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Financing Affordable Off-Grid Electricity: Subsidy Design, Implementation and Risk Allocation in Nigeria's DARES and Kenya's KOSAP

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Abstract

Public subsidies support off-grid electrification, but their contribution to affordable service depends on how financing and delivery arrangements operate. This study examined subsidy design, procurement, payment arrangements and risk allocation in Nigeria's Distributed Access through Renewable Energy Scale-up project and Kenya's Off-grid Solar Access Project for Underserved Counties. A comparative documentary assessment used publicly available programme documents and relevant research, with structured questions and a process-tracing framework. Comparable standalone-solar and isolated mini-grid activities formed the analytical focus, while programme maturity, unmatched components and reporting periods informed interpretation. The reviewed documents identified distinct financing windows and implementation dependencies involving qualification, land access, safeguards, contracting and verification. They also demonstrated the importance of separating signed agreements, reported installations and inherited obligations. Payment conditions linked public support to compliance, but comparable evidence on processing times and developer liquidity effects remained insufficient. Likewise, deployment figures did not establish household affordability, which required information on upfront charges, recurring payments, financing costs and sustained service use. The assessment supported component-specific reporting, transparent payment tracking, explicit contractual responsibilities and stronger consumer evidence. However, incomplete documentary coding and corroboration prevented definitive causal conclusions or programme rankings. The study contributes an analytical framework connecting financing rules with implementation processes and affordability conditions, while identifying the evidence required for stronger comparative explanations of publicly supported off-grid electricity delivery in practice.

Keywords: Affordability, Off-grid electricity, Payment arrangements, Procurement, Risk allocation, Subsidy design.

1. Introduction

1.1. Background to the Study

Off-grid electricity can extend access to communities where grid expansion remains costly or slow. However, commercially viable provision does not necessarily produce services that poorer households can afford. Developers face substantial investment and operating costs, while consumers encounter connection charges, recurring payments and expenditure on appliances. In Kenya, Best (2023) found that household assets and access to financial accounts were associated with solar adoption, suggesting that supply expansion alone may leave financially constrained households underserved.

Public support seeks to address these constraints, but its design matters. Subsidies can reduce investment costs, procurement can influence competition and delivery obligations, and payment rules can determine how long developers finance activities before reimbursement. Geospatial modelling for Nigeria showed that concessional loans, capital subsidies and productive-use financing affected electrification options differently (Husein et al., 2024). Similarly, Sesan et al. (2024) identified tensions between commercial viability and inclusion in rural mini-grid deployment in Nigeria and Kenya. These findings support examining financing arrangements alongside the services they are intended to sustain.

Nigeria's Distributed Access through Renewable Energy Scale-up project (DARES) and Kenya's Off-grid Solar Access Project for Underserved Counties (KOSAP) provide relevant comparative settings. DARES supports private-sector-led distributed electricity through mini-grids, standalone solar and technical assistance. KOSAP combines several delivery approaches within underserved counties, including household solar financing. Their differing programme histories and component structures require comparison at equivalent activities and implementation stages rather than through aggregate achievements (World Bank, 2023, 2024, 2025).

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1.2. Research Problem and Gap

The central problem concerns how public financing rules translate into implementation and affordable service. A subsidy may improve project viability without establishing that savings reach consumers. Competitive selection may lower requested support while imposing demanding financing obligations. Verification can protect public resources, yet its interaction with payment timing may affect developer liquidity. These are mechanisms requiring investigation, rather than assumed programme effects.

Existing research establishes the importance of investment incentives, household resources and inclusive business models. However, modelling investment responses does not establish how procurement, verification and payment operate during implementation. Likewise, household adoption evidence cannot explain programme contracting and risk allocation. The gap addressed here concerns the connection between these financing arrangements and documented implementation and affordability conditions.

The comparison also requires careful treatment of programme change. KOSAP's public record includes a September 2026 restructuring paper, demonstrating the need to distinguish original arrangements from subsequent revisions (World Bank, 2026).

