR 10.3 trillion for 2026 following IDR 3.6 trillion in 2025 that reached 1,361 locations. Earlier estimates from the Directorate General of Electricity placed total investment needs for universal access — network, generation, service-hour improvement, and connection subsidies — at roughly IDR 50 trillion over 2025–2029.

Aceh sits precisely at this margin. PT PLN (Persero) UID Aceh has committed to electrifying every hamlet in the province by 2027 and uses GIS-based geospatial mapping to identify unserved settlements including Buntul Saraine (Bener Meriah), Perabis (Aceh Singkil), and Pucok Lala (Pidie). Most are classified as 3T areas requiring more than three hours' travel from the district capital. Progress has been real and should be stated plainly: in early April 2026, fourteen locations across Aceh were energised within a matter of days, Perabis among them. This progress changes the composition of the residual problem rather than eliminating it. What remains are the settlements where grid extension is most expensive per connection and slowest to complete — precisely the cases in which cost per household rises sharply with distance and terrain difficulty, a pattern documented across developing-country contexts (Come Zebra et al., 2021).

A second dimension concerns resilience rather than reach. Hydrometeorological disasters in Aceh in late November 2025 disrupted supply to some 6,500 villages; recovery was rapid, but thirteen villages remained unrestored by February 2026, eight of them in Central Aceh. Centralised systems in steep terrain are vulnerable as well as costly to extend. Distributed solar generation offers a property that grid extension does not: continued operation when the trunk network fails.

The Islamic social finance literature has moved decisively from consumptive distribution toward development financing. Hassan et al. (2023) synthesise this shift, arguing that the moral architecture of zakat, waqf, and sadaqah aligns structurally with the Sustainable Development Goals while identifying persistent implementation gaps. Bibliometric evidence confirms both the rapid growth of this field and its conceptual, rather than empirical, character (Ghlamallah et al., 2021; Ma & Sukmana, 2025).

Within this literature, energy applications cluster around waqf. Ari and Koc (2021) develop a waqf-owned financial intermediary for solar power plant financing and demonstrate through agent-based simulation that it reduces wealth inequality where conventional debt-based models increase it. The contribution is theoretically significant because it moves the argument from a normative claim about fairness to a testable distributional mechanism. Hendrasto et al. (2024) extend this logic to Indonesian conditions with a productive waqf-based model for renewable energy investment. Mukhtasor et al. (2023) go further, proposing an Islamic blended finance framework in which social funds absorb risk so that commercial capital becomes willing to participate.

A parallel strand examines market-based Islamic green instruments. Faizi et al. (2024) map Indonesia's Islamic climate finance landscape and identify the greening of Islamic social finance as a distinct and underdeveloped channel alongside capital-market instruments. Work on green sukuk is comparatively mature, covering issuance structures (Endri et al., 2022), systematic evaluation (Alam et al., 2023), investor intentions (Faisal et al., 2023), bibliometric mapping (Qosim et al., 2023), environmental performance relative to conventional green bonds (Ghaemi Asl et al., 2023), and aggregate emissions effects across OIC economies (Irfany et al., 2024). Haron and Azmi (2022) survey Islamic green financing practice more broadly, while Alkhatib and Altarturi (2025) propose fintech-enabled integration of zakat, waqf, and risk-sharing contracts.

On Aceh specifically, zakat research is well established but narrowly bounded. Studies document the effect of productive zakat on mustahik welfare at Baitul Mal Aceh (Salma & Riyaldi, 2022) and at district level (Usman et al., 2022), consistent with findings elsewhere in Indonesia on productive zakat and micro-enterprise outcomes (Mawardi et al., 2023; Santoso et al., 2024; Gofur & Kasri, 2025). Institutionally, Aceh is distinctive: Syahbandir et al. (2022) analyse the constitutional and administrative consequences of zakat's classification as locally generated revenue under Law No. 11 of 2006 and Qanun Aceh No. 10 of 2018 as amended by Qanun Aceh No. 3 of 2021. Azzuhra et al. (2025) assess BMA's performance against a maqāṣid-based index and report substantial underperformance over 2021–2023.

2 Research Gap

Three gaps follow from this mapping. Each is substantive rather than a matter of unexamined geography.

An instrument gap. Energy applications of Islamic social finance rest almost entirely on waqf (Ari & Koc, 2021; Hendrasto et al., 2024). The choice is jurisprudentially sound: waqf is perpetual by design and imposes no



requirement that assets pass into the ownership of designated beneficiaries. For precisely that reason, however, the literature avoids rather than resolves the central obstacle facing zakat-financed infrastructure — the *tamlīk* condition, which requires that zakat property become the property of the mustahik. Until that condition is addressed, proposals to finance energy assets from zakat remain rhetorical.

An institutional-context gap. Existing models generally assume zakat institutions constituted as associations or foundations, with corresponding latitude over investment decisions. Aceh presents a more constrained configuration in which zakat is public revenue subject to state financial administration (Syahbandir et al., 2022). Designs that succeed elsewhere are therefore not transferable by assumption, and feasibility conclusions must be derived from the governing local regime.

A diagnostic gap. Prevailing discourse treats fund scarcity as the operative constraint on zakat-financed development. BMA's 2024 disbursement record points in the opposite direction, and a misdiagnosis here produces misdirected policy: intensifying collection when the deficiency lies in disbursement.

3 Objectives and contribution

The study addresses four questions: (1) what financing capacity does Aceh's zakat, and specifically the *fisabilillah* category, provide for off-grid solar infrastructure in 3T hamlets; (2) how large is the gap between financing requirements and available capacity; (3) what hybrid financing design satisfies both jurisprudential and regulatory constraints; and (4) what policy implications follow for the institutions involved.

