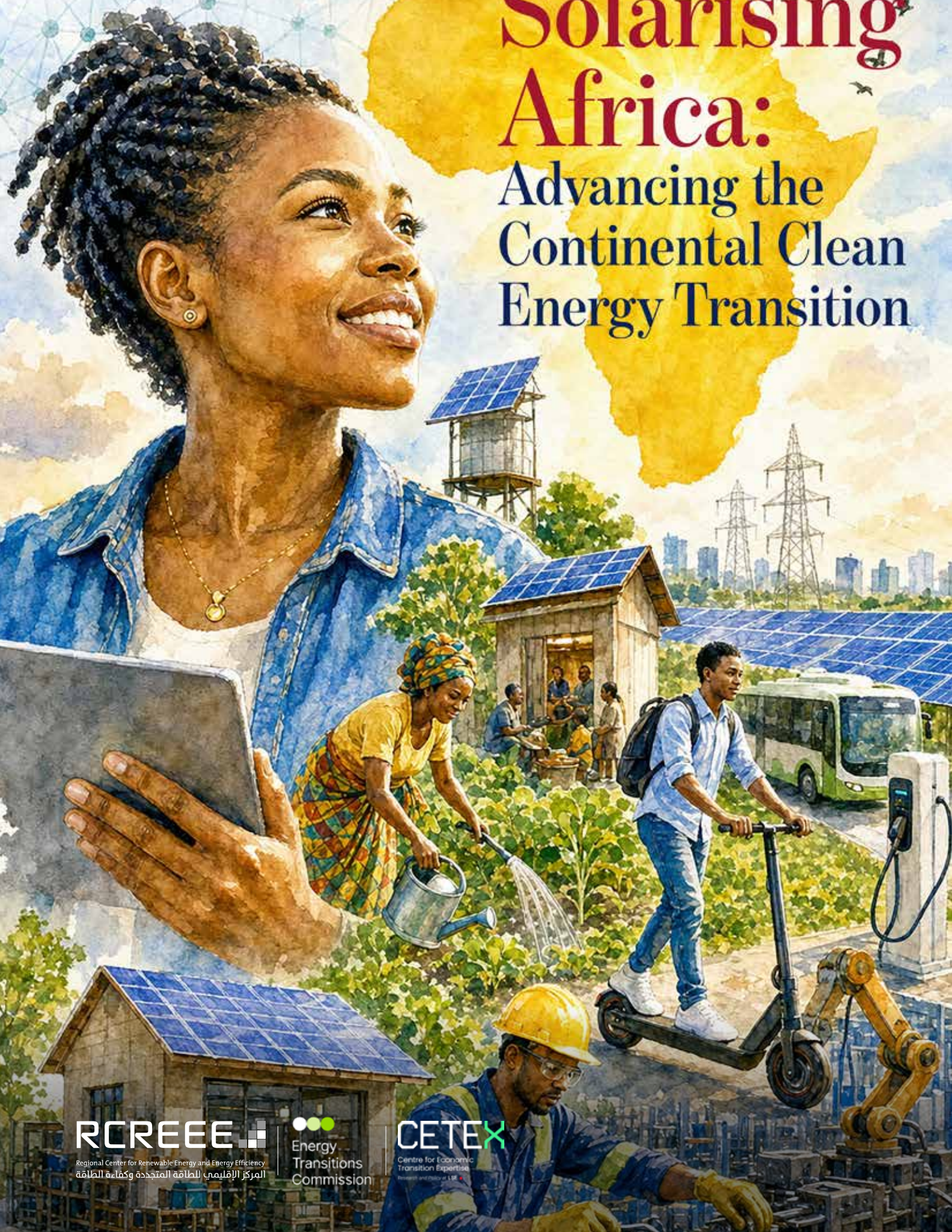




INTERNATIONAL
SOLAR
ALLIANCE

Solarising Africa:

Advancing the Continental Clean Energy Transition



RCREEE

Regional Center for Renewable Energy and Energy Efficiency
المركز الإقليمي للطاقة المتجددة وكفاءة الطاقة

**Energy
Transitions
Commission**

CETEX

Centre for Economic
Transition Expertise
Research and Policy at UNEP

Task Team

International Solar Alliance (ISA):

Namrata Mukherjee
Barakat Ahmed
Swapnil Acharya
Emeafu Francis
Mallika Kalra
Kumar Vaibhav
Eseohen Jessica
Aarti Narain
Kakul Fatima
Raman Jha

Regional Centre for Renewable Energy and Energy Efficiency (RCREEE):

Maged Mahmoud
Akram Almohamadi
Mostafa Hassanen
Omar Alrosan
Mohamed Sadeq
Alshimaa Shafey
Tala El Hariri
Nadia Elmasry
Salma Mukhtar
Abdirahman Ibrahim
Ahmed Abdelrasoul

Energy Transition Commission (ETC):

Mike Hemsley
Pheobe O'Hara

Centre for Economic Transition Expertise at the London School of Economics (CETEx):

Saumya Malhotra
Trishaa Bansal

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Foreword



Ashish
Khanna

Director General,
International Solar
Alliance

Africa's solar moment has arrived. What makes this moment different is not simply the continent's extraordinary solar resource, but the convergence of falling technology costs, unprecedented political commitment, rapidly expanding markets and an urgent imperative for energy security. With Mission 300 providing an integrated framework of national commitments and delivery, the foundations are emerging to mobilise private capital and build local capabilities at scale.

The continent possesses 60% of the world's solar resources, yet around 660 million people continue to live without reliable access to electricity, while economies bear the high costs of unreliable and carbon-intensive energy systems. At the same time, Africa's population, cities, industries and energy demand are expanding rapidly. The choices made today will therefore shape not only the continent's energy future, but its economic competitiveness, resilience and prosperity for decades to come.

Solar energy can be at the heart of this transformation.

The economics of solar have changed fundamentally. Technology costs have fallen by 90%, deployment models have diversified, and solar is increasingly capable of delivering not only affordable electricity, but reliable and productive energy for communities, agriculture, mobility and industry. Yet Africa's solar deployment remains far below the scale warranted by its resource endowment and development needs. The challenge is no longer whether solar works. It is whether we can build the policies, institutions, financing systems and capabilities that allow it to work at scale.

Solarising Africa: Advancing the Continental Clean Energy Transition addresses this critical question. It moves beyond describing Africa's solar opportunity to examine what it will take to translate that opportunity into deployment. Anchored in the commitments of Mission 300 and the National Energy Compacts, the report provides a practical, delivery-oriented framework for accelerating solar across the continent. Its focus is deliberately broader than generation alone—from distributed renewable energy and solar-powered agriculture to electric mobility, utility-scale solar and regional interconnections, supported by the cross-cutting foundations of digitalisation, institutional capacity, finance and local manufacturing.

A central message emerges clearly: **Africa's solar transition must be understood as one interconnected system.** A solar panel alone does not create development. A connection becomes transformative when it powers a farm, a cold chain, a small enterprise, a school, a health facility or a vehicle. A solar project becomes sustainable when it is supported by a creditworthy utility, appropriate financing, capable institutions, skilled people, reliable data and a functioning local ecosystem. The report's case studies, from Nigeria's distributed access programme and Uganda's solar-agriculture experience to Egypt's utility-scale development and emerging solar e-mobility models, demonstrate that solutions already exist within Africa. The task now is to scale, adapt and connect them.

This is where **Mission 300 represents a historic opportunity.** With countries having already articulated national commitments and established mechanisms for monitoring delivery, Africa has an unprecedented platform for moving from fragmented initiatives towards coordinated implementation. What is required now is to convert these commitments into bankable pipelines, strengthen delivery institutions, reduce the cost of capital, build modern and digitally enabled utilities, develop the workforce of the future and create regional markets capable of supporting investment and industrial scale.

The International Solar Alliance is committed to being a partner in this journey. Through catalytic finance, technical assistance, capacity-building platforms such as the STAR-C network, Communities of Practice, and stronger regional cooperation, ISA seeks to help countries move from successful individual projects to scalable models that can be replicated across markets. Our ambition is not simply to support more solar projects, but to help build the enabling architecture that makes solar deployment faster, more affordable, more inclusive and more sustainable.

The opportunity ahead is immense. This report envisages a pathway towards approximately **1,000 GW of solar capacity in Africa by 2050**, with solar becoming a much larger share of the continent's electricity system. Achieving this will require a sustained effort across governments, development finance institutions, private investors, technology providers, utilities, regional institutions and communities. Most importantly, it will require a shift from seeing solar as an energy technology to recognising it as an instrument of economic transformation.

Africa has the sunlight. It increasingly has the technology. It now needs the systems, institutions and partnerships to turn both into power, opportunity and prosperity.

Solarising Africa is therefore not only a report on what is possible. It is initiation of a programmatic commitment with African countries and partners to turn this ambition into delivery, to develop policy and project pipelines for enabling potential investment through a digital dashboard, thereby ensuring that Africa's solar future becomes a foundation for a more prosperous, resilient and inclusive continent.

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List of Abbreviations

AC	Alternating Current	EREA	Energy Regulators Association of East Africa
ACPU	Average Consumption Per User	EU	European Union
AFAWA	Affirmative Finance Action for Women in Africa	EV	Electric Vehicle
AfCFTA	African Continental Free Trade Area	FAO	Food and Agriculture Organisation
AfDB	African Development Bank	FI	Financial Institution
AfSEM	Africa Single Electricity Market	FiT	Feed-in Tariffs
AFUR	African Forum for Utility Regulators	FX	Foreign Exchange
AMI	Advanced Metering Infrastructure	GDP	Gross Domestic Product
ARAF	Acumen Resilient Agriculture Fund	GEAPP	Global Energy Alliance for People and Planet
ARPU	Average Revenue Per User	GGGI	Global Green Growth Institute
AU	African Union	GIS	Geographic Information System
BESS	Battery Energy Storage Systems	GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
BII	British International Investment	GW	Gigawatt
BLDC	Brushless DC Motor	IaaS	Irrigation-as-a-Service
CaaS	Cooling-as-a-Service	ICE	Internal Combustion Engine
CAPEX	Capital Expenditure	ICT	Information and Communications Technology
CDMU	Compact Delivery and Monitoring Unit	IDA	International Development Association
CO ₂	Carbon Dioxide	IEA	International Energy Agency
CPO	Charge Point Operator	IEC	International Electrotechnical Commission
CPR	Compact Progress Report	IFC	International Finance Corporation
DARES	Distributed Access through Renewable Energy Scale-Up	IFPRI	International Food Policy Research Institute
DART	Demand Aggregation for Renewable Technologies	IMF	International Monetary Fund
DC	Direct Current	IoT	Internet of Things
DES	Distributed Energy Systems	IPP	Independent Power Producer
DFC	US Development Finance Corporation	IRENA	International Renewable Energy Agency
DFIs	Development Finance Institutions	IRESEN	Institute for Research in Solar Energy and New Energies
DISCOM	Distribution Company (Distribution Utility)	ISA	International Solar Alliance
DPI	Digital Public Infrastructure	ITPC	Itezhi Tezhi Power Corporation
DRE	Distributed Renewable Energy	JICA	Japan International Cooperation Agency
DSO	Distribution System Operators	KES	Kenyan Shilling
ECOWAS	Economic Community of West African States	KPI	Key Performance Indicator
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency	kW	Kilowatt
ECSES	ECOWAS Regional Certification System for Sustainable Energy Skills	kWh	Kilowatt-hour
EE	Energy Efficiency	kWp	Kilowatt-peak
EPC	Engineering, Procurement and Construction	LCC	Life Cycle Cost
EPRA	Energy & Petroleum Regulatory Authority	LCOE	Levelised Cost of Energy
		MAAIF	Ministry of Agriculture, Animal Industry and Fisheries

MENA	Middle East and North Africa
MFI	Microfinance Institution
MIGA	Multilateral Investment Guarantee Agency
MSIP	Micro-Scale Irrigation Program
MSME	Micro, Small and Medium Enterprise
MST	Minimum Subsidy Tender
MW	Megawatt
MWE	Ministry of Water and Environment
NDC	Nationally Determined Contribution
NEP	Nigeria Electrification Program
NGO	Non-Governmental Organisation
NSAC	National Solar-Agriculture Committee
NSDU	National Solar Delivery Unit
O&M	Operations & Maintenance
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
OPEX	Operational Expenditure
PAYG/ PAYGO	Pay-As-You-Go
PAYO	Pay-As-You-Own
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PUE	Productive Use of Energy
PV	Solar Photovoltaic
RBF	Results-Based Financing
RCREEE	Regional Centre for Renewable Energy and Energy Efficiency
RE	Renewable Energy
REA	Rural Electrification Agency
RECs	Renewable Energy Certificates (RECs)
RERA	Renewable Energy Regulators Association

RETTI	Renewable Energy Technology Training Institute
RMI	Rocky Mountain Institute
SAPP	Southern African Power Pool
SCADA	Supervisory Control and Data Acquisition
SHS	Solar Home System
SMART	Specific, Measurable, Achievable, Relevant, Time-Bound
SPB	Simple Payback
SPIS	Solar-Powered Irrigation Systems
SPV	Special Purpose Vehicle
SSA	Sub-Saharan Africa
STAR-C	Solar Technology and Application Resource Centres
STEM	Science, Technology, Engineering and Mathematics
T&D	Transmission and Distribution
TCX	The Currency Exchange Fund
ToT	Train-the-Trainer
TSO	Transmission System Operator
TVET	Technical and Vocational Education and Training
UKaid	UK Government Aid
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation
USD	United States Dollar
VAT	Value Added Tax
VRE	Variable Renewable Energy
WA+	Water Accounting Plus
WACC	Weighted Average Cost of Capital
WEFE	Water-Energy-Food-Ecosystems
ZESCO	Zambia Electricity Supply Corporation Ltd



Executive Summary

Africa possesses the world's best solar resource, but it is also the continent with the highest electricity access deficit. Around 600 million people in Sub-Saharan Africa live without electricity, and close to a billion without clean cooking. The continent is already paying for that gap: an estimated 2–4% of GDP is lost every year to unreliable power, before a single new panel is installed. The status quo, not solar, is the expensive choice.

The deployment record is starker than the deficit itself. Total installed solar PV capacity across Africa at the end of 2025 was about **22.2 GW**, and **14 GW** of this capacity sits in two countries, some **0.33%** of global installed capacity. Of the **USD 521 billion** invested in solar worldwide in **2024**, only **2%**, or **USD 9 billion**, reached Africa. The cost of capital for clean-energy projects on the continent still runs at two to three times that of advanced economies.

This report treats the case for African solar deployment as settled. It is a working guide to converting ambition into action, written for the stakeholders and actors who must now deliver the commitments their nations have already made.

1.1 Why this moment is different

Reports on solar in Africa are not new. What is new is that five conditions have changed at once and together they have opened a window that will not stay open for long.

- **Solar became the cheapest option and then it became firm.** Africa's weighted-average levelised cost for utility-scale solar fell **67% between 2015 and 2024, from USD 225/MWh to USD 74/MWh**. Storing half a plant's daytime generation now adds to roughly **USD 33/MWh**, giving dispatchable solar at about **USD 76/MWh**. Lithium-ion pack prices are down **93% since 2010** to around USD 100/kWh. Solar has crossed the threshold from cheap and intermittent to cheap and dispatchable.
- **Demand has become visible for the first time.** Forty-eight countries have endorsed the Dar es Salaam Energy Declaration, and **35 governments have published National Energy Compacts** under Mission 300 carrying baseline-to-2030 targets. Africa's reform and equipment demand is now written down, comparable across borders and formally monitored, a precondition for planning that simply did not exist three years ago.
- **The market is already moving without waiting for permission.** Africa imported roughly **18.8 GW of solar panels in 2025, 48% above 2024**; excluding South Africa, imports **tripled in two years**. Twenty countries set import records in a single year, and deployment is no longer a two-market story.
- **Energy security has become a treasury question.** Transport fuel imports average **23% of merchandise imports** across Sub-Saharan Africa. When global oil markets were disrupted in early 2026, the effect reached African pumps within weeks. Electrification is now a fiscal and macroeconomic argument, not only an energy-ministry one.