1.3. Research Questions

The overarching question was: How do subsidy design, procurement, payment arrangements and risk allocation shape implementation and affordability in DARES and KOSAP?

Four questions guided the comparison:

1. How do subsidy eligibility, allocation and verification rules influence developer participation and implementation?
2. How do procurement and contracting arrangements affect competition, project selection and delivery timelines?
3. How do programme payments and consumer payment arrangements distribute financing burdens and affect documented affordability conditions?
4. How does risk allocation interact with institutional conditions to explain implementation differences?

1.4. Research Objectives

The study's overall objective was to explain how financing arrangements shape implementation and documented affordability conditions in the two programmes. Its specific objectives were to:

1. Assess subsidy eligibility, allocation and verification arrangements.
2. Examine procurement and contracting mechanisms.
3. Analyse programme and consumer payment arrangements.
4. Explain risk allocation and its interaction with institutional conditions.

1.5. Scope and Significance of the Study

The study focused on comparable household standalone-solar and isolated mini-grid arrangements, subject to documentary comparability, using public evidence available by 19 October 2026. Other components provided institutional context. Programme maturity was addressed through equivalent implementation milestones, while original designs, revisions, targets and reported delivery were distinguished.

Affordability covered documented upfront charges, recurring payments, financing terms and service entitlements. These indicators did not establish household welfare effects or demonstrate affordability without evidence of consumers' resources and sustained service use.

The study contributes a structured explanation of how public support, contracting and payment responsibilities interact in off-grid delivery. Its practical value lies in identifying financing arrangements that warrant adjustment or stronger verification, while preserving the distinction between intended affordability and demonstrated consumer outcomes.

2. Literature Review

2.1. Conceptual Review

2.1.1. Subsidy Design and Commercial Participation

Off-grid subsidies address differences between service-delivery costs, expected revenues and consumers' payment capacity. Their effects depend on eligibility, allocation, verification and disbursement rules. Capital support and productive-use financing serve different functions and should not be treated as interchangeable. Husein et al. (2024) demonstrated this distinction through Nigerian electrification modelling, which produced different investment configurations under alternative incentives. Subsidy effectiveness therefore requires examination of implementation alongside intended financial benefits.

2.1.2. Procurement and Payment Arrangements

Procurement determines entry requirements, competition, selection and contractual obligations. Programme payments concern transfers to developers or suppliers; consumer payments concern connection charges, instalments and recurring service costs. Their interaction can affect working-capital requirements and service continuity. Guajardo (2021) showed that repayment frequency and flexibility were associated with different payment patterns in off-grid solar accounts, supporting attention to contractual detail rather than payment-model labels alone.

2.1.3. Risk Allocation and Affordability

Risk allocation concerns responsibility for construction, demand, payment default, verification, maintenance and regulatory uncertainty. Affordability encompasses initial access and sustained use, including service quality and financing terms. It cannot be inferred from a subsidised installation or low advertised payment alone. Best

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(2023) linked household assets with solar adoption, while Harrington and Hsu (2024) found that warranties and customer support influenced rural Kenyan solar choices. Affordability assessment consequently requires financial and service dimensions.