The contribution is threefold. Theoretically, the study proposes a resolution to the *tamlīk* constraint through collective mustahik ownership under agency, thereby extending the instrument base for Islamic social finance in infrastructure from waqf to zakat. Empirically, it provides a transparent, replicable gap estimate built from official disbursement data and stated cost assumptions. Practically, it specifies a layered financing model with an accompanying governance architecture that can be tested through a pilot project.

Section 2 develops the literature review and conceptual framework. Section 3 details the method. Section 4 presents results and discussion across seven subsections. Section 5 concludes.

LITERATURE REVIEW AND CONCEPTUAL

1 Energy Poverty as a Distributional Problem

Energy poverty is conventionally defined as the absence of adequate, affordable, reliable, and safe modern energy services. This formulation shifts attention from generation capacity to service delivery. Under it, 3T regions experience two simultaneous failures: a reach failure, since per-connection grid extension costs rise steeply with distance and terrain; and a commercial viability failure, since household consumption is too low to recover capital costs. Their combination produces settlements that are technically electrifiable but financially unattractive to commercial investment.

The technical literature confirms that decentralised systems are the appropriate response at this margin. Come Zebra et al. (2021) review hybrid renewable mini-grid systems across developing countries and identify the conditions under which decentralised generation outperforms extension. Recent work on swarm electrification demonstrates that interconnected solar home systems can progressively aggregate into higher-service configurations, offering an incremental pathway where large capital outlays are infeasible (Fuchs et al., 2023; Sheridan et al., 2023).

The binding constraint, however, is rarely technical. Gill-Wiehl et al. (2022) show in a comprehensive review that community participation — distinct from customer acquisition — is concentrated in the operation and maintenance phase and is decisive for project survival. Wibisono (2023) argues that Indonesian rural electrification policy has been dominated by a coverage-rate storyline in which clean energy considerations remain subordinate, producing programmes optimised for connection counts rather than sustained service. Two design implications follow, and both are incorporated in Section 4.4: maintenance financing must be secured at the design stage rather than left to post-project goodwill, and community participation must be structural rather than consultative.

The distributional implication is equally clear. Neither market mechanisms nor public budgets competing against other sectors will reliably close this margin. Financing whose primary objective is not financial return is required. This is where Islamic social finance acquires analytical, not merely normative, relevance.

2 Islamic Social Finance and Renewable Energy Financing

Zakat, infaq, sadaqah, and waqf differ from commercial capital in ways that matter for financing design. Zakat is obligatory, restricted to eight designated categories (*aṣnāf*), and oriented toward the transfer of ownership. Waqf is voluntary, perpetual, and preserves the corpus while distributing usufruct. Infaq



is voluntary and least restricted in purpose. These are not administrative details; they determine which financing layer each instrument can logically occupy.

The literature exploits these differences explicitly. Ari and Koc (2021) select waqf because perpetuity matches the 25–30 year service life of solar assets. Hendrasto et al. (2024) build on waqf land as an asset base. Mukhtasor et al. (2023) combine social and commercial funds so that the former de-risks the latter. Faizi et al. (2024) identify the greening of Islamic social finance as a channel distinct from capital-market instruments and note that it remains the least developed of the three.

A critical synthesis reveals a shared limitation. Every one of these designs relies on instruments that do not require *tamlīk*, and consequently none addresses the jurisprudential constraint that binds most tightly when zakat funds a shared asset. In Aceh, however, zakat is both the largest instrument by volume and the most institutionalised in governance. Excluding it excludes the largest available resource. The evidence base on green sukuk is instructive here by contrast: it is comparatively mature (Endri et al., 2022; Alam et al., 2023; Qosim et al., 2023) yet concerns sovereign and corporate issuance at a scale and with a risk profile that has no application to a fifty-household hamlet. Instrument choice must follow project scale, not instrument prestige.

3 The *Fisabilillah* Category: Latitude and its Limits

The interpretation of *fī sabīl Allāh* is among the most consequential classical debates for this problem. The four Sunni schools generally read the category as referring to combatants who receive no state stipend. Contemporary jurists, notably Yusuf al-Qaraḍāwī in *Fiqh al-Zakāh*, extend it to any endeavour serving the collective good of the Muslim community, including da'wah, education, media, and social provision (Sukiati, 2016).

Intellectual honesty requires stating the limits of that extension rather than only its permissiveness. Al-Qaraḍāwī's argument rests on two conditions: the activity must serve a demonstrable public benefit (*maṣlaḥah*), and it must not substitute for obligations already resting on the state treasury. The second condition constitutes the most serious objection to the present proposal, since rural electrification is plainly a state responsibility carrying a dedicated budget line of IDR 10.3 trillion for 2026.

The objection can be answered, but only conditionally and narrowly. Zakat cannot be justified as a substitute for state obligation; it can be justified as a complement operating in the residual space that public provision systematically fails to reach within a reasonable horizon, and only where beneficiaries are verified mustahik. With those restrictions, zakat-financed solar provision in 3T hamlets is defensible. Without them, the scheme becomes a transfer of fiscal burden from the state to the funds of the poor. The distinction is one of kind,



not of degree, and Section 4.4 embeds it as a binding eligibility criterion rather than a rhetorical caveat.

4 The *Tamlīk* Constraint and Three Possible Resolutions

Tamlīk — the requirement that zakat property pass into the ownership of the mustahik — is the most technical and most decisive jurisprudential issue here. A communal solar installation with an associated micro-grid is by construction a shared asset, and therefore appears to violate the requirement.

Three resolutions are available, with materially different jurisprudential strength.

The first is individual ownership of household equipment. Zakat finances a standalone solar home system per mustahik household, so the equipment becomes that household's outright property. This is jurisprudentially strongest because *tamlīk* is fully satisfied, but technically and economically weakest: it forgoes economies of scale and complicates centralised maintenance. The swarm electrification literature partially mitigates this trade-off by allowing individually owned systems to be interconnected later (Fuchs et al., 2023; Sheridan et al., 2023).