- **The infrastructure is not yet locked in.** Africa's urban population will double from 700 million to 1.4 billion, and vehicle ownership remains **below 30 per 1,000 people against 210 in China**. Decisions taken this decade will decide whether that growth is electric or fossil-fuelled.

The binding constraint is therefore no longer technology, resource, or even the existence of capital. It is narrower and harder: how policy is designed, how financing is structured, how well institutions can plan and procure, and whether they can then deliver, which is the subject of this report.

1.2 What this report does differently

Most analytical reports on African solar establish the opportunity and stop at the threshold of implementation. This one starts at that threshold, structured around five choices about how the report is put together:

- **It begins from commitments that already exist.** Every thematic chapter is anchored to the National Energy Compacts and states plainly what has been committed, what is in place, and what the gap between the two requires. The report helps governments deliver the agenda they have already signed, rather than asking them to adopt a new one.
- **The organising principle is delivery, not technology.** Each chapter runs the same structure: why it matters for Africa, what is blocking it, what Mission 300 already commits and where the gap lies, the priority enablers, and a roadmap. A reader can enter at any chapter and find the same architecture.
- **Every recommendation carries an owner and a horizon.** Each roadmap sets out what needs to be done, who needs to act, and by when, sequenced across immediate, medium-term and long-term horizons. Each action is assigned to a named actor: head of state, line ministry, regulator, compact delivery unit, utility, financier or private developer.
- **The cross-cutting enabler chapters are treated as part of the consolidated Solarising Africa structure.** Digitalisation, capacity building, financing and manufacturing form the conditions on which all four delivery chapters depend, rather than a closing section, and each is written to be read against every one of them.
- **Africa is not treated as a single market.** Access rates range from under 20% to above 90%; some systems are grid-dominant, others distributed-led; regulatory traditions, languages and fiscal space differ profoundly. The report is built to support learning between African markets rather than prescription for Africa.

1.3 Mission 300: from many initiatives to one framework

For two decades, African electrification progressed through parallel but disconnected efforts: national plans, donor programmes, pilot projects and technology-specific initiatives, each running its own targets, baselines, timelines and reporting, because its shape was never visible in the first place.

Mission 300 changes the architecture not the ambition. The joint World Bank Group and African Development Bank commitment to connect 300 million Africans by 2030 has moved from declaration to delivery machinery: 48 countries have endorsed the Dar es Salaam Energy Declaration, and 35 National Energy Compacts have been published across three waves. Each compact is a government-signed reform roadmap with hard baseline-to-2030 targets for access, clean cooking, renewables share and private capital and each rests on the same five pillars: competitive generation and grids; regional integration and power trade; last-mile distributed renewables and clean cooking; private-

sector participation; and financially viable utilities. A national Compact Delivery and Monitoring Unit delivers each one and reports on it twice a year. Four practical consequences follow, and they are why this report is organised around the compacts. Demand has become **aggregable**, so manufacturers and financiers finally have a pipeline they can plan against. Every commitment has picked up a **monitoring line** that makes slippage visible rather than inferred. And every commitment has an **institutional owner**, meaning there is now somewhere for a recommendation to land.

1.4 Africa is not one market, and the differences are the opportunity

On this continent, the market type is a far more useful unit of learning than 'Africa' as a whole. Settlement geography alone splits every country into three segments, each with a different least-cost answer: dense populations within roughly **10–15 km** of the network are cheapest to reach by extending the grid; small population centres beyond that threshold are best served by mini-grids; and dispersed rural communities are most economically served by standalone systems at about **USD 1,924 per remote household against USD 3,368 to extend the grid, roughly 40% cheaper.**

The same logic holds for policy. African markets are already producing transferable answers, and they serve each other more useful than any template imported from outside.

- **Nigeria** is scaling access through the USD 750 million DARES programme, blending mini-grids, standalone systems and technical assistance into a single reference case for large, distributed-led access markets.



- **Egypt** has unlocked utility-scale investment through bankable long-term power purchase agreements (PPAs) with currency indexation and robust grid integration, the reference case for markets pursuing gigawatt-scale procurement.
- **Kenya** has folded mini-grids, standalone systems, solar irrigation and clean cooking into a single capacity-building framework, the reference case for productive-used electrification.
- **Zambia** removed VAT and import duties on solar components, and imports rose roughly eightfold year on year, the reference case for how quickly fiscal signals can move this market.
- **Ethiopia** has drawn energy-intensive manufacturing into industrial parks on the strength of low-cost clean power, the reference case for converting a power advantage into an industrial one.

Peer exchange works best when matched by **market typology** (grid-dominant against distributed-led, high-access against low-access, francophone against anglophone regulatory tradition) not by geographic proximity. Making that exchange routine rather than occasional is one of this report's central recommendations.

1.5 What transfers from elsewhere, and what does not

Countries that have closed large access gaps did not do it with superior hardware. They built an enabling ecosystem, because the acceleration is measurable: **the first 50 GW of solar took 132 months to install, the next 50 GW took 14 months, a nine-**



fold increase in build rate. Neither the technology nor the geography changed. Three things did.

- **An institution aggregated demand.** The Solar Energy Corporation of India acted as a central counterparty, running reverse auctions, shifting offtake risk away from individual developers. Tariffs fell to a record **~USD 0.027** in **2020**, and solar-plus-storage cleared at **~USD 0.032** in **October 2025**, evidence that the model now delivers round-the-clock power, not merely cheap daytime solar.
- **Finance was built around the end-user, not the asset.** Under **PM-KUSUM (~USD 4.3 billion)**, farmers pay as little as **10% upfront** for a **solar pump**, with blended subsidy and concessional credit covering the rest. **Some 2.67 million pumps** have been deployed, saving an estimated **1.38 billion litres** of diesel and about **40 million tonnes of CO₂** a year and converting diesel consumers into solar producers.
- **Skills and manufacturing were built alongside deployment, not after it**, so the acceleration never hit a workforce or supply-chain wall the moment volumes arrived.



What does not transfer matters just as much, and the report says so plainly: India had a single large national market, a sovereign balance sheet able to underwrite offtake, and a deep domestic capital market. Most African economies have none of the three. **The transferable lesson is therefore the sequence, not the scheme:** policy certainty first, then demand aggregation, then end-user finance, with skills and industry built alongside. Where a national market is too small to aggregate meaningfully, aggregation must happen regionally, which is precisely why the African Continental Free Trade Area and the regional power pools appear throughout this report as instruments of delivery rather than as background.

1.6 What the chapters prescribe

Each thematic chapter turns a diagnosis into a set of enablers and a roadmap. In brief:

- **Distributed renewable energy** is the fastest, lowest-cost route to the settlements the grid will not reach economically, and often the only option in fragile and conflict-affected areas. Its problem is cost structure, not resource: African mini grids cost around **USD 6,824/kWp against a global benchmark near USD 3,000**, because equipment is imported and every project is built from scratch. **Every USD 1,000/kWp saved unlocks about USD 4.2 billion, ~10 million more connections.** The enablers are clear licensing, defined grid-arrival compensation, cost-reflective tariffs with lifeline protection, productive-use stimulation written into every tender, and a dedicated delivery unit inside the energy ministry.
- **Solar for agriculture** delivers the widest development return of any energy investment in this report. Agriculture accounts for about a third of Africa's GDP and over 60% of its workforce, yet more than 95% of cultivated land is rain-fed and only 4% is irrigated, against 52% in India. Solar irrigation can raise productivity up to threefold while cutting lifetime energy costs **50–74%** against diesel and solar cold chains can cut post-harvest losses by up to **80%**. The enablers are integrated water–energy–food planning, end-user finance, quality standards, and extension services within reach of the farm.
- **Solar-powered e-mobility** is a window, not a trend. Africa's fleet is dominated by two- and three-wheelers, whose modest battery sizes happen to suit distributed solar unusually well, so the continent's highest-volume vehicle segment is also its most commercially viable to electrify. Charging infrastructure, subsidies and standards should be built around that fleet, rather than imported wholesale from four-wheeler markets.
- **Utility-scale solar and regional interconnection** stall on offtaker risk, currency volatility and opaque procurement, not on cost. With more than two-thirds of utilities unable to cover costs from revenue, PPAs are unbankable without scarce sovereign guarantees. The sequence is to restore utility performance, then reform tariffs, then crowd in private capital, supported by escrowed payment streams, partial risk guarantees, standardised PPAs, a published pipeline, and harmonised grid codes for regional trade. Storage and transmission are treated as what they are: enablers of integration, reliability and grid flexibility.
- **Digitalisation** is the cheapest reform on this list. Transmission and distribution losses range from **6.2%** to

38%, and collection rates from **36% in Guinea to 100% in Niger and Namibia**. Cutting losses to South African levels and closing the collection gap would lift utility revenue by up to **181% and turn 9 of 15 loss-making vertically integrated utilities profitable**.

Metering, feeder monitoring, digital billing, e-procurement and geospatial planning are what make every other chapter bankable.

- **Capacity building** surfaced in every consultation for this report as the primary bottleneck: thin technical expertise in ministries and utilities, fragmented mandates, and rules that lag the technology. Africa could generate **2.5 to 4 million solar jobs by 2050**, with technician roles dominating, but only with deliberate investment in technical and vocational education. ISA anchors this through its **STAR-C network, 13 centres operating today, building toward a target of 50 self-sustaining centres by 2030**.
- **Financing** is short of affordable, patient, risk-tolerant capital, not short

of capital in general. Africa attracts **3% of global energy investment at two to three times** the advanced-economy cost of capital, and the disbursement gap is as telling as the commitment gap: of **USD 9.1 billion committed to mini-grid electrification, only about 14% has been disbursed**. Closing the gap could unlock more than 33 GW of new solar by 2029. Different market segments need different instruments, and this report matches them explicitly.

1.7 Five imperatives

Across all chapters, five actions determine whether everything else follows.

- **Put policy certainty before project development.** Stable licensing, tariffs and procurement rules are worth more than concessional finance, and cost less to provide.
- **Mobilise affordable finance at scale** through blended structures, guarantees and local-currency instruments, and measure success by disbursement, not commitment.
- **Design for productive use, not connections.** A megawatt is an input to farm income, enterprise formation and a functioning clinic, counting connections measures activity, not outcome.
- **Modernise utilities and institutions** through digitalisation, capacity building and governance reform, because an insolvent utility makes every other reform unbankable.
- **Scale proven African solutions through structured peer exchange**, matched by market type, with governments, private sector, development finance institutions and ISA replicating what already works on the continent.

The table below indicate how the four enablers are linked with the four thematic areas of the report

→ Thematics across
↓ Enablers down

	DRE: Last-mile access	Agriculture	e-Mobility	Utility-scale
Digitalisation	Geospatial siting, PAYGo and remote monitoring	Pump telemetry, digital payment and cold-chain data	Telematics, charging management, managed charging	Revenue assurance and SCADA make the offtaker bankable
Capacity building	Regulators who can license a mini grid at speed	Technicians and extension services within reach of the farm	Battery-safety codes, inspectors and mechanics	Procurement teams that can run a competitive tender
Financing	Local-currency working capital and receivables finance	End-user finance, so the farmer can buy the pump	Asset finance for fleets and batteries	Guarantees, FX cover and a lower cost of capital
Local manufacturing	Poles, cabling, meters, balance of system, made locally	Pumps, cold rooms and dryers assembled near the farmer	Battery packs, swap hardware, 2- and 3-wheeler assembly	Mounting steel, transformers and switchgear

1.8 How to use this report

This report is a deployment blueprint. The table below sets out, for each principal actor, where to start and what to take from it.

S.N	Stakeholder	Where to start, and what to take from it
1	Heads of State and Cabinets	Treat the National Energy Compact as a delivery contract, not a pledge. Assign the compact to a named minister, give the Compact Delivery and Monitoring Unit authority across ministries, and review the twice-yearly progress report personally.
2	Energy Ministries	Start with the roadmaps at the end of each chapter. Convert the immediate-horizon actions into a dated workplan with named owners, beginning with mini-grid licensing, grid-arrival compensation and a published project pipeline.
3	Regulators	Prioritise the three rules that unlock private capital fastest: cost-reflective tariffs with lifeline protection, standardised PPAs with defined payment security, and net metering or net billing with clear interconnection rules for rooftop solar.
4	Finance Ministries	Read the financing chapter against your own duty schedule and guarantee capacity. Correct tariff inversions where inputs are taxed more heavily than finished goods and extend guarantee instruments beyond generation to offtake.
5	Utilities	Begin with the digitalisation chapter. Metering, feeder monitoring, collection and e-procurement are the lowest-cost reforms available and the precondition for a bankable balance sheet.
6	Compact Delivery and Monitoring Units	Use the chapter gap analyses directly. Each identifies what the compact commits, what is in place, and which enabler closes the difference — the same structure the progress report already requires.
7	Development Finance Institutions and Partners	Target the disbursement gap, not the commitment gap. Prioritise local-currency instruments, receivables and working-capital facilities, and technical assistance to delivery institutions rather than to project preparation alone.
8	Private Sector: developers, manufacturers, operators	Read the compacts as an order book. Aggregated across 35 countries, they set out a multi-year, multi-gigawatt pipeline of equipment, services and skills demand now visible enough to plan against.
9	ISA and Regional Institutions	Convene by market typology rather than geography. Communities of Practice, STAR-C centres and regional standards work are the mechanisms by which one country's solved problem becomes another's starting point.

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1.9 From blueprint to build rate

A flagship report changes a conversation; a delivery platform turns it into build rate.

ISA's Community of Practice model (one technology, many champions) is designed to put these findings into practice. The first, on the **solarisation of agriculture**, launches with seven founding members: **Uganda, Rwanda, Ghana, Senegal, The Gambia, Ethiopia and Zimbabwe**, each chosen for a distinct lesson the cohort can absorb. Agriculture is the entry point by design: with only 4% of arable land irrigated and Sub-Saharan Africa projected to spend close to **USD 65 billion on food imports in 2025**, early solar-irrigation results show productivity gains of **427% for tomatoes, 571% for onions, 553% for cabbages and 283% for bananas**. Successor Communities of Practice

covering utility-scale solar, mini-grids, e-mobility and digitalisation will follow the same operating logic: a defined cohort, a named anchor country, a measurable deliverable and a financier roster.

1.10 The horizon: Tera-Solar for Africa

The destination is aspirational: the African continent running on roughly **1,000 GW of solar by 2050**, lifting solar from about **3% to 40% of total electricity generation**, in three sequential phases: **lay the foundation to 2030** (100–200 GW, built on stable regulation, blended finance and utility digitalisation); **scale systemically to 2040 (~500 GW)**, through aggregation, securitisation and connected regional grids); and **consolidate to 2050 (~1,000 GW)**, through storage, flexibility and the institutional capacity to run a solar-dominated power system).

The resource is not in question, nor is the technology. What this report sets out is the far narrower set that remains: the policy choices, the financing structures, the institutions and the skills that stand between **Africa's sunlight and Africa's power system. Africa is where the global energy transition will either work or fall short. The chapters that follow set out what making that work looks like in detail.**



Introduction

Around 600 million people in Sub-Saharan Africa live without access to electricity and close to a billion without clean cooking. Africa's population is growing faster than any other region's, and its cities are set to double in size, from 700 million to 1.4 billion people, within a single generation. Connections must therefore outrun demography simply to begin closing the gap, not after it. A programme that connects millions a year yet still loses ground to population growth is not a slow success. It is failure wearing the costume of progress.