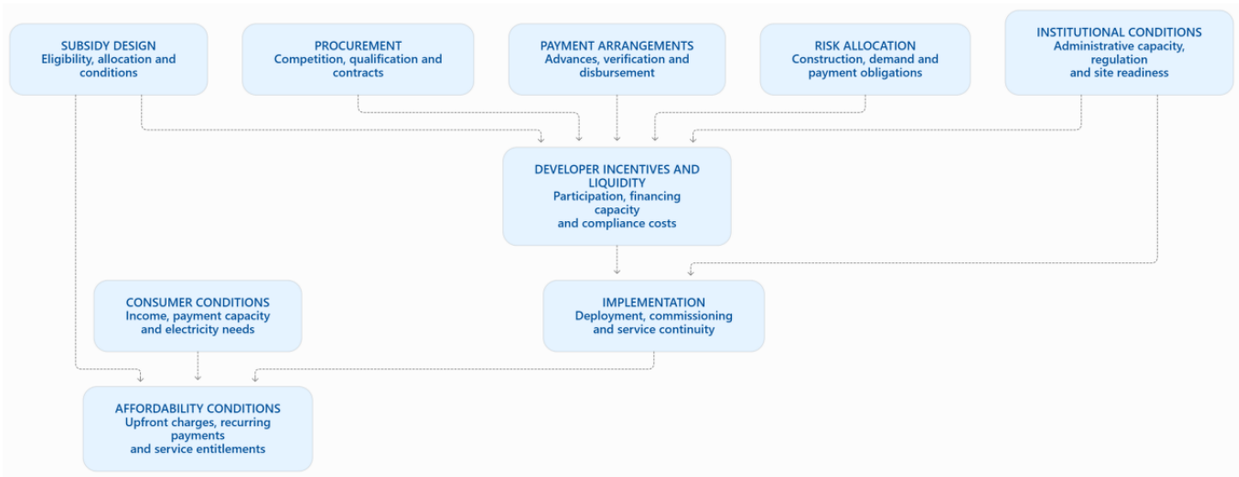


Figure 1. Financing-to-delivery mechanisms linking public support with off-grid electricity implementation and affordability conditions.
Source: Authors' conceptual synthesis, informed by Husein et al. (2024), Sesan et al. (2024), Guajardo (2021), and Best (2023).

2.2. Theoretical Review

Market-failure theory explains public support where high delivery costs, financing constraints or wider social benefits discourage commercially sufficient investment. However, support must address an identifiable constraint. Husein et al.'s (2024) modelling illustrated why financing instruments can produce different electrification outcomes, providing contemporary support for examining instrument–constraint alignment.

Principal–agent theory directs attention to differing objectives and information among funders, implementing agencies, developers and consumers. Verification and performance conditions can align incentives, but the analysis must also examine their payment and compliance implications. Transaction-cost economics complements this perspective by considering the costs of bidding, contracting, monitoring and adaptation under uncertainty. These mechanisms were analytical expectations, not assumed programme findings. Guajardo's (2021) repayment evidence reinforced the importance of examining how contractual arrangements operated in practice.

Principal–agent theory and transaction-cost economics underpinned the comparison of procurement, verification, payment and implementation. Market-failure theory provided the rationale for assessing public support, while preserving the distinction between developer viability and consumer affordability.

2.3. Empirical Review

Wamalwa et al. (2025) modelled irrigation demand and capital subsidies for Kenyan mini-grids. Productive loads reduced simulated tariffs, although additional subsidies remained necessary to achieve grid parity under the modelled conditions. The study demonstrated interactions between demand and financing, but its scenario results did not establish realised programme affordability or implementation performance.

Sesan et al. (2024) examined two mini-grid developers in Nigeria and Kenya. Their analysis suggested that supporting agricultural value chains could improve inclusion and commercial viability. However, the proposed model required further financing, policy support and testing; it did not establish effects attributable to DARES or KOSAP.

Harrington and Hsu (2024) used a discrete-choice experiment with rural Kenyan households. Warranties and after-sales support influenced choices alongside financing options, demonstrating that service safeguards mattered. Stated preferences, however, did not establish sustained affordability or actual programme uptake.

Husein et al. (2024) assessed Nigerian electrification incentives through geospatial and regulatory analysis. Their findings favoured differentiated support across technologies and financing needs, but modelled investment responses could not explain actual procurement delays or payment administration.

Best (2023) found associations between household assets, financial accounts and Kenyan solar adoption. Guajardo (2021), analysing solar-lamp repayment pilots, documented extensive use of payment flexibility. Both informed affordability analysis, although neither identified the effects of the programme arrangements examined here.

Collectively, these studies supported an integrated financing perspective. The remaining task was to explain how documented subsidy, procurement and payment rules interacted within comparable implementation stages, while separating intended affordability from demonstrated consumer outcomes.