The second is collective mustahik ownership (*shirkah milk*). The communal asset is owned jointly and proportionally by all beneficiary mustahik households in the hamlet, with Baitul Mal Gampong acting as agent under a *wakālah* contract. This preserves *tamlīk* in the form of co-ownership — a recognised category in Islamic commercial law — while retaining economies of scale. This study proposes it as the most defensible middle path.

The third is a usufruct-only approach in which the institution retains ownership and mustahik receive benefits alone. This is administratively simplest and jurisprudentially weakest, since it effectively suspends *tamlīk*. It is not recommended for zakat funds, though it is entirely sound where the source is infaq or waqf.

5 Conceptual Framework

The framework links four components in sequence. Need is determined by the number of unelectrified 3T hamlets and the unit cost of solar systems. Capacity is determined by the volume of zakat and infaq that is available and allocable. Jurisprudential and regulatory admissibility acts as a filter determining which portion of capacity is genuinely usable. Financing design is the mechanism bridging need and filtered capacity.

Maqāṣid al-sharī'ah enters as an evaluative criterion operationalised into indicators, not as normative ornament. Electricity access supports *ḥifẓ al-nafs* through lighting, medicine refrigeration, and basic health service delivery; *ḥifẓ*



al-'aql through evening study hours; *ḥifẓ al-māl* through extended productive hours for household enterprise; and *ḥifẓ al-dīn* through lighting of prayer facilities and evening religious activity. Azzuhra et al. (2025) demonstrate that maqāṣid-based indices can be applied to BMA's own performance, establishing both the feasibility of this measurement approach and a baseline against which a solar programme could be assessed. Proposed indicators appear in Section 4.6.

METHOD

1 Research design

The study employs a descriptive qualitative approach with a case study design (Creswell & Poth, 2018). The design suits questions of "how" and "why" where the boundary between phenomenon and institutional context is indistinct and the researcher exercises no control over events. The bounded case is BMA's management of zakat funds in relation to financing electrification in Aceh's 3T regions over 2021–2024, with contextual updating through mid-2026.

One point must be stated openly. This article reports the first stage of a broader research design: document review and policy analysis. The second stage — semi-structured interviews with key informants and field observation at candidate pilot sites — had not been conducted at the time of writing. Consequently every finding reported here has the status of a document-based proposition requiring field validation, and is described as such consistently throughout.

2 Data Sources

Four source groups were reviewed.

Zakat financial data. BMA disbursement records for 2021–2024, including the 2024 breakdown by *aṣnāf* category, obtained from official BMA publications and reporting that quotes official BMA statements directly.

Electricity data. PLN UID Aceh village electrification ratios and unelectrified hamlet mapping, the 2027 electrification roadmap, Lisdes programme delivery in Aceh, and national Ministry of Energy and Mineral Resources data as comparative context.

Regulation. Law No. 11 of 2006 on the Governing of Aceh; Law No. 23 of 2011 on Zakat Management; Qanun Aceh No. 10 of 2018 on Baitul Mal as amended by Qanun Aceh No. 3 of 2021; and Indonesian Ulema Council Fatwa No. 86 of 2023 on the Law of Global Climate Change Control.



Cost references. Market price ranges for household- and community-scale solar systems in Indonesia over 2025–2026. The limitations of this source group are acknowledged explicitly in Section 3.5.

3 Analytical Procedures

Analysis proceeded in three stages following Miles et al. (2014): data condensation, data display, and conclusion drawing with verification.

In thematic analysis, documents were openly coded and grouped into four themes derived from the research questions: zakat fiscal capacity patterns, regulatory obstacles, jurisprudential latitude, and financing configuration. Coding was iterative, and no theme supported by fewer than two independent sources is reported as a finding.

In gap estimation, a simple scenario simulation was used. This simulation is illustrative and is not a field measurement. Financing need per hamlet is:

$$B_d = n \times c$$

where B_d is the per-hamlet requirement, n the number of households per hamlet, and c the unit cost of a solar system per household. Zakat financing capacity is:

$$K = Z_f \times \alpha$$

where Z_f is the *fisabilillah* allocation and α the proportion transferable to an electrification programme. The number of financeable hamlets is $D = K/B_d$. The simulation is run across three cost scenarios to expose the sensitivity of results to assumptions.

In SWOT analysis, strengths and weaknesses were derived from BMA's internal institutional characteristics and opportunities and threats from the energy and fiscal policy environment. The matrix was then crossed to generate four strategy groups.

4 Data Validity

Validity was maintained through source triangulation: every figure was corroborated across at least two independent sources. The 2024 zakat and infaq disbursement totals and the category breakdown were cross-checked between official BMA publication and two news agencies quoting the same official statement, then tested for internal consistency by comparing the sum of the seven category allocations against the reported zakat total. Figures failing the consistency check were not used.



5 Methodological Limitations

Three limitations must be stated in advance so that findings can be weighed proportionately. First, the number of unelectrified 3T hamlets in Aceh is not available as published official data. Analysis is therefore presented per hamlet rather than as a provincial total. A provincial figure can only be computed once official PLN UID Aceh data are obtained. Second, unit costs are drawn from general market prices rather than site-specific feasibility studies. Actual costs in 3T locations are almost certainly higher because of logistics, and this premium is not captured in the range used. The estimates here should therefore be treated as a lower bound on cost and an upper bound on capacity. Third, no primary data have been collected. Assessments of stakeholder acceptance, community readiness, and implementation obstacles are inferred from documents and may change once fieldwork is conducted.

