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Recent Advances in Energy Infrastructure Financing and Opportunities for Strengthening the Financial Sustainability of Independent Power Producers in Sub-Saharan Africa

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ABSTRACT

Independent power producers (IPPs) have become the principal channel for private investment in electricity generation in Sub-Saharan Africa (SSA), yet the financial sustainability of these projects remains fragile. Most IPPs sell to a single, state-owned utility whose revenues fail to cover costs, whose tariffs are politically constrained and whose payment record is uneven. This paper reviews the advances in energy infrastructure financing that had taken shape by 2023 and identifies opportunities to strengthen IPP financial sustainability. It uses an integrative literature review of multilateral, governmental and peer-reviewed sources published between 2008 and 2023, combined with comparative case analysis of South Africa, Ghana, Kenya and Nigeria. The synthesis identifies seven areas of advance: competitive procurement and standardised contracts; credit enhancement and liquidity support; intermediary and non-utility offtake; legal and market reform; local-currency and domestic capital; blended and climate finance; and digitalisation of payments, analytics and asset management. The 2023 evidence also exposes persistent weaknesses, including utility arrears, political challenges to power purchase agreements, currency depreciation and grid constraints. Drawing on this synthesis, the paper proposes a conceptual model in which financing enablers affect IPP sustainability through five transmission channels (offtaker solvency, cost of capital, risk allocation, contract legitimacy and asset performance), moderated by macroeconomic conditions, grid capacity and institutional capacity, and assessed at project, offtaker and system levels. The discussion shows that most advances reduce perceived risk or transfer it, while fewer address the solvency of the offtaker. The paper sets out implications for policy, practice and theory, acknowledges its limitations and proposes an agenda for future research.

Keywords: independent power producers; project finance; power purchase agreements; offtaker risk; guarantees; blended finance; local-currency finance; utility reform; Sub-Saharan Africa

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1. INTRODUCTION

Sub-Saharan Africa entered 2023 with the largest electricity access deficit of any world region. Roughly 600 million people lacked access to electricity, and per capita installed generation capacity was a small fraction of that of other developing regions. Public finances, already stretched by the pandemic, rising interest rates and debt distress in several countries, cannot by themselves fund the generation, transmission and distribution investment needed to close this gap. Private capital is therefore not an optional supplement to public investment; it is a structural necessity.

Since the early 1990s, the dominant vehicle for private investment in African power generation has been the independent power project: a privately financed, usually greenfield plant funded on a non-recourse or limited-recourse basis and backed by a long-term power purchase agreement (PPA) with a state-owned utility or another creditworthy buyer (Eberhard and Gratwick, 2011). The World Bank's landmark review of five countries with the deepest IPP experience (Kenya, Nigeria, South Africa, Tanzania and Uganda) concluded that IPPs had become the primary vehicle for private investment in the region's power sector and that their contribution could be greatly expanded if countries combined dynamic least-cost planning with

timely, competitive procurement and appropriate risk mitigation (Eberhard et al., 2016).

The experience since then has been mixed. South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) became a global reference point for competitive renewable energy procurement. Elsewhere, however, IPPs have been caught in the financial distress of their offtakers. Utilities in many countries recover only part of their costs, accumulate arrears, and depend on irregular government transfers. When the utility cannot pay, the IPP's lenders turn to guarantees and letters of credit, and governments find that contingent liabilities they once considered remote have become actual fiscal costs. In several countries, high capacity payments under take-or-pay contracts signed during supply crises have become politically contentious once those crises eased.

This paper takes stock of where the region stood in 2023. It asks two questions. First, what advances in energy infrastructure financing have improved the ability of IPPs to reach financial close and operate sustainably? Second, what opportunities exist to strengthen the financial sustainability of IPPs, not only in the narrow sense of lenders being repaid but in the broader sense of IPP contracts being affordable for utilities and consumers, and therefore durable over their 20 to 25 year lives?

The paper is organised as follows. Section 2 describes the research method. Section 3 presents the results and discussion: a synthesis of the literature and of country experience in 2023, a conceptual model with propositions, a discussion of the findings, and their implications for policy, practice and theory. Section 4 concludes, setting out the paper's limitations and directions for future research.

2. Research Method

2.1 Research design

The paper uses an integrative literature review combined with comparative case analysis. An integrative review is suited to fields where evidence is spread across different types of source and disciplines, and where the aim is to synthesise that evidence into new frameworks and perspectives rather than to estimate a single effect size (Torraco, 2005; Snyder, 2019). IPP financing in Sub-Saharan Africa fits this description: the relevant evidence sits in multilateral reports, government and programme documents, academic journals in energy policy and finance, and a growing body of applied research on procurement, audit, power systems engineering and digital infrastructure. The comparative case analysis grounds the synthesis in the concrete events of 2023.

2.2 Sources and search strategy

Evidence was drawn from four streams. The first is the foundational literature on IPPs and power sector reform in Africa, together with reports by the World Bank, the International Energy Agency (IEA), IRENA and the African Development Bank. The second comprises official programme and legal documents, including South African procurement announcements, Nigeria's Electricity Act 2023 and Kenya's review of power purchase agreements. The third is a consolidated, multidisciplinary bibliography of peer-reviewed studies covering energy procurement and supply chains, corporate and public finance, audit and risk governance, banking, power systems engineering, asset integrity, cybersecurity and energy transition. The fourth consists of contemporaneous reporting on 2023 events in the four case countries, used only to establish facts such as arrears levels and legislative dates.

2.3 Inclusion and exclusion criteria

Sources were included if they were published between 2008 and 2023, consistent with the paper's 2023 vantage point; addressed Sub-Saharan Africa, other emerging economies or issues directly transferable to them; and dealt with at least one of the following: financing and risk allocation, procurement, offtaker finances, grid and asset performance, governance and compliance, or the digital systems that support them. Sources published after 2023 were excluded. Studies whose subject matter had no plausible bearing on power sector finance or infrastructure, such as purely clinical or agronomic research, were also excluded.