3. Methodology

3.1. Research Design

The study adopted an embedded comparative case-study design combining structured documentary analysis with process tracing. DARES and KOSAP constituted the programme-level cases, while comparable financing windows formed the embedded units. The design addressed how subsidy, procurement, payment and risk-allocation arrangements could influence implementation and affordability.

Documentary analysis provided the basis for examining formal rules and reported implementation, consistent with Morgan's (2022) discussion of document selection and interpretation. Process tracing supplied the framework for connecting contractual arrangements with observable implementation sequences, rather than estimating average programme effects (Podestà, 2023).

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3.2. Case Selection and Comparison Boundaries

The cases were selected purposively because both programmes supported off-grid electricity provision through public financing and commercial participation, while operating under different institutional arrangements.

Comparisons were restricted to household standalone-solar and isolated mini-grid activities where financing functions and service objectives aligned. Ownership, procurement and operating responsibilities remained explicit comparison variables. Interconnected mini-grids, rooftop solar, clean cooking and other unmatched activities provided context rather than direct performance comparisons.

Programme maturity was addressed through milestone-based comparison: eligibility and selection, contracting, deployment, verification, payment and service operation. Cumulative achievements were not treated as directly comparable without accounting for elapsed implementation time and component scope.

3.3. Documentary Sources and Selection

The documentary scope covered publicly accessible material available by 19 October 2026. Relevant sources included appraisal and financing documents, implementation reports, restructuring papers, procurement notices, programme guidelines, regulatory instruments and evaluations. Peer-reviewed research informed interpretation but did not substitute for programme-specific evidence.

Documents qualified for inclusion when their provenance, programme relevance and substantive contribution could be established. Superseded versions remained relevant for tracing changes, while duplicate copies were linked. Publication dates were distinguished from the periods described. Material concerning Nigeria's preceding Electrification Project required explicit separation from DARES activities and transitional obligations.

The final document count and complete source register had not yet been established; therefore, a completed documentary census was not claimed.

3.4. Common Coding Framework

A common framework was specified for both programmes, allowing the same questions to guide extraction.

Table 1. Documentary coding framework.

Dimension	Information to extract
Subsidy design	Eligibility, allocation basis, caps, conditions and revisions
Procurement	Selection method, qualification requirements, competition and contractual obligations
Programme payments	Advances, milestones, verification, approval and disbursement
Consumer payments	Deposits, connection charges, instalments, tariffs and default provisions
Risk allocation	Construction, demand, currency, payment, maintenance and regulatory responsibilities
Implementation	Dated milestones, delays, reported delivery and corrective action
Affordability	Documented charges, financing terms, service entitlements and supporting consumer evidence

The framework distinguished contractual requirements, administrative reports and independently corroborated observations. Coding and source reconciliation required completion before these categories could support final findings.

3.5. Process Tracing and Cross-Case Analysis

The tracing framework linked financing rules with expected intermediate observations. For example, a claim that verification delayed developer payment required evidence of claim submission, verification, approval and disbursement dates. A delay alone could not establish its cause.

The analysis required consideration of competing explanations, including incomplete submissions, land acquisition, regulatory approval, budget constraints and supply disruptions. Chronological association was insufficient for causal attribution. Within-case explanations preceded cross-case comparison, consistent with process tracing's emphasis on mechanisms rather than effect-size estimation (Podestà, 2023).

3.6. Affordability Assessment and Evidential Limits

Affordability assessment distinguished initial access costs from continuing payments and service quality. Charges could support descriptive comparison, but demonstrated affordability required evidence concerning household resources, payment difficulties and sustained use. Different products, service tiers and financing periods required separate treatment.

Source appraisal considered authorship, purpose, proximity to events, completeness and corroboration, following Morgan (2022). Repeated administrative figures did not constitute independent confirmation. Full coding, timeline reconstruction and independent checking remained incomplete at this drafting stage. Consequently, the methodology supported a transparent research design, but did not yet justify claims of completed process tracing, verified household affordability or welfare effects.