That gap is already expensive, and Africa is paying for it now. Unreliable power costs the continent an estimated **2–4% of GDP** every year, lost output, spoiled stock, idle machinery and the diesel bought to cover the shortfall, before a single new panel is installed. Energy poverty constrains everything downstream of it: clinics without refrigeration, schools without light, water systems without pumps, firms that cannot mechanise, and states whose fuel import bills crowd out the very spending that would fix the problem. **The expensive choice is not solar. It is the status quo.**

Why the grid alone cannot close the gap

The instinct to solve access by extending the network collides with an arithmetic problem. The levelised cost of grid supply climbs steeply with every additional kilometre of line and falls sharply with customer density: the last households to be reached are therefore also the most expensive and the least profitable to serve. Public utilities across the continent rank among the most indebted state enterprises in the region, with margins too thin to sustain loss-

making rural extension. The grid does not stop short of the last mile for lack of ambition. It stops because of cost.

The evidence points to a segmented answer. Dense populations **within roughly 10–15 km** of the existing network are cheapest to reach by extending it. Small population centres beyond that threshold are best served by **mini grids**, which can be built in **9–18 months** and can deliver solar-plus-storage power at about **USD 0.28/kWh against USD 0.60/kWh for diesel**. Dispersed rural communities are most economically served by **standalone systems**: about **USD 1,924 per remote household, against USD 3,368 to extend the grid, roughly 40% cheaper**.

This is the report's first structural conclusion, and it shapes everything that follows: universal access is affordable only if the delivery model is matched to the settlement. Grid, mini grid and standalone solar are not competitors: they are three answers to three different questions, and the policy task is to put each where it belongs.

Solar can close the gap, and the economics have already turned

Africa holds roughly **60%** of the world's best solar resource and generates about **3%** of its electricity from solar. The gap between those two figures is this report's subject. Africa's weighted-average levelised cost for utility-scale solar fell **67%** between **2015** and **2024**, to about **USD 74/MWh**, and storing half a plant's daytime output now adds only around **USD 33/MWh**: solar is therefore no longer merely the cheapest new generation across most of the continent, but increasingly the cheapest firm generation too. In several markets, a solar system repays its cost against diesel within roughly six months.

The market has already begun moving on that arithmetic, without waiting for policy to catch up. Africa imported roughly **18.8 GW of solar panels in 2025**; excluding South Africa, imports tripled in two years. Cumulative

installed capacity has reached about **22.2 GW**, with a further **77 GW projected by 2030**, and recent deployments already generate the equivalent of more than a tenth of national supply in several countries, and more than **61%** in **Sierra Leone**.

Figure 1-1 shows installed capacity against electricity access rates across the continent.

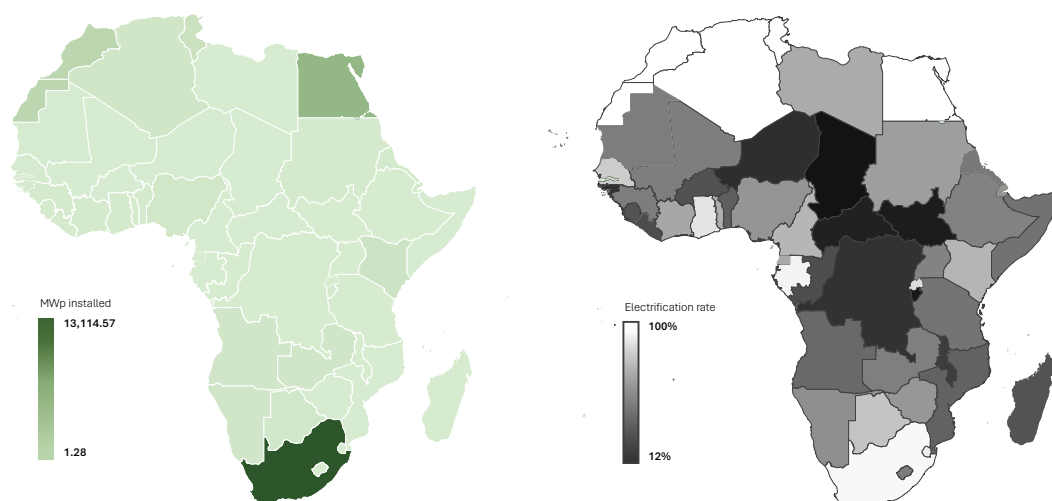


Figure 1.1: PV installed capacity versus electricity access rates.

Source: RCREEE Analysis

Yet the distribution of that capacity remains the problem in miniature. **14 GW of the continent's 22.2 GW sits in two countries: South Africa and Egypt**. The remaining **54 economies** hold roughly **8 GW**, about **0.33%** of **global installed capacity**, sitting on **60%** of the world's best resource. Of the **USD 521 billion invested in solar globally in 2024**, only **2% reached Africa**, and clean-energy capital on the continent still costs two to three times what it costs in advanced economies. Neither the resource nor the technology is the constraint. Something else is.

Why the gap has persisted and what it tells us about how to close it

Africa has never lacked solar projects. It has lacked the conditions that let projects become programmes. Four structural issues recur across every technology and across every market

type, and they are why deployment has stayed concentrated and slow.

- **Demand has been invisible and fragmented.** 54 markets, each with its own targets, procurement rules, standards and reporting, have produced no aggregated pipeline that a manufacturer, a financier or a training institution could plan against. With visible demand absent, there is no scale, no price discovery and no reason to build supply capacity, so every project carries first-project transaction costs.
- **The offtaker has not been creditworthy.** More than two-thirds of African utilities cannot cover their costs from revenue. Transmission and distribution losses range from **6.2% to 38%** and collection rates from **36% in Guinea to 100% in Niger and Namibia**. An insolvent utility cannot sign a bankable power purchase agreement, so private capital either prices sovereign risk into every project or does not arrive at all.
- **Capital has been committed but not delivered.** Of the **USD 9.1 billion committed to mini-grid electrification across the continent, only about 14% has been disbursed**. The binding constraint is not the headline figure. It is the shape of the money: its tenor, its currency, and the absence of instruments matched to small, distributed assets earning local-currency revenue.



- **Neither the industry nor the workforce was built alongside deployment.** Africa imports almost all its equipment while holding roughly **30% of the world's critical mineral reserves**, capturing little of the manufacturing value and none of the cost advantage of proximity. Meanwhile, institutional capacity, technical expertise in ministries and utilities, regulators able to license at speed, procurement teams able to run a competitive tender, surfaced in every consultation for this report as the single most cited bottleneck.

These four issues are not incidental, nor are they confined to one technology. They have blocked the mini-grid and the gigawatt plant alike, in high-access and low-access markets, under every regulatory tradition on the continent.

That is why this report treats them as chapters rather than as caveats

inside others. It is also why the report is built the way it is: four chapters on where solar reaches people, and four on the conditions that decide whether it does.

Mission 300 removes the first failure and makes the other three measurable

The first of those four failures is already being resolved, which changes the terms of the discussion. Mission 300 has moved from declaration to delivery machinery. Forty-eight countries have endorsed the Dar es Salaam Energy Declaration, and 35 governments have published National Energy Compacts: government-signed reform roadmaps carrying baseline-to-2030 targets, built on the same five pillars, and delivered by a national Compact Delivery and Monitoring Unit, which reports on progress twice a year.

For the first time, Africa's demand and reform commitments are written down, comparable across borders and formally monitored. Targets can be compared against one another, demand can be aggregated into a pipeline, and every commitment now carries both a monitoring line and an institutional owner. This report deliberately anchors itself to those compacts: each chapter states what has been committed, what is actually in place, and which enabler closes the difference.

How the report is built: four thematic areas, four enablers

The report's eight substantive chapters fall into two groups of four. The first group covers the routes by which solar reaches people; the second covers the four conditions identified above.

Four thematic chapters

Chapter 2 Distributed Renewable Energy for Last-Mile Access: mini-grids, solar home systems and rooftop solar for the settlements the grid will not reach economically, and for fragile and conflict-affected areas where they are often the only viable option.

Chapter 3 Solar for Agriculture: irrigation, cold chains, processing and mechanisation across the agri-food value chain, where energy investment produces the widest development return.

Chapter 4 Solar-Based e-Mobility: the two- and three-wheeler fleet that dominates African transport, and the charging and battery-swap infrastructure it requires.

Chapter 5 Utility-Scale Solar, Regional Interconnections and One Grid Africa: bulk generation, storage, transmission and the regional power trade that make them bankable.

Four cross-cutting enabler chapters

Chapter 6 Digitalisation: metering, revenue assurance, grid visibility, e-procurement and geospatial planning, the reforms that make the offtaker creditworthy and every other chapter's outcome measurable.

Chapter 7 Capacity Building: the institutions, regulators, delivery units and technical workforce without which committed capital does not convert into connections.

Chapter 8 Enabling Financing Ecosystem: the cost, tenor, currency and risk structure of capital, and the instruments that change them.

Chapter 9 Local Manufacturing and the African Solar Value Chain: where the equipment is made, and what Africa forgoes when it is made elsewhere.

How the chapters connect (I): the four technologies are one chain

Bulk power sets the price everything else competes against. Utility-scale solar and regional interconnection determine the cost and reliability of grid electricity - the benchmark a mini-grid is measured against when the grid eventually arrives, the tariff an electric two-wheeler pays to charge, and the running cost of a cold room once it is connected. When One Grid Africa gives a country's surplus generation a cross-border buyer, it changes the economics of every plant behind it and with them, the fiscal room a government has for last-mile programmes.

A connection without a load is a stranded asset, and agriculture supplies the load. Distributed renewables build the connection base, but viability is settled by what runs on it. Pumps, mills, dryers and cold rooms are the anchor customers that turn a mini-grid from a subsidised service into a business, which is why this report recommends writing



productive use into mini-grid tenders from the outset rather than treating it as a later phase. In that sense, the agriculture chapter forms the demand-side half of the distributed renewables chapter.

Mobility closes the loop, and hands hardware back. Battery-swap stations are themselves anchor loads: their daytime charging profile matches solar generation unusually well, making them natural customers for both mini-grids and rooftop systems. Retired traction batteries, refurbished domestically, return as second-life storage for those same systems.

How the chapters connect (II): four enablers underneath all four technologies

The second group of chapters is not an appendix to the first. It is the set of conditions on which the first stands.

A mini-grid without a meter cannot bill; without a licence it cannot be built; without local balance-of-system it carries an import premium of more than twice the global benchmark, at **USD 6,824/kWp against roughly USD 3,000/kWp**, and without local-currency working capital it cannot survive its own growth. A solar pump carries an equivalent four-link chain, as do a battery-swap network and a gigawatt-scale plant. Table 1 sets out all 16 links.

Table 1: Cross-Cutting Enablers Across Solar Applications

→ Thematics across
↓ Enablers down

	DRE: Last-mile access	Agriculture	e-Mobility	Utility-scale
Digitalisation	Geospatial siting, PAYGo and remote monitoring	Pump telemetry, digital payment and cold-chain data	Telematics, charging management, managed charging	Revenue assurance and SCADA make the offtaker bankable
Capacity building	Regulators who can license a mini grid at speed	Technicians and extension services within reach of the farm	Battery-safety codes, inspectors and mechanics	Procurement teams that can run a competitive tender
Financing	Local-currency working capital and receivables finance	End-user finance, so the farmer can buy the pump	Asset finance for fleets and batteries	Guarantees, FX cover and a lower cost of capital
Local manufacturing	Poles, cabling, meters, balance of system, made locally	Pumps, cold rooms and dryers assembled near the farmer	Battery packs, swap hardware, 2- and 3-wheeler assembly	Mounting steel, transformers and switchgear

How the chapters connect (III): the enablers are a loop, not a list

The four enablers also depend on one another, and in a specific order. Digitalisation produces the operating data without which a utility cannot be priced: finance cannot value what it cannot see, so metering and revenue assurance precede bankability rather than follow it. Financing pays for industrial capacity, and manufacturing

lowers the capital cost financing must cover: every USD 1,000/kWp taken out of a distributed system unlocks roughly USD 4.2 billion and about 10 million additional connections, so each makes the other affordable. Manufacturing creates the technician demand that capacity building must supply, and capacity building in turn supplies the engineers, regulators and procurement officers without whom none of the other three can be absorbed.

This interdependence runs as a vicious circle, currently spinning in the wrong direction. An insolvent utility cannot sign a bankable power purchase agreement; without bankable offtake, private capital stays away; without private capital, generation remains scarce and expensive; scarce and expensive power



pushes households and industry onto diesel; diesel drains foreign exchange, with transport fuel already at 23% of merchandise imports; and a government with less fiscal space is less able to recapitalise the utility.

This report identifies the cheapest point to break it: the meter. Cutting transmission and distribution losses to South African levels and closing collection leakage would raise utility revenue by up to 181%, turning 9 of 15 loss-making vertically integrated utilities profitable, without a single additional megawatt of generation. That is why digitalisation runs through this report rather than sitting inside one chapter of it. The second break point is demand: productive use converts a connection into a revenue stream, which is what makes the utility and the mini-grid solvent at the same time. Generation

is the visible part of the problem. Revenue and load are the binding parts.

Evidence base and method

Solarising Africa is a flagship report of the International Solar Alliance, developed in partnership with the Regional Centre for Renewable Energy and Energy Efficiency (RCREEE), the Energy Transitions Commission (ETC) and the Centre for Economic Transition Expertise (Cetex). It draws on four bodies of evidence: the **35 published National Energy Compacts** and their compact progress reports; **structured consultations** with ministries, regulators, utilities, developers, manufacturers and financiers across the continent; **analysis contributed by the partner institutions**; and published data from the IEA, IRENA, Ember, ESMAP, the World Bank, the African Development Bank and the Global Solar Council.

Country examples are drawn from programmes already operating rather than from proposals (Nigeria's DARES programme, Egypt's currency-indexed PPA framework, Kenya's integrated productive-use model, Zambia's duty reform, Ethiopia's industrial parks) because the report's purpose is replication rather than illustration. Where evidence is contested or incomplete, the text says so.



Scope and how to read this report

The report covers Solar PV. It is continental in scope but built on national evidence, and it deliberately avoids treating Africa as a single market: access rates range from under 20% to above 90%, some systems are grid-dominant and others distributed-led, and regulatory traditions and fiscal space differ profoundly. Its recommendations are therefore framed to support learning between African markets rather than prescription for Africa.

Every chapter follows the same structure: why it matters, what is blocking it, what Mission 300 commits and where the gap lies, the priority enablers, and a roadmap setting out what needs to be done, who needs to

act, and by when, sequenced across the immediate, medium and long term and assigned to a named actor.





Distributed renewable energy for Last-Mile Access

2.1 Why distributed renewable energy matters for Africa?

DRE refers to renewable (predominantly solar, due to its modular installation) generation sited at or close to the point of consumption, rather than at large, centralised plants connected through **long transmission and distribution networks**. Instead of a single technology, DRE is a spectrum of products matched to a community's density, demand and distance from the grid: from a solar lantern lighting one home, through solar home systems and standalone systems powering individual appliances, to **mini grids that supply whole settlements**.