2.4 Analytical approach

The analysis proceeded in three steps. First, each source was coded against two frames: the level at which it bears on financial sustainability (project, offtaker or system) and the type of financing advance or challenge it addresses. Second, the coded material was synthesised thematically into the landscape, advances and country evidence presented in Sections 3.1 to 3.3. Third, the recurring relationships identified in the synthesis were abstracted into the conceptual model and propositions in Section 3.4. The four case countries were selected purposively to provide variation: South Africa as the leading example of competitive procurement, Ghana as a case of utility arrears and overcontracting, Kenya as a case of political scrutiny of contracts, and Nigeria as a case of market decentralisation.

2.5 Rigour and quality appraisal

Primary sources were preferred for factual claims, and figures were checked across more than one source where possible. Conceptual and review papers in the multidisciplinary bibliography were treated as sources of mechanisms and propositions rather than as empirical proof. Table 1 summarises the methodological choices.

Table 1. Summary of the methodology

Element	Approach adopted
Design	Integrative literature review with comparative case analysis
Time window	Sources published 2008 to 2023; no sources after 2023

Element	Approach adopted
Source types	Multilateral and agency reports; legal and programme documents; peer-reviewed journal articles; contemporaneous reporting for factual context
Inclusion criteria	Relevance to SSA or transferable emerging-market settings; bearing on financing, risk, procurement, offtaker finances, grid and asset performance, governance or supporting digital systems
Coding frames	Level of sustainability (project, offtaker, system); type of financing advance or challenge
Cases	South Africa, Ghana, Kenya and Nigeria, selected for variation in experience
Outputs	Thematic synthesis (Sections 3.1 to 3.3); conceptual model and propositions (Section 3.4)

Source: Author.

3. Results and Discussion

This section presents and discusses the results of the review. Sections 3.1 to 3.3 synthesise the literature on the financing landscape and its persistent challenges, the advances in financing that had emerged by 2023, and the evidence from country experience in 2023. Section 3.4 develops a conceptual model and propositions from this synthesis. Section 3.5 discusses the findings, and Sections 3.6 and 3.7 set out their implications for policy, practice and theory.

3.1 The financing landscape and persistent challenges

3.1.1 Scale and sources of finance

Investment needs are large. The International Energy Agency's *Africa Energy Outlook 2022* estimated that achieving the continent's energy and climate goals would require more than doubling energy investment this decade, with clean power generation, grids and access accounting for much of the increase. Earlier World Bank work estimated the annual cost of addressing SSA's power needs at around US$40 billion, far above actual spending (Eberhard et al., 2016). Africa attracted only a small share, around 2 percent, of global clean energy investment in the years leading to 2023, despite holding a large share of the world's best solar resource (IEA, 2023a).

Private IPP finance in SSA has historically come from a relatively narrow pool: DFIs (such as IFC, the African Development Bank, Proparco, FMO, DEG, British International Investment and the US International Development Finance Corporation), export credit agencies, a handful of international commercial banks, and, in South Africa, a deep domestic banking and institutional investor market. Sponsors and lenders increasingly rely on structured financial planning, decision analytics and treasury architectures that manage foreign exchange exposure across jurisdictions (Lawal and Oduleye, 2019b; Dada et al., 2021a). Chinese policy banks and contractors have also financed a large volume of generation, though mostly on a public-sector or engineering, procurement and construction (EPC) plus financing basis rather than as classic IPPs.

3.1.2 Structural challenges

Several structural challenges continued to define the landscape in 2023.

- **Offtaker credit risk.** Most IPPs sell to a single utility with a weak balance sheet. In 2023 Ghana's IPPs warned of shutdowns over arrears owed by the Electricity Company of Ghana (ECG) that had risen to around US$1.5 to 2 billion, at a time when IPPs supplied close to half of national generation. Arrears raise lenders' perceived risk across the market, not only for affected projects, and lenders increasingly assess this exposure with credit-risk and default-prediction models (Uzondu et al., 2020).
- **Currency risk.** IPP tariffs are usually denominated in or indexed to US dollars or euros, because debt and equipment are sourced in hard currency. Local-currency depreciation (sharp in Ghana, Nigeria, Zambia and others between 2022 and 2023) raises the local-currency cost of each kilowatt-hour, widening utility deficits unless retail tariffs keep pace, which they rarely do. The same volatility raises the cost of imported equipment and fuel (Asibor et al., 2021).
- **High cost of capital.** Country, currency and offtaker risks combine into a weighted average cost of capital for renewable energy projects in Africa that is commonly two to three times that seen in advanced economies (IEA, 2023b). For capital-intensive assets such as solar, wind and hydro, the cost of capital is often the largest single driver of the levelised tariff.
- **Planning and procurement weaknesses.** Many IPPs have been procured through unsolicited, directly negotiated deals, often during emergencies. Such deals tend to produce higher tariffs, less transparent terms and greater political risk later in the project's life, weaknesses that structured supply chain risk management and digital procurement governance can reduce (Agbabiaka et al., 2019; Ahiaeke Patrick et al., 2020).
- **Grid and system constraints.** Transmission bottlenecks, limited balancing capacity and weak dispatch rules expose IPPs to curtailment and deemed-energy disputes. In South Africa, grid capacity in the best wind and solar areas of the Cape provinces had become a binding constraint on new projects by 2022-2023. Engineering studies point to voltage control with distributed generation and decentralised control architectures as practical limits on how much new generation a network can absorb (Oshevire et al., 2017; Adenuga, 2022).
- **Small and fragmented markets.** Many national systems are too small to absorb large plants efficiently, and transaction costs for small projects are high relative to project size.

These challenges reinforce each other. A utility that pays late because tariffs do not reflect costs in turn raises the cost of capital for new IPPs, which raises tariffs, which deepens the utility's deficit. Breaking this cycle is the core task.

3.2 Recent advances in energy infrastructure financing

Despite the challenges, the decade to 2023 produced genuine advances. They can be grouped into seven areas. Table 2 summarises them.