4. Results and Discussion

4.1. Documentary Evidence and Comparison Boundaries

The reviewed documents revealed differences in delivery arrangements, implementation dependencies and reported progress. These findings supported a bounded documentary comparison rather than a completed causal evaluation. Programme reports were treated as administrative evidence, while targets, contractual commitments and reported installations remained distinct.

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Table 2 summarises the principal observations. The KOSAP document was a restructuring paper, rather than an implementation-status report, and was interpreted accordingly.

Table 2. Selected documentary observations.

Dimension	DARES	KOSAP
Delivery arrangements	Separate mini-grid grant and tender windows	Mini-grid EPC/O&M procurement and household solar RBF
Implementation dependencies	Qualification, site approval, agreements and compliance	Land arrangements, safeguards, procurement and contracting
Reporting distinction	Legacy obligations separated from new activities	Household solar progress separated from mini-grid delivery
Evidential boundary	Agreements were not completed installations	Forecast commissioning was not verified delivery

Sources: World Bank (2024, 2025) and Rural Electrification Agency [REA] (2025).

4.2. Subsidy Design and Developer Participation

DARES documentation distinguished performance-based grants from minimum-subsidy tenders, indicating that participation operated through different selection routes (World Bank, 2025). KOSAP's household-solar arrangements similarly used competitively awarded RBF grants, whereas mini-grid provision followed a different contracting structure (World Bank, 2024). Consequently, neither programme could be represented by a single subsidy mechanism.

This differentiation was consistent with Husein et al. (2024), whose modelling showed that alternative incentives affected electrification options differently. However, the documents did not establish whether one allocation mechanism caused greater competition, lower consumer prices or better delivery. Such conclusions required comparable bid, award and implementation records.

Table 3. Comparative financing arrangements and documented risk responsibilities in DARES and KOSAP.

Panel A. Household standalone-solar financing.

Dimension	Nigeria: DARES	Kenya: KOSAP	Comparative interpretation
Public-support mechanism	Standalone-solar support within a private-sector-led electrification programme	Competitively awarded RBF grants supporting solar providers in underserved counties	Compare equivalent household-solar windows rather than total programme financing
Provider selection	Technical, financial and environmental/social qualification	Competitive applications and grant agreements with solar service providers	Eligibility requirements influence entry; participation effects require application and award records
Verification and payment	Appraisal design linked payments to verified results; detailed conditions depended on implementation documents	Independent verification supported RBF implementation	Payment conditions were documented; comparable processing times were not established
Pre-payment financing exposure	Providers potentially financed activities before verified reimbursement	Providers potentially financed eligible activities before results-based payments	Actual exposure depended on advances, financing terms and payment timing
Consumer payment arrangements	Comparable household-level terms were not established from the reviewed evidence	Comparable household-level terms were not established from the reviewed evidence	Programme grants should not be treated as direct consumer price reductions
Affordability evidence	Deployment reporting did not establish sustained household affordability	Deployment reporting did not establish sustained household affordability	Assess deposits, total payments, service quality and payment difficulties separately

Sources: World Bank (2023, 2024, 2025). Statements concerning pre-payment exposure are analytical implications requiring contractual verification.

Panel B. Isolated mini-grid financing and contracting.

Dimension	Nigeria: DARES	Kenya: KOSAP	Comparative interpretation
Delivery structure	Appraisal design envisaged privately financed, owned and operated mini-grids supported by subsidies	Reviewed restructuring paper described procurement of engineering, procurement and construction (EPC) and operation and maintenance (O&M) contracts	Financing and ownership models were not interchangeable
Allocation and procurement	Minimum-subsidy tenders and performance-based grants constituted separate routes	Competitive procurement of EPC/O&M packages	Analyse each route separately; tender competition does not itself establish lower consumer charges
Developer obligations	Private participation included financing the balance of capital costs and meeting programme requirements	Contractor obligations followed EPC/O&M arrangements	Private financing exposure cannot be equated with contractor performance obligations
Payment basis	Appraisal design specified verification and grant milestones	Restructuring paper identified anticipated advances and subsequent works payments	Planned payment arrangements were not evidence of actual payment performance
Site and regulatory requirements	Community agreements, eligibility and regulatory compliance formed part of project development	Land arrangements, community engagement and safeguards affected procurement readiness	Compare readiness at equivalent stages before attributing differences to subsidies