At least four factors together decide the best-suited option: location, geography and terrain; the socio-economic vulnerability and ability to pay off the end user; the type of financing accessible to that user; and who will own and maintain the asset. Productive-use appliances in particular span a wide wattage range: a solar tailoring unit or digital service centre may draw 40-200 W, while an irrigation pump or cold room draws several kilowatts. The main DRE products this chapter refers to are summarised below:

Table 2: Distributed Renewable Energy Solutions and Their Typical Applications

DRE product	Typical capacity	Primary uses	Best-suited context
Pico-solar and solar lanterns	0.5–10 Wp	Lighting and phone charging (MTF Tier 0–1)	Remote households with the lowest ability to pay, and those unable to access low-cost credit to purchase a larger asset
Solar Home Systems	11–350 Wp	Lights, TV, fan, radio, small refrigeration (Tier 1–3)	Dispersed rural households beyond mini-grid reach, where low-cost financing is available and individual ownership secures long-term maintenance
Standalone solar for productive use	~0.3–10 kW (appliance-sized)	Irrigation pumps, cold storage, milling, agro processing	Farms, agro-processing units, micro-enterprises and SMEs that are off-grid or unreliably connected, particularly where outages fall in daytime or early-evening working hours, when an inverter-based standalone system may suit better than a mini-grid
Mini grids	~10 kW to <1 MW (viable up to 10 MW)	Village AC supply for homes, businesses and anchor loads (Tier 3–5)	Clustered settlements beyond ~10–15 km from the grid, where collective ownership and maintenance arrangements can be sustained

Source: ISA analysis

The category spans four distinct segments that this chapter treats together: off-grid solar, pico-lights and solar home systems sold directly to households, largely through pay-as-you-go models; mini-grids, which serve clustered settlements; standalone productive-use systems for farms and enterprises; and rooftop solar for households, commercial and industrial consumers and public facilities, whether behind the meter or grid-connected. These segments differ in customer, capital intensity, delivery model and

regulatory need, and the analysis that follows distinguishes them where the economics diverge.

2.1.1 Why DRE makes sense

Electrification has traditionally rested on expanding centralised grid systems: distribution networks extend outward to connect households to electricity generated at large-scale facilities. This model, reliant mainly on conventional generation such as coal, natural gas and hydropower, has delivered real gains in access, particularly where economic and demographic conditions are favourable. But it applies less well where population density is low, remoteness is high and demand is limited, a combination common across much of Africa.

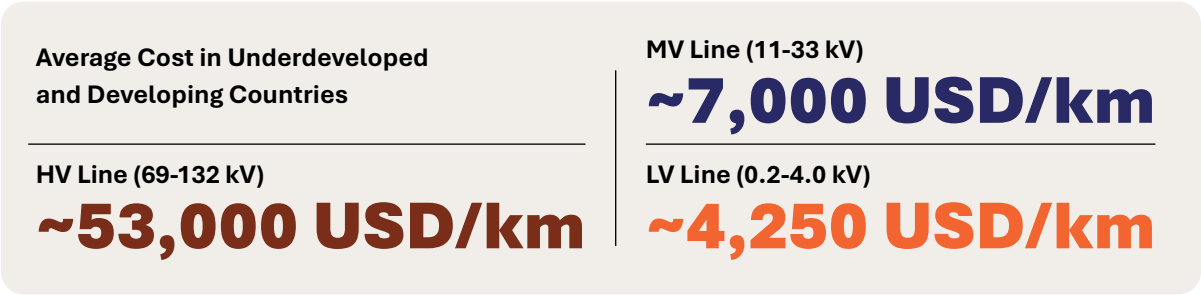


Figure 2.1: Average cost of transmission lines in underdeveloped and developing countries

Source: ISA Analysis

In many unserved and underserved regions, particularly in rural areas of developing countries, the high fixed costs of extending distribution infrastructure over long distances are hard to justify against the relatively small and dispersed consumer base. These challenges are compounded by difficult terrain and weak connectivity, which increase both upfront capital requirements and ongoing operation and maintenance costs, while also affecting service reliability. At the same time, demand profiles in such areas tend to be low and uncertain, reflecting limited purchasing power and a lack of productive loads, which thereby reduces the financial viability of conventional grid extension. Because these high fixed network costs are spread across very little energy sold, each additional remote consumer pushes up the utility's average cost of supply, deepening the cross-subsidy burden carried by the rest of the system.

Grid expansion also must be viewed within the wider system it sits in. Extending service to new areas often necessitates complementary investments in upstream generation and transmission capacity to maintain system adequacy and reliability. In parallel, utilities in many developing countries are already under pressure to strengthen and expand networks in rapidly growing urban centres, placing additional strain on constrained financial and institutional resources.

Grid extension costs can reach up to approximately USD 2,500 per connection, and achieving universal access through a grid-centric approach alone is estimated to require investments exceeding USD 600 billion. These financial demands are further compounded by the weak balance sheets of state-owned utilities in many least developed countries, limiting their ability to sustain such capital-intensive expansion.

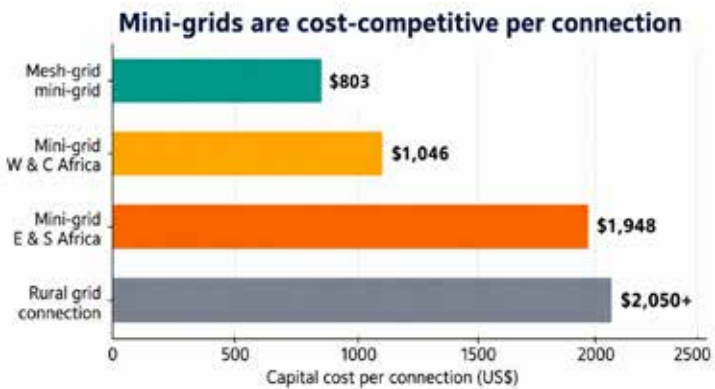


Figure 2.2: Cost competitiveness of mini-grids per connection
Source: Africa Minigrid Developers Association

Taken together, these structural and financial constraints highlight the limitations of a purely grid-based approach to achieving universal access and underscore the need for complementary solutions. **Decentralised renewable energy systems offer a pragmatic and increasingly cost-competitive alternative** by aligning system design with localised demand, minimising reliance on extensive network infrastructure, and leveraging declining renewable energy costs to deliver more timely, scalable, and financially sustainable electrification, particularly in hard-to-reach and underserved areas.

For remote and dispersed communities, DRE offers a more viable and cost-effective pathway. Positioned between grid extension and standalone systems, mini grids provide a scalable solution capable of delivering higher service levels while remaining more economical than grid expansion in distant locations. Which DRE product suits a given place depends on several factors. For example, **mini grids are well suited to settlements beyond 10–15 km from the grid and when the system size is lesser than 10 MW, with costs influenced by**

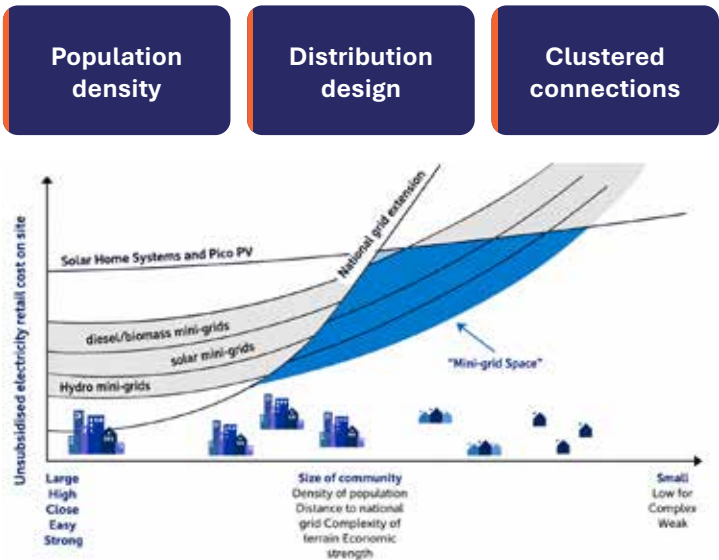


Figure 2.3: The mini-grid viability space.
Source: ISA Analysis



Additionally, the mesh-grid configuration can further improve cost efficiency. Standalone systems, while deployable in most contexts, are generally limited to meeting basic household demand and are most appropriate for sparsely populated areas where even mini grids are not economically viable. In addition to cost and deployment timelines, factors such as terrain complexity, distance from the existing grid, and the economic capacity of target populations are critical in determining the most appropriate electrification strategy. For instance, the least-cost technology maps closely to a settlement's distance from the existing network: grid extension nearest, standalone systems furthest, and mini-grids in between.

2.1.2 Resilience in a period of rising climate risk

A further argument for decentralisation has become more prominent as climate risk intensifies. Centralised grids carry their own exposure to climate stress. Heavy rainfall, flooding and landslides damage lines and substations; heat

derates transformers and conductors; and long radial feeders serving remote communities take the longest to restore once an extreme event hits. For the communities those feeders serve, an outage lasting days or weeks is not an inconvenience. It cuts off health services, water pumping, cold chains and livelihoods.

Distributed systems break that link. A mini-grid, rooftop or standalone system generates at or near the point of use, so it has no hundreds of kilometres of line to fail, and it keeps running when the wider network is down. Localised, resilient infrastructure is therefore more than the least-cost answer to distance and dispersion set out above. It is an adaptation measure in its own right and one that matters most for precisely the communities with the least capacity to absorb disruption. Health facilities, water systems, cold storage and communications are the loads where this resilience dividend is largest, and they are also, as the anchor-load discussion below shows, among the loads that make distributed systems commercially viable.

2.1.3 Economic logic of last-mile productivity

Beyond a threshold of distance and dispersion, grid extension simply stops paying: the average cost of reaching each additional remote consumer, the same figure introduced earlier, climbs faster than that consumer will ever pay back. It is at exactly this point that mini-grids become the least-cost option, sitting between grid extension and standalone systems. a reliable grid still gives the best service for dense residential, commercial and industrial demand; its limits in the last mile

are reach and speed, not what it can technically deliver.

Mini-grids can also be deployed far faster than the grid, within 9-18 months, at an estimated USD 0.3-0.5 million per site for 50-100 kW systems. They are already cost-competitive with grid extension per connection: average capital cost per connection is approximately USD 1,046 in Western and Central Africa and USD 1,948 in

Eastern and Southern Africa, while rural utility connections frequently exceed USD 2,000. And these costs keep falling. Mesh-grid design, which links distributed solar kits through a central hub powering multiple nodes, has cut infrastructure cost per connection by 41% in one comparison, from USD 1,358 at a conventional mini-grid control site to USD 803.

In addition, DRE systems are significantly more cost-effective than diesel generators. A large diesel fleet still runs across the continent, and every generator in it exposes people and economies to fossil fuel price swings. Table 3 sets out the comparison:

Table 3: Comparison of Mini-grids against Diesel Generator and solar-diesel hybrid

Parameter	Diesel Generator	Solar-Diesel Hybrid	Solar + Storage Mini-Grid
LCOE (USD/kWh)	USD 0.35–0.60	USD 0.20–0.35	USD 0.15-0.28
Fuel cost exposure	High / Volatile	Medium / Partial	None
O&M complexity	High	Medium	Low-Medium
Carbon emissions	High	Moderate	Near-zero
Scalability	Limited	Moderate	High
Typical lifetime	10–15 years	15–20 years	20–25 years

Source: ISA & RCREEE Analysis

On these numbers the case is no longer marginal, it is decisive. A solar-plus-storage mini-grid delivers power at roughly **USD 0.15-0.28 per kWh** against **USD 0.35-0.60 for diesel**, connects a household for about **USD 1,000-1,950** against more than **USD 2,500 for rural grid extension**, and does it in months rather than the years grid extension takes. World Bank's ESMAP programme names mini-grids the least-cost route to electricity for around half a billion people on exactly this basis, and close to half of the **300 million connections targeted under Mission 300 are expected to come from distributed renewables**.

2.1.4 Analysing DRE technologies

2.1.4.1 Mini grids

Mini-grids carry the largest share of the remaining access gap that neither the grid nor household systems can close. -Standalone solar covers dispersed

households, rooftop covers connected consumers, and clustered settlements beyond economic grid reach, home to a substantial share of the unserved population, fall in the gap between them. They deliver the service tiers that productive use requires: a solar home system supports lighting, phone charging and a television; a mini-grid supports a mill, a cold room, a welding workshop and a health facility on the same network, which is what converts electrification into income. Of all four DRE segments, mini-grids are also the most institutionally demanding and the least commercially mature. A household system sells like a product, through a shop or an agent. A mini-grid needs licensing, tariff approval, grid-arrival rules, concession arrangements and a long-term counterparty relationship, which is why this chapter carries more policy content for mini-grids than for the segments that reach customers through retail markets, and why the gap between what has been built and what universal-access targets imply is widest here.

None of this displaces standalone productive use, which requires its own distinct set of interventions: appliance innovation, end-user finance, skilling and market linkages and which is addressed both in the productive-use discussion below and in the way forward at the end of this chapter.



2.1.4.2 Off-grid

Off-grid solar, pico-products and solar home systems sold directly to households, will contribute a substantial share of Africa's remaining access gains, particularly for the dispersed populations that neither the grid nor mini-grids will reach economically. Its central lesson is worth stating plainly, since it applies well beyond this segment: technology has never been the binding constraint. Panels, batteries and appliances have been affordable and reliable for a decade. Success or failure has come down to whether a company can build a commercially sustainable model for serving low-income, geographically dispersed customers at scale.

Six operational challenges define that model, and none of them is technical.

- Distribution networks must reach villages that no retail chain serves, which means recruiting, training and supervising agents across vast rural geographies.

- Customer acquisition costs are correspondingly high and, because ticket sizes are small, they must be recovered over the life of a payment plan rather than at the point of sale.
- After-sales service determines whether a system is still working in year three - and whether the next household in the village buys one.
- Repayment performance is the segment's central financial variable: pay-as-you-go turns a hardware sale into a consumer-credit portfolio, and portfolio quality, not unit volume, is what investors ultimately price.
- Working capital is required continuously, because the company finances the customer's system upfront and recovers it over one to three years, so growth consumes cash rather than generating it.
- Foreign-exchange exposure cuts through all of it: equipment is imported, and debt is often dollar-denominated, while customer receipts are in local currency and cannot be repriced when the currency moves.

Policy support for off-grid solar should therefore target the delivery model, not the hardware. Instruments that fix working-capital cycles, local-currency lending, receivables financing and portfolio quality will do more for access at scale than unit subsidies. Quality standards with verified certification protocols matter too, since repayment performance is what the whole segment's access to capital rests on.

2.1.4.3 Rooftop solar

Rooftop solar has become the fastest-growing segment of Africa's solar market, and it is growing for a reason that has little to do with subsidy: for a commercial or industrial consumer facing unreliable supply and rising tariffs, a rooftop system is the most affordable and fastest form of self-generation available. Utility-scale projects can take years to procure and connect. A rooftop installation, by contrast, goes up in weeks on infrastructure the customer already owns, and it competes not against wholesale generation prices but against the retail tariff plus the cost of diesel back-up. That is a far easier hurdle to clear, and it is why the segment has scaled with private capital in markets from South Africa and Nigeria to Kenya and Ghana, even as grid-scale pipelines take longer to move.

For the energy system, the segment does three things at once. It relieves peak demand on constrained networks

at the point of consumption, avoiding transmission and distribution investment. It keeps productive activity running through outages, protecting the industrial and commercial output on which tax revenue and employment depend. And it converts consumers into prosumers, deepening the market for storage, smart meters and demand-side services. Rooftop is also the segment where distributed and grid-connected solar meet: most commercial systems remain connected to the network, which makes their treatment a question of tariff and interconnection design rather than of off-grid policy.

Three policy conditions determine whether the segment scales or stalls.

- Net-metering or net-billing rules must be clear, bankable and stable, so that a consumer investing in a 20-year asset knows how surplus energy will be valued.
- Interconnection procedures must be standardised and time-bound, with simplified approval for small systems, because permitting delay is the single most common cause of abandoned rooftop projects.
- Import duty and VAT treatment of panels, inverters and batteries must be consistent: Zambia's removal of VAT and duties on solar components, paired with fast-tracked agreements, produced an eightfold year-on-year increase in solar imports within 12 months.



The Utility Aggregator model: Way forward for solar rooftop in Africa

The constraint on rooftop solar is rarely the technology or even the tariff: it is transaction size. Individual rooftops are too small to interest institutional lenders, too heterogeneous to underwrite cheaply, and too dispersed for developers to reach at low customer-acquisition cost. The Utility Aggregator Model addresses precisely this problem, and it is model African utilities are well placed to adapt.