Table 2. Summary of recent advances in IPP financing in Sub-Saharan Africa (status as of 2023)

Area of advance	Representative examples	Main contribution to financial sustainability
Competitive procurement and standardisation	South Africa REIPPPP (Bid Windows 1 to 6); Scaling Solar (Zambia, Senegal); GET FiT (Uganda, Zambia)	Lower tariffs; transparent, bankable standard documents; reduced transaction costs and political risk
Credit enhancement and guarantees	World Bank IBRD/IDA guarantees, MIGA, African Trade and Investment Development Insurance (ATIDI) liquidity facility, GuarantCo	Protects cash flows from offtaker payment delays and political events; lowers cost of debt
New offtake models	Africa GreenCo intermediary offtaker (Zambia, South Africa, Namibia); wheeling and private PPAs in South Africa; captive mining power	Diversifies away from single, weak utility offtakers; brings in creditworthy commercial buyers
Legal and market reform	Nigeria Electricity Act 2023; South Africa removal of licensing threshold for embedded generation (2022) and market reform agenda; Zambia 2019 energy laws	Opens room for state, regional and bilateral markets; reduces dependence on a single national buyer
Local-currency and domestic capital	South African bank and pension investment in REIPPPP; TCX currency hedging; green bonds in Nigeria and Kenya	Reduces currency mismatch; deepens investor base
Blended and climate finance	Just Energy Transition Partnership (South Africa); climate funds; Convergence-designed vehicles; results-based grants for mini-grids	Concessional capital absorbs first loss or early-stage risk, crowding in commercial lenders
Digitalisation and payment innovation	Smart contract and distributed ledger payment models; predictive public financial oversight; renewable output forecasting	Faster, auditable settlement; earlier detection of arrears; fewer forecasting disputes

Source: Author's synthesis from sources cited in the text.

3.2.1 Competitive procurement and standardised contracts

The single most important advance has been the shift from negotiated to competitive procurement. South Africa's REIPPPP, launched in 2011, procured onshore wind, solar photovoltaic (PV), concentrated solar power, small hydro and biomass through successive bid windows with standardised PPAs, implementation agreements and direct agreements. Within four years South Africa had attracted more IPP investment than the rest of SSA had in the previous quarter-century (Eberhard and Naude, 2016). Tariffs fell dramatically across bid windows, and by 2019 committed private investment had exceeded R200 billion. Bid Window 5, whose projects signed in 2021-2022, achieved some of the lowest tariffs in the programme's history, with a weighted average solar PV bid below R0.50 per kWh. By December 2022 the government reported that 19 Bid Window 5 projects had signed, representing R34.3 billion of investment with about 49 percent South African ownership (DMRE, 2022).

Two features of REIPPPP stand out for financial sustainability. First, its institutional home, the IPP Office, combined Department of Energy, National Treasury and Development Bank of Southern Africa capability in a dedicated unit outside the utility, which helped insulate procurement from Eskom's own commercial interests. Second, the programme relied overwhelmingly on domestic capital: the majority of the debt was raised from South African commercial banks, funds and DFIs, which limited currency mismatch.

Outside South Africa, the World Bank Group's Scaling Solar programme offered a one-stop package of advisory support, standardised documents, pre-approved financing and guarantees. Its first tenders in Zambia (2016) and Senegal produced solar tariffs among the lowest then recorded in the region. The GET FiT programme in Uganda, and later Zambia, combined a top-up premium to the feed-in tariff with standardised documents and partial risk guarantees, enabling a portfolio of small renewable projects to close. These programmes demonstrated that process quality, not only resource quality, determines price, a conclusion echoed by research showing that well-governed procurement lowers costs and supply risk (Okonkwo et al., 2018a; Akinleye and Adeyoyin, 2021) and that efficient public infrastructure delivery systems improve outcomes (Nwafor et al., 2019b).

3.2.2 Credit enhancement and risk mitigation instruments

A second advance is the deepening of the toolkit for mitigating offtaker and political risk. Table 3 sets out the main instruments in use.

Table 3. Main risk-mitigation instruments used in SSA IPP financing

Instrument	Risk addressed	Typical provider	Strengths and limitations
Partial risk guarantee (PRG)	Government failure to meet contractual obligations, including termination payments	World Bank (IDA/IBRD), AfDB	Strong signal to lenders; but requires sovereign counter-indemnity, adding to contingent liabilities
Political risk insurance	Expropriation, war, transfer restriction, breach of contract	MIGA, ATIDI, private insurers	Widely used for equity and debt; does not cover ordinary commercial payment delays
Liquidity support / letter of credit	Short-term payment delays by offtaker	Commercial banks, ATIDI Regional Liquidity Support Facility	Bridges arrears of several months; must be replenished; does not cure underlying insolvency
Escrow and revenue ring-fencing	Payment priority for IPP	Utility, central bank or trustee	Improves payment discipline; can disadvantage other creditors and suppliers
Sovereign guarantee / put-call option	Utility default and termination	Ministry of finance	Often required by lenders; directly increases fiscal exposure
Currency hedging	Exchange rate movements	TCX, local banks	Enables local-currency lending; costly and short tenor in thin markets

Source: Author's synthesis based on Eberhard et al. (2016), World Bank and AfDB instrument documentation.

A notable innovation is the Regional Liquidity Support Facility hosted by the African Trade and Investment Development Insurance agency (ATIDI, formerly ATI) with support from Germany's KfW and Norway. It provides liquidity coverage of up to six months of IPP revenues, so that a utility's short-term payment delays do not trigger default on project debt. Because it is cheaper and faster to arrange than a traditional bank letter of credit backed by a sovereign, it lowers transaction costs, particularly for small and medium renewable projects.

The limitation common to all of these instruments is that they treat symptoms. They protect lenders when the offtaker falters, but the cost of that protection is borne, ultimately, by governments and DFIs. When arrears become chronic, as in Ghana in 2022-2023, guarantees and liquidity facilities can be exhausted or called, and the burden shifts to the sovereign balance sheet at precisely the moment when it is least able to bear it. This is why the wider literature on financial risk governance stresses integrated enterprise risk management and capital adequacy over reliance on any single protective instrument (Mensah et al., 2019a; Akomolafe and Agu, 2019c), and why evaluations of public-private partnership frameworks are relevant to IPP design (Uduokhai et al., 2022).

3.2.3 Diversified and intermediary offtake models

A third advance is the emergence of offtake structures that reduce dependence on a single weak utility.