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Construction and maintenance risk	Private ownership and operation implied continuing developer responsibilities, subject to contracts	EPC/O&M contracting assigned specified delivery functions	Exact liabilities, guarantees and remedies required contract-level assessment
Demand and revenue risk	Private operating structure indicated potential exposure; precise allocation required agreements	Allocation was not established by the reviewed restructuring paper	Do not infer revenue-risk allocation solely from procurement structure
Affordability provisions	Subsidy support could reduce financing requirements; tariff pass-through was not established	Public financing and procurement did not independently establish household affordability	Neither arrangement supported an affordability ranking

Sources: World Bank (2023, 2024) and REA (2025). Appraisal provisions describe intended design; later manuals and signed agreements may revise them.

4.3. Procurement and Implementation Dependencies

KOSAP's restructuring account linked land acquisition, community engagement and safeguards requirements with delays in procurement preparation. This provided an administrative explanation of a sequence through which institutional requirements affected implementation. It did not demonstrate that subsidy inadequacy caused the delays (World Bank, 2024).

DARES reporting identified qualification, site approval, agreement execution and disbursement as separate stages. REA (2025) reported 379 approved and signed isolated mini-grid projects; that status did not establish commissioning. The comparison therefore indicated the importance of tracing intermediate milestones before interpreting programme expenditure or agreements as delivered electricity access.

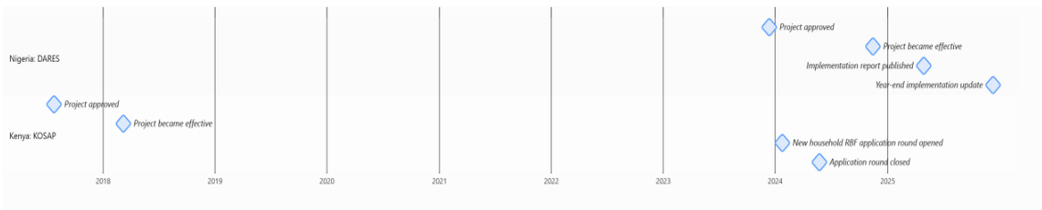


Figure 2. Selected documented milestones in DARES and KOSAP, showing programme maturity and implementation reporting.
Source: Authors' compilation from World Bank (2024, 2025) and Rural Electrification Agency (2025).

Programme	Additional milestone	Date precision and interpretation
KOSAP household solar	Eight new solar-provider RBF agreements became effective	August 2024; exact day was not established and is therefore omitted from the dated graph
DARES isolated mini-grids	REA reported 379 projects approved and signed	Reported on 12 December 2025; this was a reporting snapshot, not a common signing or commissioning date

The timeline places documented milestones in calendar order, making differences in programme maturity visible. It distinguishes approval and effectiveness from financing-round events and reporting dates. KOSAP's longer history prevents direct interpretation of cumulative achievements as superior performance. Missing milestones remain evidence gaps. The figure supports chronological comparison but does not establish component delivery durations, causal mechanisms or household affordability outcomes.

4.4. Payment Arrangements and Risk Allocation

Payment conditions connected developer compliance with access to public support. REA (2025) warned that inaccurate claims would be rejected, documenting a verification requirement but not its average processing time or liquidity effect. KOSAP's restructuring paper reported resolution of earlier unpaid RBF claims, without establishing a comparable developer-level payment-duration measure.

Table 4. Risk questions supported by the documentary comparison.

Risk	Documentary assessment required
Pre-payment financing	Who funded activities before reimbursement?
Verification	What conditions triggered acceptance or rejection?
Construction and maintenance	Which contractual party carried each obligation?
Consumer default	Who absorbed missed payments or service interruption?
Regulatory and land access	How were responsibilities and delays allocated?