Under the model, a utility (or an aggregator licensed by it) assembles many small rooftop sites into a single procurement and financing package. The utility standardises the technical specification, tenders the portfolio competitively, and either owns the assets or contracts a developer to build and operate them, with the consumer paying through the existing electricity bill rather than through a separate loan. Four advantages follow. Competitive tendering at portfolio scale delivers price discovery that no individual rooftop can achieve. Aggregation converts hundreds of small, unbankable contracts into one investable asset class with a diversified revenue base. Billing through the utility relationship removes the customer-acquisition and credit-assessment costs that dominate rooftop economics. And because the utility remains the counterparty, the model aligns rooftop growth with network planning instead of leaving distributed capacity to appear unmanaged on constrained feeders.

The model also gives utilities a constructive role in a segment they often perceive as a threat to revenue. A distribution utility losing its highest-value commercial customers to self-generation faces a genuine erosion of its balance

sheet; the same utility acting as aggregator earns a service margin, retains the customer relationship, and gains visibility over distributed capacity on its own network. For African utilities pursuing the financial turnaround discussed in the digitalisation chapter, that is a materially better position than resisting a segment that will grow regardless. Aggregation is most readily piloted on public buildings, schools, hospitals, ministries and water utilities, where the offtaker is the state itself, procurement is already centralised and payment risk is manageable.

2.2 Current barriers limiting DRE potential

Despite this potential, solar lights and solar home systems reached only 258.2 MW of the continent's 18.4 GW of solar installations in 2024. This is because the constraint has shifted from technology to energy delivery economics. Four structural barriers explain most of the underperformance.

- **A structural financing gap not a capital shortage:** Universal energy access in Africa by 2030 requires an estimated investment of USD 91-127 billion to reach 380-490 million people. As of early 2025, only 14% of the USD 9.1 billion committed to mini-grid electrification in Africa had been allocated, and only USD 1.28 billion had been disbursed about 2.1% of the capital needed over the rest of the decade. Results-based framework disbursements remain low because programmes require developers to pre-finance projects, while limited access to capital, cumbersome due diligence and verification processes, and regulatory uncertainty delay project execution and fund release. The result is a mismatch between funding commitments and actual deployment, with contract signing taking an average of 2.8 years and up to 4 years in some cases.
- **An Africa-specific CAPEX premium:** Even where capital is available, the cost of deploying mini-grids in Sub-Saharan Africa remains structurally higher than global benchmarks. African mini-grid CAPEX (2024) sits at USD 6,824 per kWp against a global benchmark of USD 3,000 per kWp. The 2.3× premium has identifiable causes: high import duties on solar components in many jurisdictions, fragmented supply chains with thin regional manufacturing, expensive last-mile logistics, and small project sizes that miss procurement economies.
- **Local-currency risk:** Equipment imports and most concessional debt are priced in USD or EUR, while revenue from end-users is collected in local currency. When African currencies depreciate, the economics of every project on the books deteriorate overnight. For example, the cost of basic solar lanterns in Nigeria rose by between 91% to 300% in local-currency terms in 2023, entirely offsetting the global decline in solar component prices.

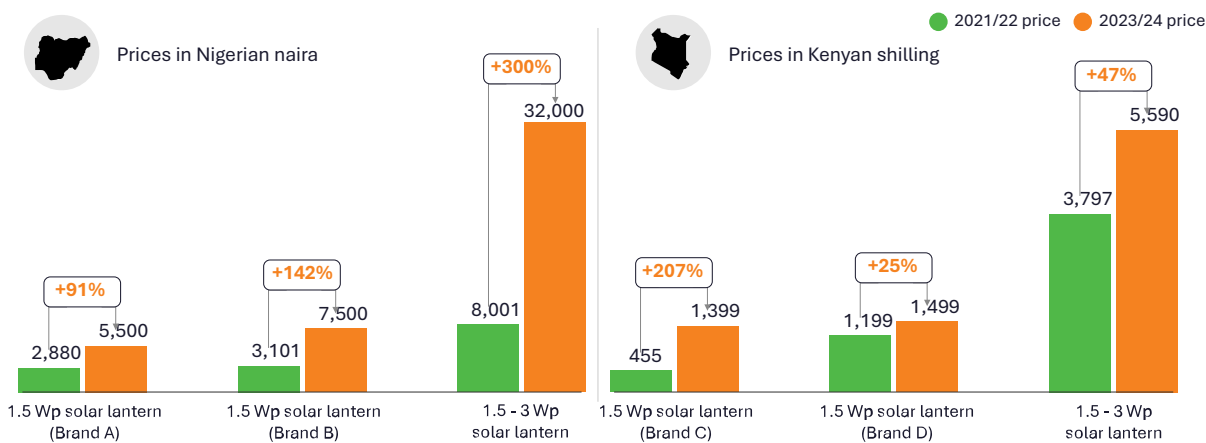


Figure 2.4: Off-grid Solar Lantern Price Trends
Source: ESMAP

- **Regulatory friction at multiple stages of the project lifecycle:** Regulatory frameworks designed for centralised utilities apply poorly to decentralised systems. Licensing and approval timelines in many African mini-grid markets exceed 12 months per site (these numbers vary by countries as shown in the figure), consuming a large share of developer working capital before construction can begin.
- **Absent local manufacturing and patient capital, which together block adaptation to local needs:** Because almost all equipment is imported, there is little capacity in-country to innovate on productive-use technologies for local conditions, to fabricate, adapt or retrofit equipment for particular crops, trades and operating environments, or to supply spare parts quickly. Product development for African productive use requires patient, risk-tolerant capital and a domestic fabrication base; without either, the market is confined to imported appliances that often fit local conditions poorly and fail early as a result.

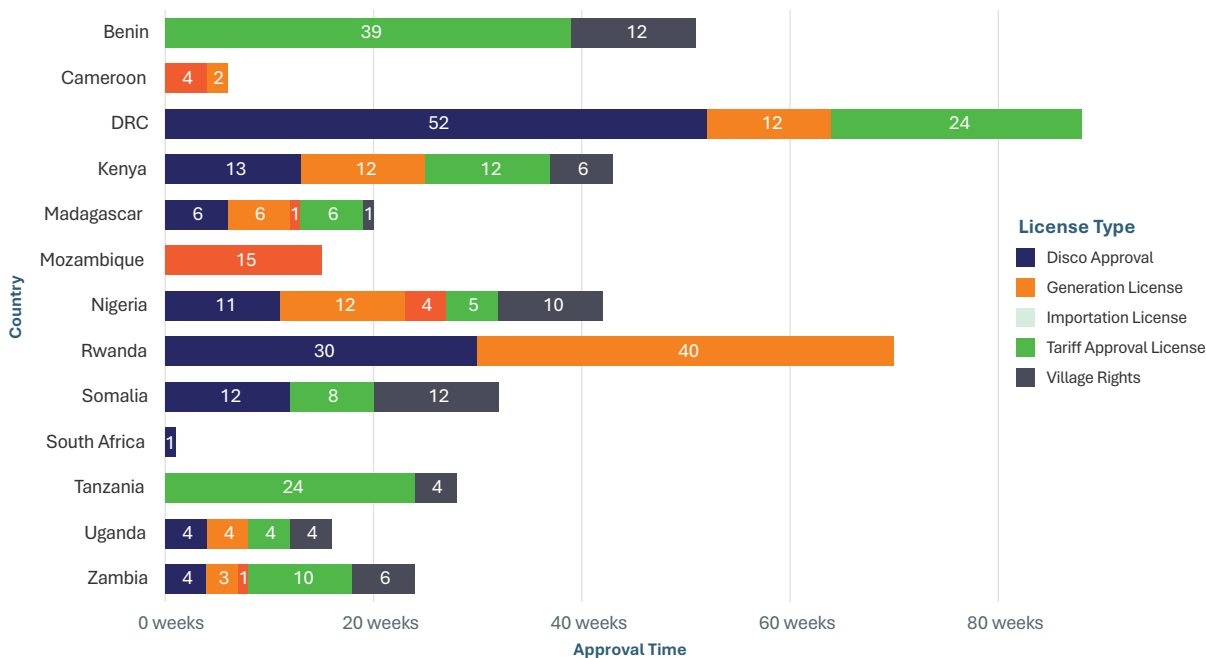


Figure 2.5: Off-grid Solar Licensing Approval Times

2.3 Mission 300: Scaling the model across the continent

2.3.1 What is being done?

Nigeria's DARES is one national expression of a much larger effort. Mission 300 is the joint pledge of the World Bank Group and the African Development Bank to connect 300 million Africans (roughly half of Sub-Saharan Africa's ~600 million access deficit) to electricity by 2030. Its engine is the National Energy Compact: a government-led, signed reform roadmap with hard baseline-to-2030 targets for access, clean cooking, renewables, utility viability and private capital. Thirty-five compacts have now been published, and by mid-2026 more than 50 million people had been connected across 40 countries.

What makes Mission 300 more than a pledge is that it hard wires distributed renewables into national policy. Every compact is built on the same **five pillars: competitive generation and grid, regional power trade, last-mile access through DRE and clean cooking** (Pillar 3), **private-sector participation, and financially viable utilities**. Roughly half of the 300 million new connections are expected to come from mini-grids and standalone solar.

The programme also pairs reform with capital aimed squarely at the hardest part of the stack. The World Bank and AfDB have committed USD48 billion to 2030 and aim to mobilise more than USD238 billion in public and private investment, and have launched Zafiri, an investment company targeting up to USD1 billion to close the equity gap that has held back decentralised renewables. Alongside guaranteed platforms such



as ISA's Africa Solar Facility, this is the financing architecture that can turn signed compacts into connections. With Nigeria's DARES, the working template for the rest of the continent already exists.

The country-wise evidence shows how differently the same Pillar 3 commitment lands. **Zambia**, at 24 inhabitants/km², commits to 294,719 connections (mini-grid and SHS) per year, adding 1,768,311 household connections between 2023 and 2030 and enacts the mini-grid regulations by December 2026 to enable the private sector participation through streamlining approvals. **Liberia**, whose 5.56 million people are dispersed across 14,000 settlements, targets 100,000 household connections a year with DRE as the only economic route outside Monrovia. **Lesotho** has formalised a national clustering approach separating off-grid, mini-grid and standalone zones from grid densification; in **Malawi**, 1.55 million of the 2.7 million planned connections are off-grid, raising electricity access to 70% up from 25.9%; and **Uganda** plans roughly 2,712 mini-grids in a phased manner along with continued scale up of standalone solar systems, cumulative 6 million units by 2030, to deliver the 85% electricity access by 2030.

2.3.2 What needs to be done?

The arithmetic of the gap is unforgiving. Reaching 300 million connections by 2030 from the 50-million mark of mid-2026 requires roughly 60 million new connections a year, about double the pace of the programme's first eighteen months, and if half are to come from DRE as the compacts assume, mini-grid and standalone solar system deployment need to scale faster.



Table 4: Mission 300: Progress, Gaps and Priority Enablers for Scale-Up

National Energy Compact commitments	Where the continent stands	Gap to close	Closing enabler
~150 million connections via mini-grids and standalone solar by 2030	50 million+ people connected by mid-2026 across 40 countries	The connection pace must more than double, with DRE carrying half the load	Financing the build-out: smart subsidies integrated with the results-based connection payments – designing the RBF payments in two parts, with the first part linked to the successful connections achieved and the second component linked to demand growth structured in the form a payment risk sharing facility alongside financing for customers, appliance supply chains and technical support
Dated DRE regulation in compacts (Zambia's mini-grid rules due Dec 2026)	Licensing, tariff and grid-arrival clarity still missing in many markets	The regulatory enablers set out above, executed on compact deadlines	Transparent licensing, grid-arrival rules, cost-reflective tariffs - executed on compact deadlines
Programme capital aligned	Mini-grid capex ~USD 6,824/kWp vs ~USD 3,000 benchmark; only 14% of committed mini-grid finance disbursed	Guarantee-led finance, pooled procurement and local assembly to close the cost and disbursement gaps	Pooled procurement, duty removal and local assembly (way-forward priority); every USD 1,000/kWp saved connects ~10 m more people
Pillar 3 pairs electricity with clean cooking in all compacts	~600 million without electricity; close to 1 billion without clean cooking; 3.7 m premature deaths/year	Demand side: systems without productive, paying loads stay unviable	Building viable, paying demand around each system through appliance financing, anchor customers, deliberate load growth
Pillar 1 least-cost planning commitments	A least-cost mini-grid/grid mix would save ~USD 90 bn by 2030 across 15 modelled markets	Planning tools not yet steering national investment programmes	Geospatial least-cost electrification; DRC precedent

Source: National Energy Compacts submitted by African countries

The consumer-side barriers are as binding as the investor-side ones. The constraints set out above are framed from the perspective of governments, financiers and developers, but adoption ultimately turns on household and enterprise decisions. Affordability is the first filter: even where a system is the least-cost option over its life, the upfront payment or the monthly instalment must fit an income that is often seasonal and irregular, which is why pay-as-you-go structures and repayment schedules aligned to harvest cycles matter as much as the tariff itself. Willingness to pay is shaped less by price than by experience: perceptions of equipment quality, the visibility of after-sales support, and trust in the provider's ability to repair a fault quickly. Sub-standard imports and abandoned systems damage that trust well beyond the customers directly affected, which is why quality standards, verified certification and consumer-protection rules are demand-side instruments, not merely technical ones.

2.4 Priority enablers to accelerate deployment

Closing these gaps is no longer primarily a technology problem; it is a problem of demand and finance. The interventions that move mini grids from pilots to a scalable market fall into two reinforcing categories:

- Building viable, paying demand around each system
- Structuring capital so that scarce public money mobilises far larger private investment.

The two sub-sections below detail these two enablers and highlight how they can be applied at national scale.

2.4.1 Building viable, paying demand around each system

Three structural levers decide whether a given mini-grid is viable at all, before demand can even be built: how it is engineered, what it is built around, and the rules it operates under. Small changes in each move the two numbers that determine whether a system pays for itself: the cost per connection and the load factor.

- **Regulation.** The first lever is the rulebook, and it is where clarity pays the highest return. Frameworks written for centralised utilities fit decentralised systems poorly: licensing that exceeds 12 months per site, tariffs forced to match subsidised grid prices, and no clear answer to what happens when the main grid arrives all raise risk and cost. **Nigeria offers one of the clearest templates for reducing regulatory risk and accelerating DRE deployment.** Under NERC's Mini-Grid Regulations 2026, regulatory requirements are tiered by project size: mini-grids up to 100 kW require only registration, while larger systems obtain a single permit that consolidates generation, distribution and supply approvals, with a target processing time of 30 business days. Separately, the regulations expand the scale of projects eligible under the mini-grid framework by allowing isolated mini-grids of up to 5 MW and interconnected mini-grids of up to 10 MW. The framework also introduces portfolio applications, clear grid-arrival procedures, and compensation mechanisms that protect developers when the main grid reaches a service area. The



key lesson is that capacity-tiered, single-window regulation, combined with flexible, cost-reflective tariff structures that allow mini-grid operators to serve households and productive-use customers sustainably, investor protection, and integrated electrification planning, can significantly reduce regulatory risk and accelerate private investment in DRE.