Creditworthy intermediary offtakers. Africa GreenCo, headquartered in Zambia, was designed as an independently managed, creditworthy buyer that purchases power from renewable IPPs and sells it on to utilities, commercial customers and the Southern African Power Pool (SAPP). By aggregating a portfolio of projects and buyers, it diversifies risk in a way no single utility can. Zambia's 2019 energy legislation created a licence category for such intermediaries, and GreenCo became the first non-asset-owning member of SAPP. In 2023 it signed its first greenfield PPA, for an 85 MW solar project in South Africa, and concluded an implementation agreement with the Government of Zambia (Convergence, 2023; P4G, 2023). The model draws on the precedent of PTC India, created to act as a creditworthy trader for privately financed power.

Commercial and industrial (C&I) and wheeling markets. South Africa's decision to raise and then, in December 2022, remove the licensing threshold for embedded generation unleashed a rapid expansion of private projects selling directly to mines, manufacturers and retailers, either on site or through wheeling over the Eskom grid. These buyers are often far more creditworthy than any utility, and their contracts are typically shorter and more flexible. Similar dynamics are visible in mining-heavy economies such as Zambia, the Democratic Republic of Congo and Ghana, where captive and hybrid solar-plus-storage projects are increasingly financed on the strength of mining company balance sheets, and techno-economic studies show how hybrid solar systems and smart microgrids can serve industrial and underserved users (Sunday and Omoegun, 2018; Komi and Ganiu, 2023).

Distributed and off-grid models. Mini-grid and solar home system companies are not classic IPPs, but they represent a growing share of new connections and have developed financing tools of their own, including results-based grants, securitisation of pay-as-you-go receivables and local-currency debt funds, often supported by fintech-enabled digital lending (Okafor et al., 2021). Their experience with currency risk and customer credit is directly relevant to grid-connected IPPs.

3.2.4 Legal and market reform

A fourth advance is legal reform that broadens the range of permissible buyers and sellers. Nigeria's **Electricity Act 2023**, signed in June 2023, followed a March 2023 constitutional amendment that allows states to legislate on

generation, transmission and distribution within their territories. The Act consolidates sector legislation, provides for the transition from the federal regulator to state regulators where states establish their own electricity markets, and creates a framework for state-level procurement and licensing. Lagos, Edo and Kaduna already had electricity market laws at the time of enactment. For IPPs, the reform opens the possibility of selling to state-level buyers, bilateral customers and embedded distribution networks, rather than relying solely on the federal bulk trader, whose payment shortfalls have long undermined generator finances.

South Africa's reform agenda in 2022-2023, including the Electricity Regulation Amendment Bill, which proposed an independent transmission system operator and a competitive wholesale market, and the unbundling of Eskom into separate generation, transmission and distribution entities, points in the same direction. Zambia's 2019 Electricity Act and Energy Regulation Act likewise introduced open access and intermediary trading. These reforms do not by themselves make offtakers creditworthy, but they create alternatives to single-buyer arrangements, which over time can discipline the incumbent utility. Regional integration under the African Continental Free Trade Area also shapes the legal infrastructure on which cross-border power and equipment trade relies (Jones and Ominyi, 2022a).

3.2.5 Local-currency finance and domestic capital mobilisation

A fifth advance, still modest outside South Africa, is the mobilisation of local-currency finance. REIPPPP shows what is possible when domestic banks and institutional investors have the depth and appetite to finance long-dated infrastructure: currency mismatch largely disappears, and the tariff can be set in local currency with inflation indexation. Elsewhere, the Currency Exchange Fund (TCX) has expanded hedging availability, and green and infrastructure bonds have been issued in Nigeria, Kenya and other markets. Pension fund assets in countries such as Nigeria, Kenya, Namibia and Botswana are substantial and growing, and regulatory reforms permitting allocation to infrastructure have been adopted in several jurisdictions. Infrastructure credit enhancement companies such as InfraCredit in Nigeria have shown that guaranteeing local-currency infrastructure bonds can draw pension funds into long-tenor energy assets. ESG and climate-risk disclosure increasingly shapes access to green finance and bank lending appetite (Kinyanjui et al., 2021; Ominyi and Anichukwueze, 2022b).

3.2.6 Blended finance and climate-aligned capital

Finally, climate finance and blended structures have grown in scale and sophistication. South Africa's Just Energy Transition Partnership, announced at COP26 with an initial pledge of US$8.5 billion and set out in an investment plan in 2022, includes grants, concessional loans and guarantees aimed at accelerating coal retirement and renewable deployment, including grid investment. Multilateral climate funds and philanthropic capital increasingly provide first-loss tranches, project preparation grants and viability gap funding. The joint IEA and IFC report on scaling private finance for clean energy in emerging economies, published in 2023, emphasised that concessional capital is most effective when it is targeted at risks the private market cannot price, such as early-stage development, offtaker liquidity and currency, rather than at simply lowering returns on otherwise bankable projects (IEA, 2023b). Climate-aligned capital also demands credible measurement, which blockchain-enabled ESG reporting and improved carbon accounting can support (Abioye et al., 2023; Lamidi, 2023).

3.2.7 Digitalisation, analytics and payment innovation

A seventh, emerging advance is the application of digital tools to the financial plumbing of the power sector. Distributed ledger and smart contract models for supplier payments and liquidity optimisation suggest ways to automate and secure the flow of tariff payments and settlements between utilities, IPPs and lenders (Akomolafe et al., 2022; Olaogun et al., 2023), and blockchain-based audit trails can support tamper-proof records in project finance (Oshoba et al., 2020).

Predictive analytics is also becoming part of public financial oversight (Ashore-Onisemo and Unamma, 2022b). At the enterprise level, cash flow and working capital models and machine-learning-assisted valuation give utilities and IPP sponsors better visibility of liquidity and value (Tonoyan et al., 2021b; Oduleye and Medon, 2023a), while renewable yield and wind forecasting reduce the forecasting errors that drive deemed-energy disputes and curtailment (Komi, 2021; Ezeugwa et al., 2023b).

3.3 Evidence from country experience in 2023

The events of 2023 illustrate both the progress and the fragility of IPP financing in the region. Four country cases are especially instructive.