RESULT AND DISCUSSION

1 Zakat fiscal capacity: substantial, but not in the expected category

BMA disbursed IDR 89.46 billion in zakat and infaq in 2024 to 29,859 mustahik and beneficiaries, comprising IDR 64.59 billion in zakat to 29,217 mustahik and IDR 24.87 billion in infaq to 642 beneficiaries. The zakat breakdown by category appears in Table 1.

Table 1. Baitul Mal Aceh Zakat Disbursement by *Aṣnāf* Category, 2024

Category	Value (IDR billion)	Share (%)
Miskin (poor)	42.33	65.5
Ibn al-sabīl (wayfarer)	8.41	13.0
Faqīr (destitute)	5.23	8.1
Fisabilillah	2.76	4.3
Muallaf (new convert)	2.38	3.7
Ghārimīn (indebted)	2.19	3.4
'Āmil (administrator)	1.25	1.9
Total	**64.55**	**100.0**

Table 1 yields a first finding that demands interpretive caution. The *fisabilillah* category — jurisprudentially the most elastic and therefore most frequently invoked as the entry point for financing public benefit — is the fourth smallest allocation, at 4.3% of zakat disbursement. The *miskin* category dominates absolutely at 65.5%.

This structure has a direct consequence for zakat-financed energy provision: broad juristic latitude does not by itself constitute broad fiscal latitude. Arguments resting solely on the elasticity of *fisabilillah* without examining its allocated magnitude will systematically overstate available potential. The finding corrects an assumption that recurs implicitly across the productive zakat literature.

2 The Financing Gap: an Illustrative Simulation

To translate fiscal capacity into meaningful units, a scenario simulation was constructed with assumptions stated openly in Table 2.

Table 2. Simulation assumptions for per-hamlet solar financing requirements in 3T areas

Parameter	Low scenario	Mid scenario	High scenario
Households per hamlet	40	50	60
System cost per household (IDR million)	15	20	25
Requirement per hamlet (IDR billion)	**0.60**	**1.00**	**1.50**

Capacity was computed under two allocation scenarios: $\alpha = 1.0$ (the entire *fisabilillah* allocation redirected — unrealistic, but useful as an upper bound) and $\alpha = 0.3$ (partial allocation, more realistic given that *fisabilillah* also funds da'wah and religious activity). Results appear in Table 3.

Table 3. Hamlets financeable by funding source and cost scenario

Funding source	Value (IDR billion)	Low	Mid	High
Fisabilillah, α = 1.0	2.76	4.6	2.8	1.8
Fisabilillah, α = 0.3	0.83	1.4	0.8	0.6
Undisbursed balance, 2024	89.20	148.7	89.2	59.5
Total zakat + infaq disbursed, 2024	89.46	149.1	89.5	59.6

Three patterns follow.

First, under the mid scenario, the *fisabilillah* category under partial allocation finances fewer than one hamlet per year. Even under the unrealistic full-redirection case it reaches approximately three. The implication is unambiguous: a scheme resting solely on *fisabilillah* cannot resolve



electrification in Aceh's 3T regions. It suffices to finance a pilot — and that is precisely where its value lies, as proof of concept rather than as a scaled solution.

Second, the IDR 89.2 billion undisbursed in 2024 corresponds to roughly 89 hamlets under the mid scenario. This figure is nearly identical to the amount successfully disbursed in the same year, implying an absorption rate near 50%. BMA states the cause directly: the regulatory mechanism governing investment and equity participation activities is not yet effective, so those activities could not be executed.

This second finding reverses the diagnosis. The binding constraint on zakat-financed renewable energy in Aceh is not fund scarcity but disbursement incapacity. The policy consequence inverts accordingly: priority belongs to reforming the legal instruments of disbursement, not to intensifying collection. Recommendations urging expanded zakat collection — however conventional in the literature — are misdirected in this context.

Third, results are highly sensitive to cost assumptions, with a 2.5-fold spread between low and high scenarios. Because actual 3T costs likely exceed even the high scenario owing to logistics, all figures in Table 3 should be treated as upper bounds on capacity rather than central estimates.

3 Regulatory Obstacles: Three Interlocking Layers

Document review identifies three obstacles that operate in sequence, such that resolving any one alone is insufficient.

Layer one: zakat's status as regional revenue. Under Law No. 11 of 2006, zakat constitutes Aceh's own-source revenue administered by Baitul Mal. This status confers legitimacy and institutional certainty while simultaneously binding zakat to the regional financial management regime, with its annual budget cycle, standardised expenditure classifications, and accountability mechanisms designed for government spending. Syahbandir et al. (2022) analyse this dual character in detail, showing that the same provision that empowers Baitul Mal also constrains it. The BMA chair has stated publicly that this linkage reduces the flexibility required for broader deployment of funds.

Layer two: the absence of an appropriate expenditure account. The proposed dedicated Zakat Expenditure and Infaq Expenditure accounts remain pending approval from the Ministry of Home Affairs. Without a fitting expenditure classification, disbursement must be forced into available categories — a condition that generates administrative doubt and, in practice, delay. This obstacle is technical and administrative, but its effect is substantial because it operates at the point of execution.

Layer three: the absence of provisions for investment and long-term assets. Investment and equity participation as a basis for sustainable funds could not be executed because the governing mechanism is not yet effectively regulated. Financing solar infrastructure is inherently long-horizon capital expenditure entailing asset ownership, depreciation, and maintenance across budget years. Absent such provisions, zakat-financed solar has no operational foundation whatsoever.

The three layers interlock: resolving layer two without layer three merely smooths consumptive disbursement, while resolving layer three without layer one collides with the annual budget cycle. The second amendment to Qanun Aceh No. 10 of 2018, whose final deliberation was agreed between the Aceh Government and the provincial legislature in October 2025 and forwarded for harmonisation at the Ministry of Home Affairs, is therefore a materially relevant window for this agenda.