- **Building demand.** Hundreds of millions of people worldwide still lack electricity, and most solutions focus on extending power supply infrastructure. But in marginalised areas, low electricity demand makes the expense of that infrastructure hard to justify. Increasing the use of energy-efficient appliances in these areas can attract electricity supply investments while delivering climate benefits. Reaching the level of appliance use needed to close this gap would require allocating 15% of supply-side investments, or USD 38 billion, toward demand growth between now and 2030. The funding should focus largely on improving appliance affordability.
- **Design and technology.** Because distribution, not generation, drives mini-grid cost, network architecture matters more than the panel price. The mesh-grid designs, where shorter, lighter cables let neighbouring homes share power, cut infrastructure cost per connection by 41%, from USD 1,358 at a conventional site to USD 803. Smart and multi-load metering, grid densification, remote monitoring, and right-sizing systems to measured rather than assumed demand compound these savings. On the demand side, raising a mini-grid's load factor from 22 to 40% through productive use could cut the cost of supply by up to 27%. Interconnected configurations and smart, multi-load metering with pay-as-you-go billing cut technical and commercial losses further, the quiet leakages of energy and revenue that sink mini-grid returns.
- **Anchor loads.** The customer whose steady, creditworthy demand underwrites the system and lifts its load factor. The type of anchor shapes the entire business case, from load profile to bankability. The Anchor-Business-Community pattern examined below, a telecom tower or agro-processor underwriting a cluster of shops and homes, is the configuration most consistently associated with commercial viability. Productive use itself spans three broad families of application, and programme design should address them distinctly rather than as a single category: agriculture - irrigation pumping, on-farm mechanisation, agro-processing, milling and cold storage; livestock, milk chilling, poultry lighting and egg incubation; and micro-enterprise and services, digital service centres, tailoring units, barber shops, grocery and refrigeration, local crafts, pottery and small-scale manufacture. These differ in load profile, seasonality, capital requirement and the type of end-user finance they need, and the appliances that serve them range from tens of watts to several kilowatts.

Table 5: Typical Anchor Customers and Load Characteristics

Anchor type	Load profile	Why it anchors the system
Telecom towers	Steady, 24/7, ~1-3 kW	Bankable, creditworthy offtaker providing a predictable base load
Agro processing and mills	High, daytime, seasonal	Large productive daytime load that keeps value inside the village
Irrigation and cold storage	Daytime, seasonal	Raises load factor and farm incomes; strengthens food security
Health facilities	Steady, priority	Reliable, often publicly backed offtaker with high development value
Water pumping/utilities	Daytime, flexible	Deferrable load that absorbs surplus daytime solar generation
Commercial and hospitality	Mixed, day and evening	Broadens the revenue base; higher willingness to pay
Micro-enterprises and SMEs on unreliable grid supply	Daytime and early evening	Enterprises that are nominally connected but experience outages during working hours are a real and creditworthy demand segment. Where the grid exists but is unreliable, an inverter-based standalone or behind-the-meter system may serve them better than a mini-grid.

Source: ISA & RCREEE Analysis

Two illustrations show how anchor loads work in practice. The first is a continental-scale opportunity assessment rather than a single deployment; the second is an operating business model already in use across several markets. The anchor loads are explained in detail by two case studies:

Case study 1: Opportunity for electric mills

Maize is Africa’s most widely grown cereal. Sub-Saharan Africa mills around 90 million tonnes of maize annually, burning ~900 million litres of diesel and emitting 2.3 million tonnes of CO2 in the process. Replacing that diesel-powered milling fleet with electric mills run by mini grids could add around USD 2.5 billion to African economies each year by 2030. The mill is not simply another customer here: it is the anchor load that transforms a mini-grid’s commercial profile.

The downstream effects reach well beyond the mill itself. An electric mill displaces diesel and the price volatility that comes with it. It cuts both the cost and the physical labour of milling, freeing time for school and enterprise. It keeps milling and its margins inside the village, rather than exporting grain and value to distant towns. It creates local jobs in operation, maintenance and processing. It strengthens farm-gate incomes and food security. And because it deepens daytime load, it pulls the mini-grid itself away from subsidy dependence and towards commercial viability. In this configuration, electricity access becomes the first link in a chain of development outcomes, not the last.

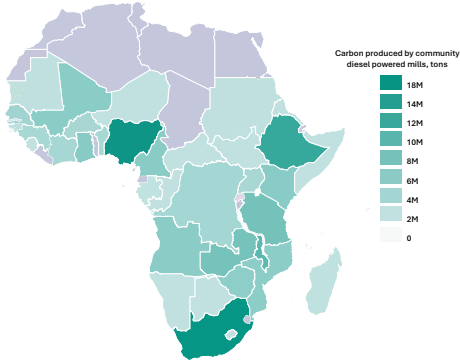


Figure 2.6: Diesel Mini-grid Emissions in Africa
Source: Cross Boundary Energy

Case study 2: Anchor Business Model

The Anchor-Business-Community (ABC) model centres on a high-value anchor load, typically a telecom tower, supporting 5–10 businesses and 200–500 households, powered through a ~14 kW solar PV mini-grid with battery storage. The anchor’s steady demand ensures reliable revenues and system stability under a Build-Own-Operate-Maintain framework, strengthened by financing support and regulatory oversight. The configuration is in commercial operation in several African markets (most visibly in Nigeria) where telecom-tower-anchored mini-grids have been developed under the Rural Electrification Agency’s programmes.

Financial viability is driven by differential tariffs: the anchor pays a premium that cross-subsidises affordable tariffs for businesses and households. Smart metering, prepaid billing and flexible payment options reduce revenue risk and support demand uptake. The model delivers reliable power for lighting, phone charging and productive uses, lowers diesel dependence, and enables local income generation.

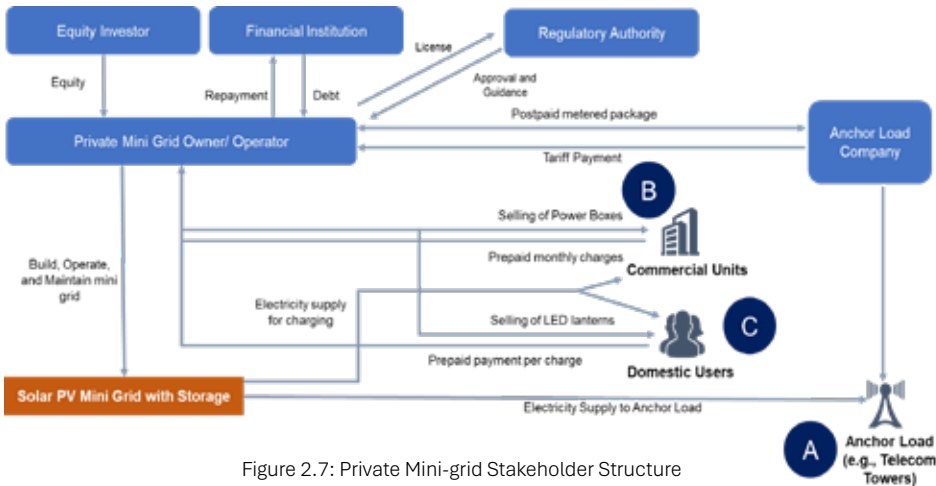


Figure 2.7: Private Mini-grid Stakeholder Structure
Source: ISA Analysis

Both cases make the same point: a mini-grid's commercial viability depends on what is plugged into it. Productive use is not a downstream benefit of access; it is what makes access pay for itself.

Enterprise readiness is the missing link between finance and the end user.

Even where credit lines exist, financial intermediaries report rejecting a high proportion of enterprise applications for reasons that have little to do with the underlying business opportunity. Experience from intermediaries in Nigeria is instructive here. Rejections cluster around a small number of recurring weaknesses: unclear governance structures within the enterprise or cooperative; the absence of signed contracts with anchor-load or offtake clients; business viability that has not been mapped or evidenced; and weak procurement and supply-chain arrangements. The practical response is to fund enterprise preparation alongside capital: support for detailed project reports, business plans and financing proposals, delivered with an understanding of the specific criteria on which lenders in that market decide. This is a low-cost intervention that raises the conversion rate of existing credit lines, and it should be treated as part of the financing architecture rather than as a training activity.

2.4.2 Financing the build-out: smart subsidies, aggregation, and blended finance

Reaching universal access through mini-grids is, in the end, a capital-formation problem. The **USD 91-127 billion** needed to **electrify 380-490 million people by 2030** will not be met by public budgets alone. The work is to structure scarce public finance so that it mobilises larger pools of private and institutional capital.

- **Smart subsidies – public money that crowds in, not crowds out.** The role of subsidy is to bridge the gap between what remote customers can afford, what cost-reflective service requires and how it can contribute to demand growth, without displacing private capital. Results-based financing and minimum-subsidy reverse-auction tenders pay only against verified connections and force developers to compete on the lowest subsidy needed, directing public funds to the projects that deliver the most access per dollar. Demand-side subsidies targeted at the poorest customers preserve affordability while keeping tariffs viable. Smart subsidies can also be integrated with results-based connection payments in a two-part structure: the first part linked to successful connections achieved, the second linked to demand growth, structured as a



payment risk-sharing facility. In plain terms: results-based financing means the developer builds first and is paid once an independent verifier confirms the connections are working, while a minimum-subsidy tender awards the project to whichever qualified developer asks for the least public money per connection.

- **Portfolio aggregation – from one-off projects to an investable asset class.** Individual mini grids are too small and dispersed to interest institutional investors, and their transaction costs are disproportionate. Bundling many sites into portfolios (standardising contracts, procurement, O&M and reporting) lowers per-site costs, spreads risk, and creates ticket sizes large enough for commercial debt and equity. Aggregation is the bridge from grant-dependent pilots to a bankable, scalable market. Put simply, aggregation bundles many small sites into a single package large enough for an institutional investor to assess and finance once, rather than site by site.

- **Local-currency considerations - a constraint, but also a hedge.** Currency depreciation is an economy-wide shock, not a solar-specific one: it raises the local-currency cost of everything imported, from mini-grid components to the diesel that fuels the incumbent alternative. For a solar project the effect cuts both ways. Up front, because equipment and most concessional debt are priced in hard currency while revenue is collected in local currency, depreciation inflates CAPEX and can erode a project's economics overnight; the cost of basic solar products in Nigeria rose 91% to 300% in local-currency terms in 2023. Yet once built, a solar asset carries no fuel-import bill, so it is insulated from the very exchange-rate and fuel-price volatility that keeps making diesel generation more expensive in local-currency terms. Depreciation therefore worsens solar power's entry cost while strengthening its lifetime competitiveness and its value as an energy-security hedge. The policy task is to attack the entry-cost side directly: through local-currency lending facilities, partial-risk and currency-hedging instruments, revolving debt facilities such as the IFC window within DARES, and local assembly and manufacturing that shrink the imported share of CAPEX.
- **A blended-finance architecture for productive DRE markets.** These instruments work as a stack: concessional grants and results-based financing absorb first-loss and bridge affordability; development and blended debt (including local-currency and guarantee instruments) lower the cost of capital; and de-risked, aggregated portfolios attract private equity and commercial debt at scale.

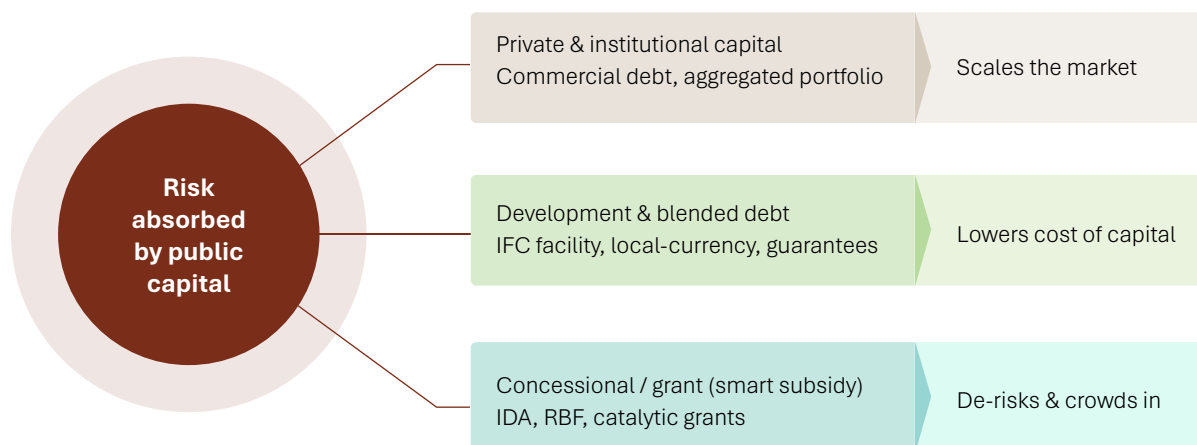


Figure 2.8: Blended Finance Architecture for Productive DRE

Source: ISA Analysis

ISA's Global Solar Facility:

Within this stack, guarantees are the single most powerful lever in Africa, because the binding constraint is rarely the absence of capital: it is the perception of risk. ISA has operationalised this approach through its **Global Solar Facility (GSF)**, with the **Africa Solar Facility (ASF)** as its first regional vehicle. ASF deploys three reinforcing instruments: a payment-guarantee fund to backstop offtaker payment risk; an insurance fund to cover residual project, currency and political risks; and a concessional seed investment fund supported by development banks. Together, this de-risk the entire payment chain without displacing private capital, while technical assistance addresses the regulatory barriers that deter investment in the first place.

ASF is targeting **USD 200 million** in total, with an initial **USD 74 million phase ready for launch**. The blended-finance structure has been finalised, the risk-mitigation tools defined, anchor capital secured, and governance arrangements established to ensure strong, Africa-based execution. A clear project pipeline has been identified, and replication pathways through country platforms and thematic investment stacks are designed to extend the facility's reach across the region.

2.4.3 Case study: Nigeria DARES

Nigeria carries the world's largest electricity access deficit: roughly 85 million people without supply, some 35% more than the next-least-electrified country. Access has grown at about

1.1% a year while the population has expanded at close to 3%, meaning the absolute deficit continues to widen. Unreliable supply is estimated to cost the economy around USD 25 billion a year, equivalent to 5–7% of GDP. This is precisely the terrain in which decentralised renewables are the least-cost answer: dispersed rural demand, weak utility balance sheets, uneconomic grid extension.