3.3.1 South Africa: procurement success, system constraints

South Africa demonstrates the value of a credible procurement institution, standardised contracts and domestic capital. Yet 2023, the worst year of load-shedding on record, also exposed the limits of procurement in isolation. Delays between bid windows, Eskom's deep financial crisis (which led the National Treasury to announce debt relief of R254 billion in its February 2023 budget), and grid capacity constraints in the best resource areas slowed the pace at which new capacity could connect. Bid Window 6 awarded far less capacity than offered, largely because of grid limits in the Cape provinces. The lesson is that IPP procurement must be integrated with transmission planning and investment, or contracted capacity cannot be delivered. Grid-connected battery storage and drone, LiDAR and GIS-based inspection of transmission corridors offer ways to raise hosting capacity

and speed the repair of grid bottlenecks (Komi and Ganiu, 2022; Dagodzo and Ahiaeke Patrick, 2021a).

3.3.2 Ghana: the cost of overcontracting and currency mismatch

Ghana illustrates the danger of contracting capacity in emergencies without a robust least-cost plan. Following the *dumsor* power crisis of 2012-2016, the country signed a large number of PPAs, many of them on take-or-pay terms, leaving it with contracted capacity well in excess of demand. Combined with cedi depreciation and below-cost retail tariffs, this produced large and growing arrears. In mid-2023 the chamber of IPPs threatened to stop declaring capacity unless it received an interim payment of 30 percent of arrears, which by then were reported at around US$1.6 billion and rising toward US$2 billion. An interim deal averted the shutdown, and arrears restructuring became part of Ghana's broader debt restructuring and IMF-supported programme. Ghana also introduced a Cash Waterfall Mechanism to allocate utility revenues among suppliers. The episode underlines that no contract structure can protect IPPs indefinitely from a structurally insolvent offtaker. It also shows why public financial management matters: budget compliance, reconciliation controls and single-source-of-truth reporting can make arrears visible and manageable (Dogbatsey and Ebhojie, 2018; Unamma et al., 2019a), while revenue assurance in utility operations can close the collection gap that drives arrears in the first place (Sakyi et al., 2023).

3.3.3 Kenya: political scrutiny of PPAs

Kenya has one of the most diversified generation mixes in the region, with large geothermal, hydro and wind capacity, and a long record of IPP investment. Yet high retail tariffs prompted a Presidential Taskforce in 2021 to review all PPAs. It identified skewed contract terms, particularly capacity payments for thermal plants, as a significant cause of high electricity costs, and a moratorium on new PPAs followed. The Cabinet lifted the moratorium in March 2023, but in April 2023 the National Assembly imposed its own moratorium pending further inquiry. For investors, this sequence created significant regulatory uncertainty. The Kenyan experience shows that IPP contracts perceived as unfair will eventually be challenged, and that transparent, competitive procurement against a published least-cost plan is the best protection. It also points to the value of an independent IPP procurement office, a recommendation subsequently made by Kenyan lawmakers. Contract research on liability mitigation and force majeure points to ways of making PPAs both fairer and more durable (Uchechi and Ominyi, 2019; Uchechi et al., 2020).

3.3.4 Nigeria: decentralisation and liquidity

Nigeria's power sector has long suffered from a liquidity shortfall across the value chain: distribution companies collect too little from customers, the bulk trader pays generators only part of their invoices, and the government has repeatedly injected funds to cover the gap. The Electricity Act 2023 does not resolve this by itself, but by enabling state electricity markets, bilateral contracting and embedded generation, it creates routes for IPPs to sell to more creditworthy buyers. The 2023 removal of fuel subsidies and the unification of exchange rates were important signals of a shift toward cost-reflective pricing, though they increased the naira cost of dollar-indexed generation tariffs. Gas-fired IPPs remain central to Nigeria's generation mix, so gas supply reliability is a financial as much as a technical risk, and flare-gas recovery shows how gas currently flared could support domestic power supply while lowering emissions (Asibor and Isong, 2020; Makut and Olisakwe, 2022).

3.3.5 Cross-cutting lessons

Four cross-cutting lessons emerge from these cases.

1. The quality of planning and procurement determines the long-run durability of IPP contracts. Competitively procured contracts aligned with least-cost plans are far less likely to be challenged.
2. Credit enhancement buys time but does not solve offtaker insolvency. Utility reform, including cost-reflective tariffs and loss reduction, is a precondition for sustainable IPP markets.
3. Currency risk is the most underpriced risk in the system. Where it is passed in full to utilities that earn local currency, it becomes a fiscal risk that crystallises during depreciation.
4. Grid investment has become a binding constraint. IPP finance without transmission finance produces stranded or curtailed capacity.

3.4 Conceptual model

3.4.1 Three levels of financial sustainability

It is useful to distinguish three levels at which financial sustainability can be assessed.

Project-level sustainability concerns whether the IPP generates enough cash, reliably enough, to cover operating costs, service its debt and pay a return to equity commensurate with risk. This depends on the tariff and its indexation, the volume of energy or capacity paid for, the timeliness of payment, and the cost and tenor of capital.

Offtaker-level sustainability concerns whether the buyer, usually a state-owned utility, can meet its obligations without recurring bailouts. A utility that buys power under PPAs but sells it at tariffs below cost recovery, or loses a large share of energy to technical and commercial losses, will eventually fall behind on payments however well drafted the PPA is. Kojima and Trimble (2016) found that only a small minority of SSA utilities fully recovered their operating and capital costs.

System-level sustainability concerns whether the contracts signed with IPPs are consistent with least-cost expansion, affordable for consumers and manageable for the public finances. An IPP that is profitable because it is paid for capacity the system does not need, or at a tariff well above alternatives, is financially viable for its owners but

may be politically and fiscally unsustainable. Such contracts tend to be challenged, renegotiated or ignored, which in turn raises the risk premium demanded on every subsequent project.

The central argument of this paper is that the three levels are linked. Credit enhancement can protect project-level cash flows from offtaker weakness for a time, but it does so by shifting risk to governments and development finance institutions (DFIs). Lasting financial sustainability requires that IPPs are procured at competitive prices, against a credible plan, and sold to offtakers that can pay. Headline metrics such as megawatts contracted or dollars mobilised are necessary but not sufficient indicators of success.

3.4.2 The IPP financial sustainability model

Building on these three levels and on the synthesis in Sections 3.1 to 3.3, Figure 1 presents a conceptual model of IPP financial sustainability in Sub-Saharan Africa. The model has four components.