4 A Five-Layer Hybrid Financing Model

Drawing on the capacity findings (Sections 4.1–4.2), the jurisprudential constraint (Section 2.4), and the regulatory obstacles (Section 4.3), the study specifies a layered financing model. The design principle is straightforward: each cost layer is funded by the instrument best matched to the nature of that cost under shariah and regulation, rather than by whichever instrument happens to be largest.

Layer 1 — Core capital expenditure: zakat (*fisabilillah* and *miskin* categories). Funds solar panels, storage, controllers, and household installation for mustahik. Ownership transfers to mustahik as *shirkah milk*, with Baitul Mal Gampong acting as agent under *wakālah*. Binding conditions: all beneficiaries must be verified mustahik, and the location must fall outside PLN's grid connection plan for the next three years. The second condition operationalises the limit set out in Section 2.3, preventing zakat from substituting for state obligation.

Layer 2 — Perpetual maintenance fund: infaq and cash waqf. Funds replacement of consumable components, principally batteries, whose service life is materially shorter than that of panels. Infaq is selected for its flexibility of purpose and because maintenance of a shared asset cannot readily be justified as zakat *tamlīk*. Funds are held as a managed corpus whose returns finance maintenance, following the logic of the waqf-owned financial intermediary developed by Ari and Koc (2021).

Layer 3 — Supporting infrastructure: district and village budgets. Funds land acquisition, powerhouse construction, security fencing, access roads, and local operator stipends. Placing these outside zakat matters as a matter of principle:



they are ordinary public expenditures requiring no special shariah justification and already fall within village government authority.

Layer 4 — Knowledge transfer and technical support: corporate social responsibility and PLN. Funds operator training, spare parts provision, performance monitoring systems, and first-year technical accompaniment. This layer addresses the most commonly documented failure mode in community renewable energy projects, where post-project maintenance collapses (Gill-Wiehl et al., 2022).

Layer 5 — Community tariff: beneficiary households. A modest monthly contribution administered by the village-owned enterprise or a local cooperative, calibrated below current household expenditure on kerosene, dry cells, and off-site device charging. Its purpose is not capital recovery — which is not intended — but the formation of ownership and the provision of recurrent maintenance funds. The evidence that community participation concentrates in the operation and maintenance phase supports embedding this layer structurally rather than optionally (Gill-Wiehl et al., 2022).

One theoretical implication requires emphasis. This model is not blended finance in the conventional sense: it involves no return-seeking commercial capital and does not deploy social funds as a risk absorber for investors, in contrast to Mukhtasor et al. (2023). What is blended here are non-profit sources with differing shariah characteristics. The distinction matters because it insulates the design from the objection that community funds are being used to subsidise commercial returns.

5 SWOT Analysis

Table 4. SWOT matrix for zakat-based solar financing in Aceh

Strengths (S)	Weaknesses (W)
S1. Zakat as own-source revenue with firm legal basis	W1. *Fisabilillah* is only 4.3% of zakat disbursement
S2. Baitul Mal structure extends to village level	W2. Absorption rate near 50% in 2024
S3. Large fund volume; IDR 89.2 billion balance available	W3. No approved Zakat/Infaq expenditure account
S4. High social legitimacy of zakat in Aceh	W4. No provisions for investment and long-term assets
S5. Juristic latitude of *fisabilillah* admits public benefit	W5. No in-house technical capacity for energy asset management

Opportunities (O)	Threats (T)
O1. PLN's 2027 full-hamlet target opens partnership space	T1. Juristic objection to zakat funding shared assets
O2. National Lisdes budget raised to IDR 10.3 trillion in 2026	T2. Risk of zakat being seen as displacing state obligation
O3. MUI Fatwa 86/2023 legitimises climate action as *maṣlaḥah*	T3. Post-project maintenance failure in community energy
O4. Second Qanun amendment currently in process	T4. Asset vulnerability to hydrometeorological disaster
O5. Post-2025 disaster demand for energy resilience	T5. 3T logistics costs exceeding planning assumptions

Crossing the matrix produces four strategy groups. S–O strategies position a *fisabilillah*-financed pilot as a formal component of PLN UID Aceh's electrification roadmap, securing technical legitimacy while avoiding locational overlap. W–O strategies use the ongoing Qanun amendment to insert provisions for capital expenditure and long-term asset management. S–T strategies deploy the authority of BMA's Shariah Advisory Board to issue a written opinion on the *shirkah milk* structure, answering jurisprudential objections before implementation rather than after. W–T strategies establish the infaq-based perpetual maintenance fund at the planning stage, addressing post-project failure risk structurally.

6 Governance, Accountability, and Impact Indicators

A financing model without explicit governance will fail at the accountability stage, particularly since Aceh's zakat funds are subject to state audit. Four components are proposed.

Role separation. BMA acts as funder and supervisor; Baitul Mal Gampong as owner's agent on behalf of mustahik; the village-owned enterprise or cooperative as operator; and PLN UID Aceh as technical quality assurer and coordinator with grid planning. Separation prevents conflict of interest between the party disbursing funds and the party assessing performance.

Layered audit. Financial audit follows regional financial management provisions; shariah audit is conducted by BMA's Shariah Advisory Board with focus on contract validity and beneficiary eligibility; technical audit assesses generation performance periodically.

Data-based transparency. Periodic publication of electricity generated, system availability, and maintenance fund utilisation. Remote performance monitoring simultaneously serves as an accountability instrument toward muzakki. Evidence that transparency and digital reporting strengthen zakat management



accountability and growth (Hadi et al., 2024) supports treating this as a design requirement rather than a communications activity.

Maqāṣid-based impact indicators. Following Section 2.5: for *ḥifẓ al-nafs*, the number of health facilities and households with adequate evening lighting; for *ḥifẓ al-'aql*, average evening study hours and school participation rates; for *ḥifẓ al-māl*, the number of new household enterprises and the change in household energy expenditure; for *ḥifẓ al-dīn*, lighting availability at prayer facilities and the frequency of evening religious activity. All indicators are measured before and after intervention, with comparison hamlets where feasible. The maqāṣid index approach applied to BMA by Azzuhra et al. (2025) offers both a methodological precedent and an institutional baseline.