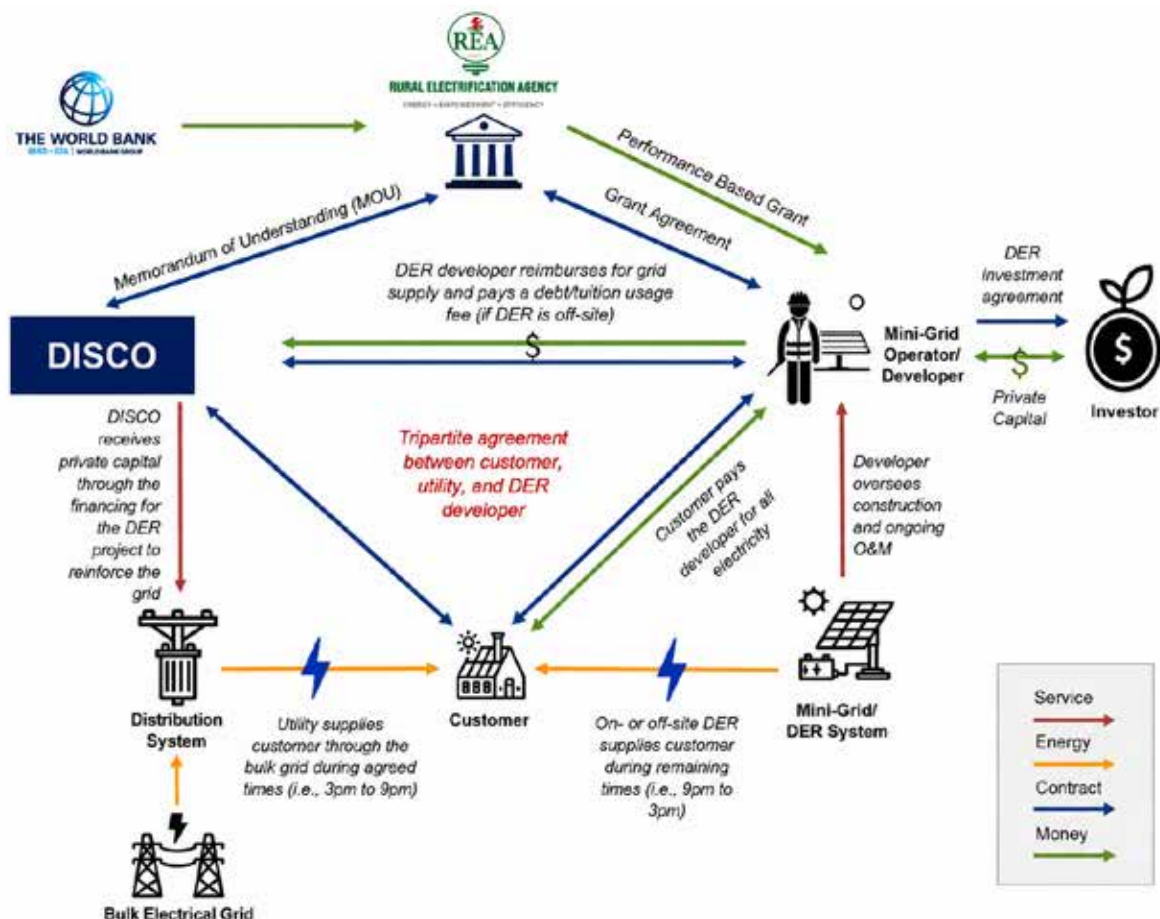


Figure 2.9: Results-Based Financing Model for Mini-grids

Source: ISA Analysis



The Distributed Access through Renewable Energy Scale-up (DARES) project is a **USD 750 million** IDA-financed programme implemented by the **Rural Electrification Agency (REA)**, targeting new or improved electricity access for **17.5 million Nigerians**. It is the scale-up of a proven approach rather than a fresh experiment. Its predecessor, the Nigeria Electrification Project, demonstrated in-country that a results-based, private-sector-led model works: **180 mini-grids commissioned**, more than **5.4 million people reached** through solar home systems, every **USD 1 of public money mobilising around USD 1.50 of private capital**, and a competitive field of more than **100 qualified developers**. DARES carries that template into a much larger pipeline.

The programme's design responds directly to each of the structural barriers identified earlier. Of the **USD 750 million**, **USD 410 million** is allocated to mini-grids alongside **USD 300 million** for standalone solar and **USD 40 million**

for technical assistance. This public capital is blended with JICA co-financing, an IFC revolving debt facility, and GEAPP support, structured to mobilise more than **USD 1.1 billion** in total investment. The architecture maps onto the four structural barriers as follows.

- **Closing the financing gap with catalytic, blended capital.** DARES pools concessional IDA credit with development-partner and commercial finance so that scarce public money de-risks investment rather than displacing it, repeating roughly the same 1.5x leverage the predecessor programme achieved, and pushing total mobilisation past USD 1.1 billion.
- **Compressing the CAPEX premium through competitive price discovery.** Alongside developer-led Performance-Based Grants, DARES introduces a Minimum Subsidy Tender in which developers bid the lowest subsidy they need and the market sets the price. Aggregated, REA-prepared site pipelines and standardised contracts capture economies of scale across hundreds of sites: directly attacking the small-project, fragmented-procurement costs that inflate African mini-grid CAPEX.
- **Shifting performance and payment risk onto results.** Grants are paid only against verified milestones (customer connections first, then a minimum capacity-utilisation factor after a year of operation) so public funds follow delivery, not promises, while the IFC debt facility and local financing

readiness ease the local-currency pressure that erodes project economics.

- **Removing regulatory friction.**

REA acts as a single, credible counterparty and one-stop shop. A streamlined single-stage tender process and standardised tripartite and franchise agreements pre-cleared with the regulator cut the per-site licensing timelines that elsewhere consume a year or more of developer working capital before construction can start.

DARES's most distinctive innovation is the interconnected mini grid, a new USD 127 million window aimed not at remote villages but at the underserved urban and peri-urban areas that grid-connected utilities serve poorly. Through tripartite and franchise agreements, developers ring-fence a cluster, take over metering and collections, invest in the local network, and pay the distribution company for bulk power and network use. The utility is paid in full for energy delivered, sheds collection losses, and earns network and franchise fees, while customers get reliable supply, turning a loss-making segment into a revenue generator.

With this programme, Nigeria is building one of the largest public solar mini-grid programmes in the world, and, more importantly, a replicable blueprint for moving distributed renewables from pilot to scale through blended finance, competitive subsidy and utility partnership.

2.4.4 Sustaining service beyond first connection

Access programmes are measured at the moment of connection, but their value is realised over 15 to 20 years, and this is where distributed markets have historically underperformed. As Africa's DRE installed base matures,

three obligations move from peripheral to central. Maintenance ecosystems must exist within reach of the customer: a trained technician, a spare-parts supply chain and a service relationship that survives the end of the project that financed the installation. Battery replacement is a scheduled, predictable event, not a contingency. Most systems will need it once or twice within their operating life, and neither tariffs nor subsidy structures routinely provide for it, which is a principal reason mini-grids and home systems fall out of service. And end-of-life management for panels, inverters and especially lithium and lead-acid batteries requires collection and recycling arrangements that barely exist at present; extended producer responsibility, applied at the point of import or sale, is the most practical way to establish them before volumes make the problem unmanageable. This is also where the mobility chapter's retired traction batteries become an asset rather than a liability: second-life packs are a natural fit for mini-grid and rooftop storage, closing a loop between two chapters of this report.

The programmatic implication is that support instruments should be designed around the whole service life, not the installation event. Results-based payments that reward verified electricity use and continued operation in year five, rather than connections in year one, do this directly and they align the incentives of developers, financiers and governments with the outcome that matters.



2.5 The way forward

The technology debate is settled: solar mini-grids and standalone systems are now the lowest-cost path to universal electricity access across much of Africa. What remains is not innovation but execution, specifically how systems are delivered and financed. African mini-grids cost about USD 6,824/kWp, more than double the global benchmark of roughly USD 3,000. Closing that gap will take local manufacturing, pooled procurement, removal of import duties, and sustainable, affordable demand creation among end-use consumers. Every USD 1,000/kWp reduction could unlock roughly USD 4.2 billion (at ~USD 450/connection), enough to connect 10 million additional people. Seven mutually reinforcing priorities can convert this potential into connections, and connections into livelihoods.

- **Make demand bankable, not just available.** Anchor every system in productive use (appliance financing, anchor customers and deliberate load growth) so that electricity drives income and each mini-grid earn its way to viability. The electric-mills opportunity alone illustrates the impact: a USD 2.5 billion annual dividend, with ripple effects across jobs, gender, food security and emissions.
- **Back innovative business models that deepen investor interest.** The DARES case study highlights the replicability potential of the interconnected mini-grid business model, targeted at underserved urban and peri-urban areas where grid-connected utilities serve poorly. It is the segment where paying customers already exist, which makes it easier to build a commercially viable business model.
- **De-risk capital with guarantees, not just grants.** Scale guarantee-led instruments that convert perceived

risk into bankable cash flows and mobilise private capital at a high multiple of the catalytic funds committed. Payment guarantees, insurance and local-currency cover should become the default architecture for African DRE finance, not the exception.

- **Channel subsidy through results-based service and minimum-subsidy (reverse-auction) mechanisms** that pay only for verified connections, result in demand growth (measured through minimum level of actual use of electricity), rationalise support toward the hardest-to-reach, and protect affordability for the poorest without distorting the market.
- **Create regulatory and programmatic clarity.** Provide transparent licensing, cost-reflective tariffs and clear rules for what happens when the main grid arrives, and design national programmes that sequence pilots into aggregated portfolios, lowering transaction costs and turning dispersed projects into an investable asset class.
- **Codify learning and build a continental community of practice.** Lessons from Africa and beyond (on what has worked, what has not, and why) need to be captured systematically and shared. Replicable blueprints, common technical standards, and a community of practice anchored at ISA can shorten deployment timelines and reduce costs across markets.
- **Design programmes at ecosystem level, not around a single instrument.** Results-based financing paid against sales or installations alone is the most common oversimplification in this market, and it reliably produces stranded assets: equipment deployed where there is no service network, no productive demand and no market linkage to sustain it. Durable programmes combine a minimum set of ecosystem interventions - quality assurance and performance standards, technician training and after-sales capacity, end-user and enterprise finance, technical assistance, and market linkages for the goods that customers produce with the power. Not every intervention can be delivered everywhere at once; the practical test is to identify the minimum combination without which assets will strand, and to fund that combination deliberately rather than assume it will emerge.

The destination is clear and the instruments are in place. The decisive variable now is execution. The countries that move first (making demand bankable, capital guaranteed, subsidies results-based, regulation enabling, and learning shared) will set the pace, accelerating progress toward universal access well before 2030. The dividend is not access alone, but the wider economic outcomes that flow from it: jobs, productivity, energy security, and a more inclusive form of growth.

2.5.1 Roadmap for Scaling DRE

Africa's energy future depends on harnessing its abundant solar resources for sustainable development, and this roadmap sets out a multistakeholder framework for accelerating DRE as a national electrification priority. Backed and guided by Africa's leadership, its main target is to bridge the energy access gap while driving agricultural productivity, green job creation, and climate resilience. Built on six connected pillars: Policy Framework, Legal and Regulatory, Institutional Architecture, Infrastructure, Financing Frameworks and Instruments, and

Skilling and Workforce Capacity Building, and it sets out the actions and roles that ministries of energy, finance, education and ICT, regulators, private developers, financiers and delivery units must carry out together.

The roadmap requires energy access that supports income-generating activities, alongside faster licensing, fair cost-reflective tariffs, and performance-based grants. It also suggests creating a dedicated DRE delivery unit to ensure momentum. Key focus areas include isolated and grid-connected systems, standalone solar home systems (SHS), contracting models, and digital infrastructure. By tapping into technical support from the International Solar Alliance (ISA), requiring certification for local workers, and reducing financial risks through central bank facilities and currency protection tools, this roadmap delivers a ready-to-invest, repeatable blueprint. This paves the way for sustainable energy access, a more resilient grid, and lasting socio-economic growth for communities. The Figure 2.10 below illustrates the roadmap framework for scaling DRE in Africa.

ACTOR	IMMEDIATE — Establish foundations Priority actions to unlock deployment	MEDIUM TERM — Build systems & scale Deepen coordination across actors	LONG TERM — Sustain & optimise Embed enabling environment at scale
Head of State / Cabinet	Declare DRE a national infrastructure & access priority Anchor DRE in jobs, food-security & climate agendas	Ratify Cabinet Decision; gazette DRE policy Budget speech carry DRE-linked metrics	DRE a standing measurable in GDP, NDC & SDG reporting
Ministries — Energy · Finance · Planning · Agri	Least-cost electrification plan with DRE priority zones Differentiated subsidy architecture; digital procurement	Convert plan to site-level investment pipeline RBF window with verified disbursement; workflow live	Pipeline anchors DFI + private capital RBF transitions to commercial lending window
Energy Regulator / Standards	Draft licensing, tariff & grid-arrival rules Set consumer-protection standards; launch sandbox	Gazette mini-grid desk; approve portfolio tariffs Accredit Independent Verification Agents	Bulk licensing via digital portal Tariffs converge to grid parity; sandbox standard
DRE Delivery Unit / Utility	Mandate utility to recognise DRE in least-cost plan Establish Delivery Unit (PMU); define 3-track model	Open grid + DISCOM loss maps; onboard developers All three models operational at scale	Utility–DRE co-management protocols Unit matures into autonomous agency
Private Sector / Developers	Market scoping & regulatory consultation Embed productive-use; build local supply chains	Win first tender; sign 10–20 site concession Deploy appliance finance; raise local content	Scale to 100+ site portfolio, self-sustaining Capture downstream margin; domestic debt financing
Financier / DFI / ISA	Activate sovereign–DFI partnership framework Design blended-finance instruments; local-currency via TCX	First milestone-based DFI disbursement Pilot instruments; first portfolio guarantee	DFI exits as domestic capital takes over Scale & securitise

Figure 2.10: DRE roadmap framework

Source: ISA Analysis



Solar for agriculture: powering agri-food value chains

3.1 Why solar agriculture matters for Africa

3.1.1 Context and Background

Africa's agricultural sector is the backbone of the continent's economy, **employing over 60% of the labour force** and **contributing approximately 35% of GDP**. **Smallholder farmers produce nearly 80% of the continent's food**. However, the sector remains trapped in a cycle of low productivity and high climate vulnerability. **More than 95% of cultivated land in Sub-Saharan Africa is rainfed**, making agricultural production highly dependent on increasingly variable rainfall. At the same time, **only about 4–6% of cultivated land is irrigated**, among the lowest irrigation rates globally. Where irrigation exists at all, farmers typically rely on costly diesel pumps or unreliable grid power, and limited energy access for processing, cold storage and value addition constrains productivity and rural incomes further.

The consequence is a structural food-energy gap: agriculture underpins livelihoods across Africa, yet the continent accounts for only around 4% of global energy consumption. The deficit is most severe in regions where food insecurity is highest: more than 50% of East Africans and over 75% of rural populations in Sub-Saharan Africa lack access to reliable electricity. Limited energy access

constrains agricultural productivity across the entire agri-food value chain, from irrigation, mechanisation, milling, drying, pumping and processing to refrigeration, cold storage, grading, packaging, digital advisory services and market connectivity. Without reliable electricity, farmers are often unable to preserve perishable produce, undertake value addition, or access higher-value markets. As a result, post-harvest losses remain exceptionally high, with the absence of adequate cold-chain infrastructure alone costing Sub-Saharan Africa an estimated USD 4 billion annually in spoiled perishables.

The resource to close this gap is quite literally overhead: Africa holds 60% of the world's best solar resource, with average annual irradiation exceeding **2,100 kWh/m² and a global-leading average of 4.51 kWh/kWp/day.**

Leveraging this immense potential is not merely a marginal technological upgrade; it is a structural necessity for Africa's future. Implementing solar-powered agri-food value chains that span the entire agricultural production cycle, from irrigation, mechanisation

and harvesting to processing, drying, milling, cold storage, milk chilling, and value addition, offers a pathway to improving agricultural productivity, reducing post-harvest losses, strengthening rural enterprises, and enhancing food security. Beyond crop production, solar technologies can also support livestock watering, fisheries, hatcheries, farm logistics, and emerging climate-smart solutions such as agrivoltaics. Together, these applications show solar energy's potential as a key enabler of resilient, productive agri-food systems that can address the interconnected challenges of hunger, unemployment and climate vulnerability over the coming decades. As illustrated in Figure 3.1, integrating solar energy across every stage of the agri-food value chain forms the cornerstone of this transformation.



Figure 3.1: Productive use of solar energy

Source: ISA & RCREEE Analysis

The economics are well demonstrated at every link of the chain. Solar water pumping lifts smallholder yields by up to 300%, as seen in Kenya, where solar water pumping combined with high-efficiency drip irrigation, rather than traditional surface methods, drives these results. These peak gains typically come from letting families irrigate through the dry season for the first time, moving from vulnerable rain-fed agriculture to consistent, year-round irrigation,

particularly for high-value horticultural crops like vegetables, which respond more dynamically than staple grains.

Agrivoltaics performance is inherently site- and crop-specific, with outcomes determined by the unique intersection of local environmental conditions, soil types, and specialised system designs. While panel shading shields crops from extreme heat and significantly reduces evapotranspiration and irrigation demand in semi-arid regions, crop responses vary widely; for example, leafy vegetables and drought-sensitive crops often show yield increases, whereas shade-intolerant species may experience productivity declines. **Solar dryers** and mechanised



threshers cut labour and spoilage in post-harvest handling.