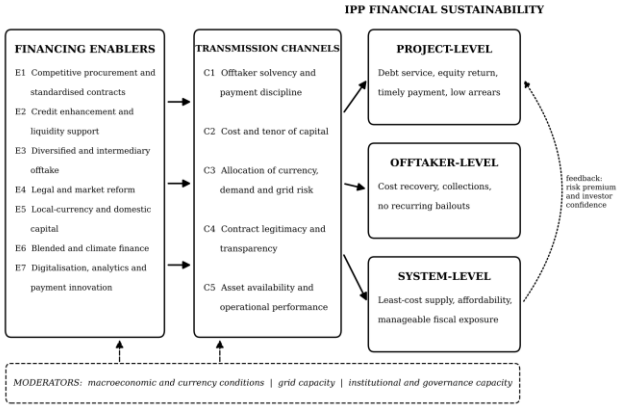


Figure 1. Conceptual model of IPP financial sustainability in Sub-Saharan Africa

Source: Author, based on the literature synthesis in Sections 3.1 to 3.3.

- **Financing enablers (E1 to E7)** are the seven areas of advance identified in Section 3.2. They are the levers available to governments, regulators, DFIs and investors.
- **Transmission channels (C1 to C5)** are the mechanisms through which the enablers affect outcomes: the solvency and payment discipline of the offtaker; the cost and tenor of capital; the allocation of currency, demand and grid risk; the legitimacy and transparency of contracts; and the availability and operational performance of assets.
- **Outcomes** are financial sustainability at the project, offtaker and system levels defined in Section 3.4.1. A feedback loop runs from system-level outcomes back to the project level: contracts that prove affordable and legitimate lower the risk premium on future projects, while contracts that are challenged or unpaid raise it.
- **Moderators** condition the strength of each relationship. Macroeconomic and currency conditions determine how far dollar-indexed tariffs strain utilities; grid capacity determines whether contracted capacity can be delivered; and institutional and governance capacity determines whether reforms are implemented as designed.

The model's central claim is that enablers which act only on the cost of capital (C2), for example by transferring risk through guarantees, can improve project-level outcomes in the short run without improving offtaker or system-level outcomes. Durable sustainability requires enablers that also act on offtaker solvency (C1), risk allocation (C3) and contract legitimacy (C4).

3.4.3 Propositions

The model yields six propositions that can guide both policy and future empirical research. They are summarised in Table 4.

Table 4. Propositions derived from the conceptual model

No.	Proposition	Main supporting evidence
P1	Competitive, transparent procurement against a least-cost plan (E1) increases contract legitimacy (C4) and lowers the probability that PPAs are later challenged or renegotiated.	South Africa REIPPPP; Kenya PPA review (Section 3.3)
P2	Credit enhancement and liquidity support (E2) improve project-level outcomes but do not by themselves improve offtaker-level outcomes; where arrears are structural, they shift risk to the sovereign.	Ghana arrears; risk instrument literature (Section 3.2.2)
P3	Diversified and intermediary offtake (E3) and market reform (E4) reduce concentration risk and improve payment discipline (C1) by creating alternatives to a single weak buyer.	Africa GreenCo; South African wheeling; Nigeria Electricity Act 2023
P4	Local-currency finance (E5) reduces the system-level fiscal cost of currency depreciation more than it reduces project-level returns (C3).	REIPPPP domestic financing; currency evidence from Ghana and Nigeria
P5	Digital payment, audit and analytics systems (E7) improve offtaker-level outcomes when combined with governance reform, by making arrears visible and collections more complete (C1).	Public financial management, audit and payment literature (Sections 3.2.7 and 3.3.2)
P6	The effect of every enabler is weaker where currency volatility is high, grid capacity is constrained and institutional capacity is low (moderators).	South Africa grid constraints; cross-country comparison

Source: Author.

3.5 Discussion

This paper set out to answer two questions: what advances in energy infrastructure financing had improved the prospects of IPPs in Sub-Saharan Africa by 2023, and what opportunities exist to strengthen their financial sustainability. The synthesis shows that the advances are real but uneven, and that their effect depends on the channel through which they work.

3.5.1 Advances concentrated where institutions are strongest

The most significant advances, notably South Africa's competitive procurement programme and its reliance on domestic capital, occurred where institutional capacity, financial depth and a credible procurement unit already existed. Elsewhere, advances have been more fragmented: individual guarantee facilities, pilot intermediary offtakers and new legislation whose implementation was only beginning in 2023. This is consistent with the model's moderators. The same enabler produces different results depending on governance capacity and macroeconomic stability, which explains why programmes that succeeded in one country have proved difficult to replicate in others.

3.5.2 Risk transfer versus risk reduction

A central finding is that a large share of the financing toolkit transfers risk rather than reducing it. Guarantees, liquidity facilities, escrow accounts and sovereign put options shift the consequences of offtaker weakness from lenders to governments and DFIs. This makes projects financeable, which is valuable, but it leaves the underlying cause, an offtaker that cannot pay, unchanged. Ghana's 2023 experience shows the limit of this approach: once arrears became structural, risk-transfer instruments could not prevent a crisis that ended in renegotiation. In the terms of the model, these instruments act strongly on the cost of capital (C2) but weakly on offtaker solvency (C1).

3.5.3 Contract rigidity versus legitimacy

A second tension concerns contract design. Lenders value rigid take-or-pay terms, long tenors and hard-currency indexation because they secure debt service. Yet the Kenyan and Ghanaian cases show that contracts perceived as excessive become politically contested, and that contestation raises risk for every subsequent project. Contracts that are competitively procured, transparent and aligned with system need appear to be more durable even if they offer investors less protection on paper. Contract legitimacy (C4) is therefore a financial variable and not only a political one.

3.5.4 Currency risk as the hinge of the system

Currency risk links the project, offtaker and system levels more directly than any other factor. When tariffs are indexed to the dollar and the local currency depreciates, the project is protected but the utility's costs rise, and unless retail tariffs follow, the gap becomes a fiscal liability. The 2022 to 2023 depreciations in Ghana, Nigeria and elsewhere turned this theoretical concern into an urgent one. Local-currency finance, hedging and explicit risk-sharing are therefore not peripheral refinements; they address the main route by which project-level protection becomes system-level stress.