The requirement for a comparison group is methodological rather than administrative. Without it, observed change cannot be distinguished from the trend that would have occurred regardless of intervention.

7 Discussion: Positioning the Findings

The findings engage the literature at three points.

On instrument choice. Mainstream work selects waqf for renewable energy financing (Ari & Koc, 2021; Hendrasto et al., 2024), and that choice is correct for the contexts examined. This study shows that in jurisdictions with strongly institutionalised zakat, such as Aceh, excluding zakat means excluding the largest available resource — conditional on resolving *tamlīk* through *shirkah milk* first. The finding is therefore complementary rather than contradictory.

On the diagnosis of constraints. Most Indonesian productive zakat research identifies collection limitations as the principal obstacle, with attention concentrated on micro-enterprise outcomes (Salma & Riyaldi, 2022; Usman et al., 2022; Mawardi et al., 2023; Santoso et al., 2024; Gofur & Kasri, 2025). BMA's 2024 record shows the opposite pattern in Aceh: funds are abundant but undisbursed. The divergence most plausibly stems from institutional form — zakat bodies constituted as associations do not face the state financial regime that binds BMA (Syahbandir et al., 2022). The implication is that conclusions about obstacles to productive zakat do not generalise across institutional regimes, a caveat largely absent from the comparative literature.

On the limits of the claim. Unlike work presenting Islamic social finance as a scaled solution for energy transition financing (Hassan et al., 2023; Faizi et al., 2024), the simulation in Section 4.2 shows that Aceh's *fisabilillah* capacity supports only one to three pilot hamlets annually. Claims beyond that are unsupported by the data. The strategic value of this scheme lies in proof of concept and partnership leverage, not in replacing public financing. Stating this limit is not a concession; it is what distinguishes a testable proposal from advocacy.



CONCLUSION

This study mapped the potential of Baitul Mal Aceh's zakat funds as a financing instrument for solar infrastructure in 3T regions and specified a hybrid financing model consistent with jurisprudential and regulatory requirements. Four conclusions follow.

First, *fisabilillah* capacity is limited. At IDR 2.76 billion in 2024, or 4.3% of zakat disbursement, the category finances between one and three pilot hamlets annually under mid-range cost assumptions. Broad juristic latitude does not entail broad fiscal latitude.

Second, the binding constraint is regulatory rather than financial. The IDR 89.2 billion undisbursed in 2024 — equivalent to roughly 89 hamlets — reflects the absence of an appropriate expenditure account and of provisions governing investment and long-term asset management.

Third, the *tamlīk* constraint is resolvable through collective mustahik ownership (*shirkah milk*) with Baitul Mal Gampong as agent, provided beneficiaries are verified mustahik and locations fall outside PLN's connection plan for a reasonable horizon.

Fourth, the five-layer hybrid model allocates cost types to instruments by shariah suitability: zakat for core capital expenditure, infaq and waqf for perpetual maintenance, district and village budgets for supporting infrastructure, corporate social responsibility for knowledge transfer, and community tariffs for recurrent maintenance.

Policy Implications

For Baitul Mal Aceh: (1) obtain a written shariah opinion from the Shariah Advisory Board on the validity of *shirkah milk* for communal solar assets before implementation; (2) insert provisions for capital expenditure and long-term asset management into the ongoing second amendment of the Baitul Mal Qanun; (3) prepare a single-hamlet pilot financed from the *fisabilillah* category as proof of concept.

For the Government of Aceh: (4) expedite resolution of the Zakat and Infaq Expenditure accounts with the Ministry of Home Affairs; (5) integrate the zakat financing scheme into regional energy planning documents so that it does not stand as an isolated programme; (6) allocate district budget co-funding for supporting infrastructure at pilot sites.

For PLN UID Aceh: (7) publish the list and characteristics of unelectrified hamlets together with connection schedules, enabling identification of locations



outside the three-year plan as candidates for the zakat scheme; (8) provide technical accompaniment and quality standards for off-grid systems.

For subsequent research: (9) conduct primary data collection through stakeholder interviews and techno-economic feasibility assessment at pilot sites, to test the propositions advanced here.

Limitations and Future Research

This article reports the document review stage of a broader design, so all findings are propositions requiring field validation. Three limitations most affect interpretation. First, the number of unelectrified 3T hamlets in Aceh is not published as official data, so the financing gap can be stated only per hamlet rather than as a provincial total. Second, unit costs derive from general market prices and almost certainly understate actual 3T costs, making the capacity estimates an upper bound. Third, stakeholder acceptance and community readiness remain empirically untested.

Future research should proceed along three lines: primary data collection through interviews and observation at pilot sites; techno-economic feasibility assessment using site-specific costs; and impact evaluation using a before-and-after design with comparison hamlets, employing the maqāṣid-based indicators proposed in Section 4.6.

REFERENCES

Alam, A., Ratnasari, R. T., Jannah, I. L., & El Ashfahany, A. (2023). Development and evaluation of Islamic green financing: A systematic review of green sukuk. *Environmental Economics, 14*(1), 61–72. https://doi.org/10.21511/ee.14(1).2023.06

Alkhatib, I. H. I., & Altarturi, B. H. M. (2025). Integrating zakat, waqf, and risk-sharing contracts through fintech-enabling mechanisms for sustainable Islamic microfinance toward financial inclusion in developing economies: The case of Palestine. *Al Qasimia University Journal of Islamic Economics, 5*(2).