These questions identified mechanisms for further tracing; they did not establish which programme allocated risks more efficiently.

4.5. Affordability and Integrated Interpretation

Reported deployment demonstrated programme activity, but did not establish household affordability. Comparable evidence on deposits, total payments, tariffs, service quality and payment difficulties remained insufficient for ranking the programmes.

This distinction accorded with Best's (2023) finding that household resources influenced solar adoption and Harrington and Hsu's (2024) evidence that warranties and customer support mattered alongside financing. Sesan et al. (2024) likewise showed why commercial viability and inclusion required joint consideration.

The reviewed evidence suggested that financing rules operated through procurement readiness, compliance and institutional coordination. It did not yet establish their independent effects. The defensible conclusion was

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therefore that programme design required component-specific assessment, while claims about affordability and implementation superiority remained conditional on fuller documentary coding and corroboration.

5. Summary, Recommendations and Conclusion

5.1. Summary of Findings

The documentary comparison examined how subsidy design, procurement, payment arrangements and risk allocation shaped implementation and documented affordability conditions in DARES and KOSAP.

Four observations emerged. First, both programmes contained distinct financing and delivery arrangements, making programme-wide comparisons insufficient. Second, implementation depended on intermediate processes, including qualification, land access, safeguards, contracting and verification. Third, payment conditions connected public support with compliance, but available evidence did not establish comparable processing times or developer liquidity effects. Fourth, financing commitments, signed agreements and reported installations did not demonstrate household affordability.

These observations supported component-specific analysis. They did not establish that either programme delivered superior implementation or more affordable electricity.

5.2. Recommendations

Programme agencies should align financing arrangements with component-specific constraints. Subsidy assessments should distinguish investment costs, market-entry expenses, operating requirements and consumer payment capacity. Grant and procurement windows should have clearly stated objectives and measurable delivery obligations.

Implementing institutions should coordinate procurement with site readiness. Land arrangements, safeguards and regulatory approvals should inform procurement schedules. Progress reporting should distinguish site preparation, contract award, construction, commissioning and operational service.

Programme managers should improve payment transparency. Public reporting should record claim submission, verification, approval and disbursement dates. These records would help identify payment bottlenecks and assess whether financing arrangements impose substantial working-capital burdens. Clear procedures should address incomplete submissions, rejected claims and disputes.

Contracts should make risk responsibilities explicit. Financing and procurement documents should identify responsibility for construction delays, demand shortfalls, maintenance, consumer default and regulatory changes. Reporting should distinguish contractual allocation from losses actually experienced.

Affordability monitoring should extend beyond **connection numbers.** Agencies should document upfront charges, recurring payments, total financing costs, service entitlements and payment difficulties. Consumer evidence should establish whether households can sustain service use, rather than assuming that subsidised provision ensures affordability.

5.3. Contribution and Limitations

The study's analytical contribution was to connect financing design with the administrative and contractual processes through which electricity services were delivered. It also distinguished developer support from consumer affordability and separated implementation milestones from completed outcomes.

The comparison remained limited by unequal programme maturity, different component structures and incomplete disclosure. Full documentary coding, timeline reconstruction and independent corroboration had not been completed. Administrative explanations of delays therefore remained reported accounts rather than independently established causal mechanisms. Available evidence also could not establish household welfare effects or support an affordability ranking.

5.4. Conclusion

The reviewed evidence indicated that off-grid financing arrangements operated through procurement readiness, compliance requirements, payment administration and institutional coordination. Public funding alone could not establish whether these processes produced timely delivery or affordable, sustained service.

DARES and KOSAP consequently required comparison at equivalent components and milestones. The evidence supported clearer reporting of implementation stages, payment performance and contractual responsibilities. Stronger conclusions about causal mechanisms and consumer affordability depended on completing the documentary analysis and obtaining corroborating evidence.

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