3.5.5 The role of governance, digital and engineering capabilities

The multidisciplinary literature reviewed here shows that many of the tools needed to strengthen offtaker finances already exist: audit analytics, revenue assurance, predictive financial oversight, digital payment systems, condition-based maintenance and cyber-secure grid operations. Their limited adoption in African utilities is a constraint of institutions, skills and incentives more than of technology. This supports the model's emphasis on institutional capacity as a moderator, and suggests that technical assistance and governance reform should accompany investment in digital systems.

3.6 Implications for policy and practice

Building on these advances and lessons, this section identifies the opportunities with the greatest potential to strengthen IPP financial sustainability. They are grouped by the level of the model in Section 3.4 that they primarily address, though most operate at more than one level.

3.6.1 Strengthen utility and offtaker finances

The most important opportunity lies upstream of the IPP: restoring the financial viability of the offtaker.

- **Cost-reflective tariffs with social protection.** Automatic, rules-based tariff adjustment mechanisms, covering fuel, inflation and exchange rate pass-through, reduce the political discretion that allows deficits to accumulate. Targeted lifeline tariffs or direct transfers can protect poor households more efficiently than general under-pricing.
- **Loss reduction and revenue protection.** Smart and prepaid metering, distribution concessions or management contracts, and performance-based regulation can sharply improve collections. Every percentage point of losses recovered improves the utility's capacity to pay its IPPs. Technology-enabled internal audit and risk-based control models from the financial sector can be adapted to utility finance functions (Akomolafe and Agu, 2018; Akomolafe and Agu, 2019a).
- **Transparent subsidy and arrears management.** Where governments choose to subsidise electricity, budgeting the subsidy explicitly and paying it on time is more sustainable than allowing arrears to accumulate. Arrears clearance programmes, linked to forward-looking reforms, can reset relationships with IPPs.
- **Revenue waterfall and ring-fencing mechanisms.** Ghana's Cash Waterfall Mechanism, if transparently administered and complied with, illustrates how predictable allocation of collections can reduce disputes. Its value depends on enforcement.

3.6.2 Institutionalise planning and competitive procurement

- **Dedicated IPP procurement units.** The South African IPP Office model, with technical, legal and financial capability and insulation from the incumbent utility, can be adapted to other countries. Kenya's lawmakers have called for such an office.
- **Integrated resource plans with binding procurement triggers.** Linking procurement rounds to published least-cost plans reduces the risk of overcontracting and improves public legitimacy of IPP contracts.
- **Standardised, balanced contracts.** Model PPAs that allocate risk to the party best able to manage it, and that shift from rigid take-or-pay toward capacity payments tied to availability and system need, are more durable. Standardisation also cuts transaction costs, which are disproportionately high for small projects, and capital budgeting aligned to project execution provides practical guidance for procurement units (Nwangwu et al., 2021).
- **Transparency.** Publishing PPA tariffs and key terms, as South Africa does for REIPPPP, builds trust and reduces the risk that contracts will later be attacked as opaque or unfair. Procurement units also need supply chain capability in logistics, materials readiness and plant uptime (Okonkwo et al., 2018b) to ensure that projects reach commercial operation on time and on budget.

3.6.3 Reallocate currency risk more efficiently

Currency risk deserves special attention because it is where project-level and system-level sustainability most often conflict. Several options merit wider use:

- **Local-currency or partially local-currency tariffs** for the share of costs incurred locally, combined with local-currency debt where markets allow.
- **Expanded hedging capacity** through TCX and similar vehicles, with concessional support to bring down the cost of long-tenor hedges in thin markets.
- **Credit enhancement for local-currency bonds**, following the InfraCredit model, to draw pension funds and insurers into long-dated energy assets.
- **Explicit currency risk-sharing facilities**, in which governments, DFIs and investors agree in advance how large depreciations will be shared, rather than leaving the utility to absorb them by default.

3.6.4 Scale up diversified offtake and market reform

- **Intermediary offtakers and regional trading.** The GreenCo model can be replicated or extended in other power pools, notably the West African Power Pool and the Eastern Africa Power Pool. Portfolio offtakers spread risk and can sell surplus power across borders.
- **Open access and wheeling frameworks.** Clear wheeling tariffs, grid codes and settlement rules allow IPPs to sell directly to creditworthy commercial and industrial customers. Nigeria's state markets and South Africa's wheeling framework both depend on getting these rules right.
- **Hybrid offtake structures.** Projects that sell part of their output to a utility and part to private buyers, or that combine utility PPAs with merchant sales into power pools, reduce concentration risk, and peer-to-peer trading models can improve the bankability of smaller distributed generators (Shittu et al., 2021).

3.6.5 Make blended and climate finance work harder

- **Target concessional capital at binding constraints**, such as project preparation, liquidity and currency risk, and grid connection, rather than lowering returns on already bankable projects.
- **Use guarantees at portfolio level**, through pooled or programme guarantees covering multiple IPPs, to cut costs and processing time.
- **Link climate finance to transition milestones**, as JETP-type partnerships attempt, so that grants and concessional loans support coal retirement, grid expansion and utility reform together. Scenario-based financial modelling helps test these structures against long-term planning risks (Filani et al., 2023).
- **Explore carbon market revenues** under Article 6 of the Paris Agreement as an additional, though uncertain, revenue stream for renewable IPPs.

3.6.6 Invest in grids and storage alongside generation

Grids have become the bottleneck. Opportunities include independent power transmission (IPT) projects, in which private investors build and own transmission lines under availability-based contracts; the first IPT programmes were being prepared in Kenya, South Africa and elsewhere by 2023. Battery storage procured under independent programmes, such as South Africa's Battery Energy Storage IPP Procurement Programme, can increase the value of variable renewable output and reduce curtailment. Including grid and storage needs in generation procurement rounds would help avoid stranded capacity. Asset integrity also determines whether contracted capacity is available to earn revenue, and predictive and reliability-centred maintenance lower availability risk (Adaramola et al., 2018; Obetta, 2020).

As grids become more digital, cybersecurity becomes a financial risk: a disrupted control system can interrupt generation, dispatch and metering, and therefore revenue. Research on securing utility operational technology networks and zero trust for critical infrastructure (Adegbite et al., 2020; Ahmed et al., 2021), together with enterprise security audit and risk-based cybersecurity assurance (Dosunmu and Ogundele, 2019; Fadayomi et al., 2019), sets out the controls lenders and regulators should expect.