ANTARA News. (2025, February 21). *Baitul Mal Aceh salurkan zakat dan infak Rp89,46 miliar pada 2024* [Baitul Mal Aceh disbursed IDR 89.46 billion in zakat and infaq in 2024]. https://www.antaranews.com/berita/4665629/baitul-mal-aceh-salurkan-zakat-dan-infak-rp8946-miliar-pada-2024

ANTARA News Aceh. (2026, February 9). *Tinggal tersisa 13 desa yang belum berlistrik pascabencana Aceh* [Only 13 villages remain without electricity after the Aceh disaster]. https://aceh.antaranews.com/berita/401026/tinggal-tersisa-13-desa-yang-belum-berlistrik-pascabencana-aceh



Ari, I., & Koc, M. (2021). Towards sustainable financing models: A proof-of-concept for a waqf-based alternative financing model for renewable energy investments. *Borsa Istanbul Review, 21*(S1), S46–S56. https://doi.org/10.1016/j.bir.2021.03.007

Azzuhra, A., Desiana, R., & Fitria, A. (2025). Measuring the performance of zakat management Baitul Mal Aceh based on Maqashid Sharia Index. *International Journal of Zakat*. https://ijazbaznas.com/index.php/journal/article/view/697

Baitul Mal Aceh. (2025). *Baitul Mal Aceh salurkan Rp89,46 miliar dana zakat dan infak ke masyarakat Aceh selama 2024* [Baitul Mal Aceh disbursed IDR 89.46 billion in zakat and infaq funds during 2024]. https://baitulmal.acehprov.go.id/berita/kategori/pemberdayaan/baitul-mal-aceh-salurkan-rp89-46-miliar-dana-zakat-dan-infak-ke-masyarakat-aceh-selama-2024

Bisnis.com. (2026, June 20). *5.700 desa belum terlistriki, pemerintah anggarkan Rp10,3 triliun untuk Lisdes 2026* [5,700 villages unelectrified, government budgets IDR 10.3 trillion for Lisdes 2026]. https://ekonomi.bisnis.com/read/20260620/44/1982087/5700-desa-belum-terlistriki-pemerintah-anggarkan-rp103-triliun-untuk-lisdes-2026

Come Zebra, E. I., van der Windt, H. J., Nhumaio, G., & Faaij, A. P. C. (2021). A review of hybrid renewable energy systems in mini-grids for off-grid electrification in developing countries. *Renewable and Sustainable Energy Reviews, 144*, 111036. https://doi.org/10.1016/j.rser.2021.111036

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.

Detikcom. (2025, June 30). *Duh! 1,28 juta rumah tangga di RI belum teraliri listrik* [1.28 million households in Indonesia still without electricity]. https://finance.detik.com/energi/d-7989459/duh-1-28-juta-rumah-tangga-di-ri-belum-teraliri-listrik

Endri, E., Hania, B. T., & Ma'ruf, A. (2022). Corporate green sukuk issuance for sustainable financing in Indonesia. *Environmental Economics, 13*(1), 38–49. https://doi.org/10.21511/ee.13(1).2022.04

Faisal, Y. A., Gunawan, I., Cupian, Hayati, A., Apriliadi, A., & Fajri, M. (2023). Examining the purchase intentions of Indonesian investors for green sukuk. *Sustainability, 15*(9), 7430. https://doi.org/10.3390/su15097430

Faizi, F., Kusuma, A. S., & Widodo, P. (2024). Islamic green finance: Mapping the climate funding landscape in Indonesia. *International Journal of Ethics and Systems, 40*(4), 711–733. https://doi.org/10.1108/IJOES-08-2023-0189



Fuchs, I., Balderrama, S., Quoilin, S., Crespo del Granado, P., & Rajasekharan, J. (2023). Swarm electrification: Harnessing surplus energy in off-grid solar home systems for universal electricity access. *Energy for Sustainable Development, 77*, 101342. https://doi.org/10.1016/j.esd.2023.101342

Ghaemi Asl, M., Rashidi, M. M., Tiwari, A. K., Lee, C.-C., & Roubaud, D. (2023). Green bond vs. Islamic bond: Which one is more environmentally friendly? *Journal of Environmental Management, 345*, 118580. https://doi.org/10.1016/j.jenvman.2023.118580

Ghlamallah, E., Alexakis, C., Dowling, M., & Piepenbrink, A. (2021). The topics of Islamic economics and finance research. *International Review of Economics & Finance, 75*, 145–160. https://doi.org/10.1016/j.iref.2021.04.006

Gill-Wiehl, A., Miles, S., Wu, J., & Kammen, D. M. (2022). Beyond customer acquisition: A comprehensive review of community participation in mini grid projects. *Renewable and Sustainable Energy Reviews, 153*, 111778. https://doi.org/10.1016/j.rser.2021.111778

Gofur, A. A., & Kasri, R. A. (2025). The role of productive zakat in improving the welfare of mustahik in Indonesia. *International Journal of Zakat, 10*, 87–100. https://doi.org/10.37706/ijaz.v10i4.615

Hadi, R., Shafrani, Y. S., Hilyatin, D. L., Riyadi, S., & Basrowi. (2024). Digital zakat management, transparency in zakat reporting, and the zakat payroll system toward zakat management accountability and its implications on zakat growth acceleration. *International Journal of Data and Network Science, 8*(1), 597–608. https://doi.org/10.5267/j.ijdns.2023.8.025

Haron, A., & Azmi, W. (2022). Islamic green financing: Sustainability in practice. *Journal of Islamic Monetary Economics and Finance, 8*(3), 435–450.

Hassan, M. K., Rana, M. S., Alam, M. R., & Banna, H. (2023). Revitalizing the role of Islamic social finance in achieving the SDGs: A comprehensive review. *Al Qasimia University Journal of Islamic Economics, 3*(2), 1–24.