3.6.7 Build local capacity and data

Finally, sustainable IPP markets depend on capable institutions. Regulators need skills to set cost-reflective tariffs and review PPAs; utilities need commercial and

contract management capacity; and governments need the ability to evaluate and manage contingent liabilities. Better public data on project costs, tariffs, arrears and performance would allow investors to price risk more accurately and would allow citizens and legislators to hold contracts to account, supported by real-time compliance pipelines and regulatory clearance frameworks that protect the integrity of transactions (Uchechi et al., 2022; Ominyi and Anichukwueze, 2020).

Table 5. Prioritised opportunities by actor

Actor	Highest-priority opportunities	Expected effect on IPP sustainability
Governments and ministries of finance	Budget subsidies explicitly; clear arrears; establish IPP procurement units; manage contingent liabilities transparently	Reduces payment risk and risk of contract challenge
Regulators	Automatic tariff adjustment; wheeling and open-access rules; publish PPA terms	Improves offtaker revenue and opens alternative buyers
Utilities	Loss reduction; metering; revenue waterfall compliance; contract management	Improves capacity to pay on time
DFIs and climate funds	Portfolio guarantees; liquidity facilities; local-currency and hedging support; grid finance	Lowers cost of capital and reallocates risk efficiently
Private investors and lenders	Accept local-currency structures; partner with domestic institutions; develop C&I and regional offtake	Diversifies revenue and reduces exposure to single offtaker
Regional bodies and power pools	Harmonise rules; enable intermediary traders; plan regional transmission	Expands markets and spreads risk

Source: Author.

3.7 Theoretical implications

The paper makes three contributions to theory. First, it extends the established literature on the determinants of IPP success, which has focused mainly on investment climate, contract terms and risk mitigation at the project level (Eberhard and Gratwick, 2011; Eberhard et al., 2016), by placing the offtaker and the wider power system at the centre of the analysis. Financial sustainability is treated as a property of the whole value chain rather than of the individual contract.

Second, it distinguishes between enablers that transfer risk and those that reduce it, and specifies the channels through which each operates. This offers a way to explain why markets with similar access to guarantees and DFI finance have had very different outcomes.

Third, it integrates literatures that are usually kept apart. Research on procurement, public financial management, audit, banking, power systems engineering, asset integrity and cybersecurity rarely speaks to the energy finance literature, yet each bears on one or more of the model's transmission channels. The model provides a common frame in which these contributions can be related to one another and tested.

4. Conclusion

4.1 Summary of findings

By 2023, Sub-Saharan Africa had accumulated a substantial body of experience in financing IPPs. The region had shown, most clearly in South Africa, that competitive procurement can deliver large volumes of private investment at internationally competitive prices. It had built a richer toolkit of guarantees and liquidity instruments, experimented with intermediary offtakers and private wheeling, passed significant legal reforms in Nigeria, Zambia and South Africa, and begun to tap local capital and climate finance.

Yet the events of 2023, including the arrears crisis in Ghana, renewed political scrutiny of PPAs in Kenya, record load-shedding in South Africa and currency shocks across the region, are a reminder that IPP financial sustainability is ultimately a system property. It cannot be engineered at the level of the individual contract while the offtaker remains insolvent, the plan is unclear, currency risk is misallocated, and the grid cannot carry the power. The most promising opportunities therefore lie in reforms that strengthen the whole value chain: cost-reflective and predictable tariffs, credible planning and procurement institutions, diversified offtake, better allocation of currency risk, and sustained investment in grids and storage.

The financing community's role is to make these reforms easier and to price their success: to reward countries that procure competitively and pay on time with lower costs of capital, and to direct concessional resources toward the risks that private markets cannot yet bear. If governments and their partners pursue this agenda consistently, IPPs can move from being a contingent and contested source of supply to a durable pillar of the region's energy transition and its drive toward universal access.

4.2 Limitations

The study has several limitations. First, it relies on secondary sources. Figures such as arrears levels and investment totals were taken from official statements and contemporaneous reporting, which may be revised and are not always consistent across sources.

Second, the analysis is a snapshot of conditions up to 2023. Developments in the power sector move quickly, and later changes in legislation, tariffs, programmes and macroeconomic conditions are outside its scope.

Third, the four case countries are all anglophone and among the region's larger power markets. Francophone and lusophone countries, smaller island systems and fragile states may face different constraints, so the findings should be generalised with care.

Fourth, a substantial part of the multidisciplinary literature reviewed consists of conceptual frameworks and reviews rather than empirical studies. These were used to identify mechanisms, but their claims have not all been tested in African power sector settings.

Finally, the conceptual model and its propositions are derived from the synthesis and have not been tested quantitatively. They should be read as hypotheses rather than established relationships.

4.3 Future research

These limitations point to several directions for future research.

- **Empirical testing of the model.** Project-level data on tariffs, payment delays, guarantee calls and refinancing terms could be used to test Propositions P1 to P6, for example by comparing competitively procured and negotiated projects.
- **Measuring the cost of capital.** Systematic estimates of the cost of capital for African IPPs, broken down into country, currency and offtaker components, would show which risks matter most and where concessional finance is best targeted.
- **Wider country coverage.** Comparative studies including francophone, lusophone and smaller systems, and regional power pools, would test whether the findings hold beyond the four cases studied here.
- **Evaluating new offtake models.** Intermediary offtakers, wheeling arrangements and state-level electricity markets were at an early stage in 2023. Longitudinal studies of their payment performance and effect on investment are needed.
- **Designing currency risk-sharing.** Research on how currency risk can be shared between investors, utilities, consumers and governments, and on the cost-effectiveness of hedging and local-currency finance, would address the factor this paper identifies as the hinge of the system.
- **Digital and governance interventions.** Field evaluations of digital payment, revenue assurance, audit analytics and cybersecurity measures in African utilities would show whether the tools described in the literature improve offtaker finances in practice.
- **Contract legitimacy and public trust.** Studies of how procurement transparency and public disclosure affect the durability of PPAs would deepen understanding of contract legitimacy as a financial variable.

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