Hendrasto, N., Mukhlisin, M., Harisuddin, H., & Chairiyati, F. (2024). Designing productive waqf-based financing model for renewable energy investments project: Empirical evidence from Indonesia. *Karatay Journal of Islamic Economics and Finance, 2*(2), 159–171.

Indonesian Ulema Council. (2023). *Fatwa No. 86 of 2023 on the Law of Global Climate Change Control*. Majelis Ulama Indonesia.

Infoaceh.net. (2025, February 22). *Baitul Mal Aceh salurkan Rp89,46 miliar zakat dan infak tahun 2024, masih tersisa Rp89,2 miliar* [Baitul Mal Aceh disbursed IDR 89.46 billion in 2024, with IDR 89.2 billion remaining].



https://infoaceh.net/umum/baitul-mal-aceh-salurkan-rp8946-miliar-zakat-dan-infak-tahun-2024-masih-tersisa-rp892-miliar/

Infoaceh.net. (2025, July 15). *Percepat elektrifikasi, PLN targetkan 100% dusun di Aceh berlistrik pada 2027* [Accelerating electrification, PLN targets 100% of Aceh hamlets electrified by 2027]. https://infoaceh.net/ekonomi/percepat-elektrifikasi-pln-targetkan-100-dusun-di-aceh-berlistrik-pada-2027/

Irfany, M. I., Syam, M. I. N., & Haq, D. A. (2024). The impact of Islamic finance on carbon emissions: Lessons from OIC countries. *International Journal of Energy Economics and Policy, 14*(3), 198–205.

Law of the Republic of Indonesia No. 11 of 2006 on the Governing of Aceh.

Law of the Republic of Indonesia No. 23 of 2011 on Zakat Management.

Ma, Y., & Sukmana, R. (2025). Takeaways from Islamic social finance and sustainable development goals discourse: Review and bibliometric analysis on future directions for zakat, waqf and Islamic microfinance. *Journal of Islamic Accounting and Business Research*.

Mawardi, I., Widiastuti, T., Al Mustofa, M. U., & Hakimi, F. (2023). Analyzing the impact of productive zakat on the welfare of zakat recipients. *Journal of Islamic Accounting and Business Research, 14*(1), 118–140. https://doi.org/10.1108/JIABR-05-2021-0145

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications.

Mukhtasor, Listiana, L., Hidayat, S. E., & Sulaeman, S. (2023). Scaling up renewable energy financing through Islamic blended finance: Case study in Indonesia. *International Journal of Energy Economics and Policy, 13*(5).

Putaran.id. (2026, April 7). *Dari gelap menjadi terang, 8 dusun di pelosok Aceh kini nikmati listrik PLN* [From darkness to light: 8 remote Aceh hamlets now enjoy PLN electricity]. https://putaran.id/dari-gelap-menjadi-terang-8-dusun-di-pelosok-aceh-kini-nikmati-listrik-pln/

Qanun Aceh No. 10 of 2018 on Baitul Mal.

Qanun Aceh No. 3 of 2021 on the Amendment to Qanun Aceh No. 10 of 2018 on Baitul Mal.

Qosim, N., Ratnasari, R. T., Wardhana, A. K., Fauziana, H., & Barkah, T. T. (2023). Eight years of research related to the green sukuk in the global stock exchange market to support the implementation of SDG: A bibliometric review.



Journal of Islamic Economic and Business Research, 3(2), 161–180. https://doi.org/10.18196/jiebr.v3i2.204

Salma, & Riyaldi, M. H. (2022). The effect of utilizing productive zakat, infaq, sedekah (ZIS) in improving mustahik's welfare at Baitul Mal Aceh. *International Journal of Zakat, 7*(2), 77–90.

Santoso, I. R., Mallongi, S., Siradjuddin, & Paly, M. B. (2024). Mediating effects of Islamic business success on productive zakat and mustahiq welfare. *International Journal of Business and Society, 25*(1), 111–127. https://doi.org/10.33736/ijbs.6903.2024

Sheridan, S., Sunderland, K., & Courtney, J. (2023). Swarm electrification: A comprehensive literature review. *Renewable and Sustainable Energy Reviews, 175*, 113157. https://doi.org/10.1016/j.rser.2023.113157

Sukiati. (2016). Pengalihan zakat fisabilillah untuk kepentingan umum menurut Yusuf al-Qaradawi: Sebuah penelitian hukum Islam filosofis [The reallocation of fisabilillah zakat for public benefit according to Yusuf al-Qaradawi: A philosophical study of Islamic law]. *FITRAH: Jurnal Kajian Ilmu-ilmu Keislaman*.

Syahbandir, M., Alqarni, W., Dahlawi, M. A. Z., Husin, M. A., & Abbas, S. (2022). State authority for management of zakat, infaq, and sadaqah as locally-generated revenue: A case study at Baitul Mal in Aceh. *Al-Ihkam: Jurnal Hukum dan Pranata Sosial*.

Usman, R. F. M., Nur, M., & Amru, M. (2022). Dampak penyaluran zakat produktif dalam meningkatkan kesejahteraan mustahiq pada pengelolaan zakat di Baitulmal Aceh Utara [The impact of productive zakat distribution on mustahik welfare in zakat management at Baitulmal North Aceh]. *Jurnal Ekonomi Manajemen dan Bisnis, 23*(1).

Waspada Aceh. (2025, July 15). *PLN komit, tahun 2027 dusun di seluruh Aceh sudah masuk listrik* [PLN commits: all Aceh hamlets electrified by 2027]. https://waspadaaceh.com/pln-komit-tahun-2027-dusun-di-seluruh-aceh-sudah-masuk-listrik/

Wibisono, G. (2023). The contestation of ideas behind Indonesia's rural electrification policies: The influence of global and national institutional dynamics. *Development Policy Review*. https://doi.org/10.1111/dpr.12650