Solar grain mills and solar oil presses empower rural communities to add significant economic value to raw staples locally. These processing systems, create stable income streams while reducing the time-intensive, hard manual tasks. Finally, **solar cold storage** and ice production extend the shelf life of products from 2 to 21 days, preventing spoilage, supporting refrigerated distribution to distant, high-value markets.

3.1.2 Why a solar-powered agri-food value chain is needed

Integrating solar technologies across the African **agri-food value chain optimises energy security and enhances water and food security**, delivering a ‘triple win’ of **economic, social and environmental** resilience through increased rural incomes, job creation, and reduced carbon emissions.

3.1.2.1 Energy security: transitioning from volatile diesel to reliable solar power

Decentralised solar systems substantially reduce the exposure to imported fossil fuels by providing locally generated, price-stable electricity for irrigation, agricultural processing and cold-chain infrastructure. While daytime applications such as irrigation pumping can often operate directly on solar power, **energy-intensive or continuous operations**, including cold rooms, milk chilling, milling and agro-processing, **may require battery storage, hybrid energy systems, productive-load management, or integration with mini-grids to ensure reliable round-the-clock operation**. When appropriately designed, these systems can reduce diesel consumption, lower operating costs by 60–80% and improve the resilience and self-sufficiency of rural agri-food enterprises.

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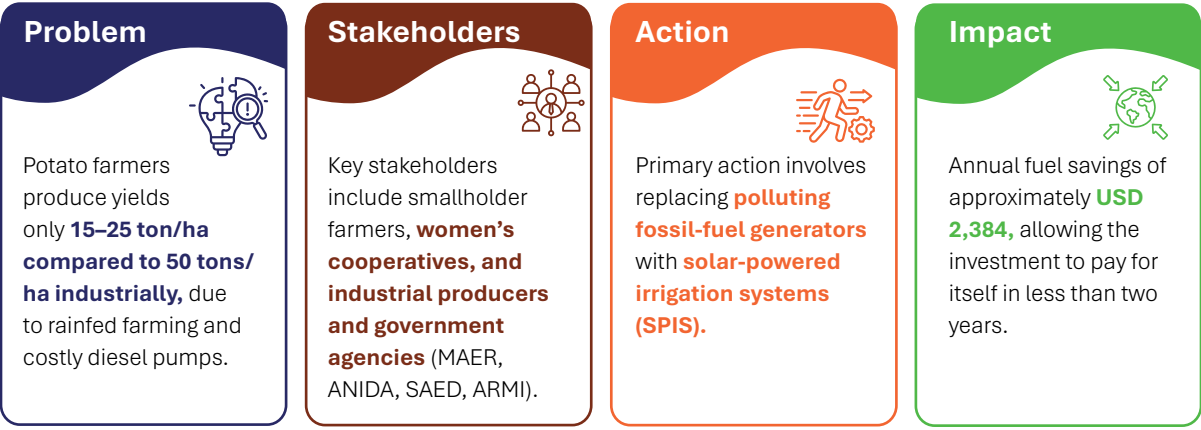


Figure 3.2: Solar irrigation in Senegal
Source: ISA & RCREEE Analysis

Climate imperative

Africa is the world's most climate-vulnerable continent, and no other region experiences more droughts. Climate change is forecast to reduce major crop yields by 8–45% by 2050. More than 80% of African cropland currently relies on low input, rainfed production. Solar irrigation is therefore not simply an economic upgrade for Africa. It is the continent's most scalable strategy for adapting to drought.

3.1.2.2 Food and Water Security

Integrating solar energy across the agri-food value chain significantly supports food security by powering sustainable irrigation, enabling year-round cropping. In sub-Saharan Africa, over one-third of unmet crop water requirements could be met using solar PV irrigation systems that are financially sustainable, potentially generating more than USD 5 billion in annual profits for farmers. Furthermore, decentralised cold storage systems reduce post-harvest losses by as much as 80%.

A holistic approach to the water-food nexus looks beyond individual technologies to the entire food-production ecosystem, integrating infrastructure such as canal systems and reservoirs to manage and convey water in arid, low-rainfall regions. To further optimise resource management, non-conventional water sources, such as treated wastewater from sewage

treatment plants, can be channelled into farmland irrigation, improving the overall efficiency of water distribution while supporting groundwater and surface-water management.

When these diverse water sources are paired with water-efficient techniques like drip and sprinkler irrigation, the agricultural sector can significantly reduce water wastage and energy requirements for pumping. Irrigation technique is chosen based on crop type, as the figure below illustrates.



Drip Irrigation	Olives, Tomatoes, Onions, Chilli, Cabbage, and various high-value vegetable crops. Drip is ideal for widely spaced, high-value crops and saline environments.
Sprinkler Irrigation	Maize (Corn), Wheat, Potatoes, Soybeans, and Bananas. Sprinklers are frequently used for field crops and are often integrated with solar pumping for both smallholder and commercial farming.
Flood/Surface Irrigation	Rice, Teff, and traditional Staple crops (such as traditional Maize and Corn). Flood irrigation remains common for traditional cereal production.

Figure 3.3: Irrigation systems suitable for crops

Source: ISA & RCREEE Analysis

Additionally, innovative agrivoltaics designs apply panel shading that reduces crop evapotranspiration, lowers irrigation water demand by up to 29% and improves crop survivability during warm periods.

Extending this holistic framework to strengthen the business capacity of smallholder cooperatives and

farmer groups is essential for turning them into commercially viable enterprises. By providing targeted capacity building in market identification and appropriate product branding, these groups can capture greater value from their produce and shift from being mere 'price-takers' to active market participants. Implementing direct-to-market linkage platforms and collective marketing strategies lets these organisations bypass traditional intermediary systems (middlemen), which currently capture a significant share of value-added benefits.

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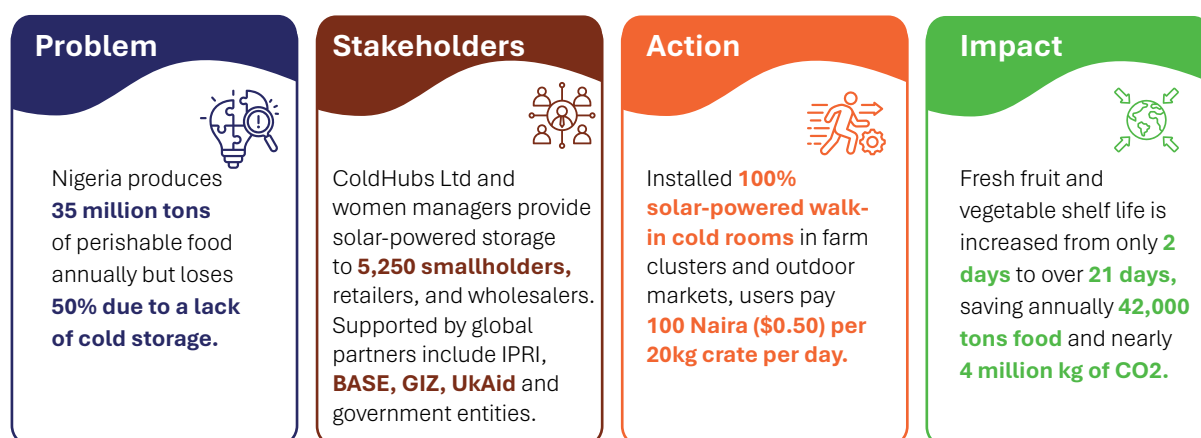


Figure 3.4: Solar-powered walk-in cold rooms in Nigeria

Source: ISA & RCREEE Analysis

Africa holds roughly **45% of the world's land area suitable for sustainable production**; however, the lack of modern practices has **left yields for essential crops at only 20% of their potential**.

3.1.2.3 Resilience: Economic, Environmental, and Social Impacts

Solar adoption in the agriculture sector triggers transformative gains across three pillars of resilience:

Economic Resilience: Transitioning from diesel to solar-powered irrigation can substantially improve agricultural productivity and rural livelihoods. Reliable and affordable irrigation enables year-round cultivation and supports the production of higher-value crops, with irrigated agriculture capable of increasing crop yields by up to **2.7 times compared to rainfed farming**. Beyond irrigation, access to solar energy can also support post-harvest activities such as drying, processing, storage, and packaging, helping to reduce post-harvest losses, extend shelf life, and enhance the market value of

agricultural produce. Improved post-harvest management not only minimises food losses but also increases farmers’ incomes, strengthens food security, and improves the overall efficiency of agricultural value chains.

Environmental Resilience: Solar applications in agriculture drastically lower carbon emissions, **saving ~1 kg of CO2 per kilowatt-hour of outputs**. That helps support countries in achieving their NDC commitments regarding carbon reduction. In addition, solar systems prevent local soil and groundwater contamination caused by diesel spills and lubricant leaks.

Social Resilience: The green energy transition is projected to generate up to **1.7 million solar-specific jobs by 2030**. Expanding access to modern energy for productive-use applications including irrigation, grain milling, bread and injera baking, milk cooling and coffee processing, is projected to unlock revenue streams worth **USD 4 billion and create approximately 190,000 new jobs** by improving mechanisation and expanding value addition. These opportunities can particularly benefit women, who play a central role in food processing and other off-farm agrifood activities across Sub-Saharan Africa, while also creating new employment opportunities for rural youth in agro-processing, digital agriculture and renewable-energy services.

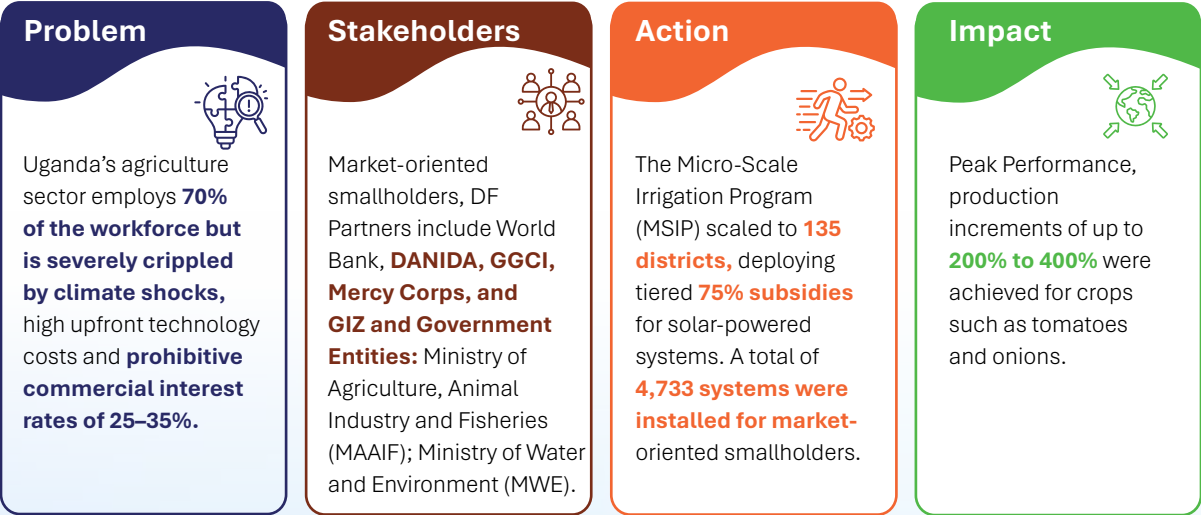


Figure 3.5: Case Study for SPIS In Uganda
Source: ISA & RCREEE Analysis



3.1.3 The Scale of the Opportunity

Deploying solar-powered solutions across African agriculture presents a vast potential to enhance productivity, mitigate post-harvest losses and drive a sustainable rural economy. **Algeria, Egypt, Ethiopia, Kenya, and Nigeria represent the top five countries**

with the highest agricultural GDP in Africa, while Burundi, Chad, Comoros, Guinea-Bissau and Niger are the top five countries with agriculture accounting for the highest share of GDP. Consequently, these countries are highly recommended as having the highest potential for maximising impact through the development of solar applications for agriculture use. Furthermore, the figure identifies the top exported high-value crops for each nation, demonstrating how targeted solar irrigation can support a diverse range of crops to simultaneously address domestic food security and strengthen international trade.

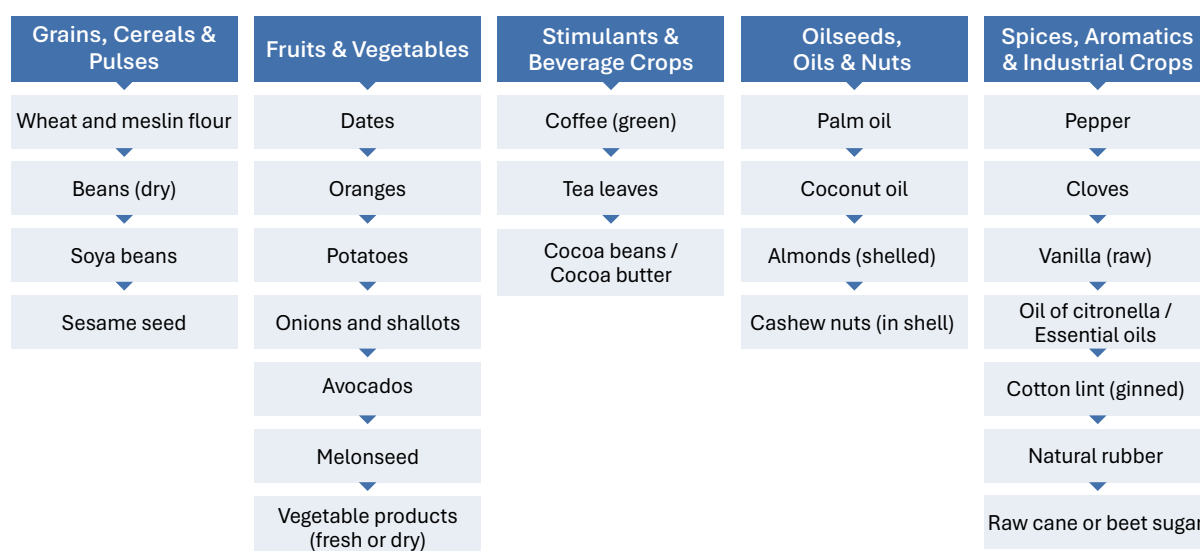


Figure 3.6: Top high-value export crops for the 10 countries selected

Source: ISA & RCREEE Analysis

There is a vast potential for various solar productive use applications across the African agriculture sector, particularly for solar irrigation, cold storage and food preservation, to address the continent's major agricultural value chain deficits.

- Solar-powered cold storage** offers a critical solution to the 37–40% of perishable food currently lost in the ‘first mile’ between harvesting and processing due to energy deficits. The African cold chain logistics market is projected to reach USD 14.85 billion by 2029, driven by urbanisation and shifting food preferences. Solar cooling can help reduce the 1.3 million hectares of forest lost each year to fuelwood and charcoal production. Key implementation considerations include utilisation rates, demand
- aggregation and sustainable business models, which are critical for long-term operational viability.
- Solar pumps:** Around 55 million hectares of rainfed harvested area, roughly 40% of the total, could be converted to irrigated cropland. Transitioning from diesel to solar pumping reduces total life cycle costs by 50–74% and cuts maintenance expenses in half. The initial investment is typically recovered within 2 to 6 years. This is typically achieved with pumping capacities between 5 kW and 20 kWp and annual operating hours ranging from 1,300 to nearly 2,000. The project economics are further influenced by diesel price escalation rates (often estimated at 5%) and financing costs reflected in discount rates of 15%. Finally, these results generally assume medium groundwater depths of 15–60 metres. The shift provides a major climate benefit by saving 0.8–1.3 kg CO₂/kWh of emissions annually.
- Jobs:** This shift to solar agri-food technologies is forecast to be a major employment engine, potentially generating between 1.5 and 3.3 million new direct jobs from the energy transition and up to 1.7 million solar-specific jobs by 2030.

The figure below maps the share of employment in the agricultural sector across Africa against total available agricultural land; Burundi, Niger and the Central African Republic have the highest share.

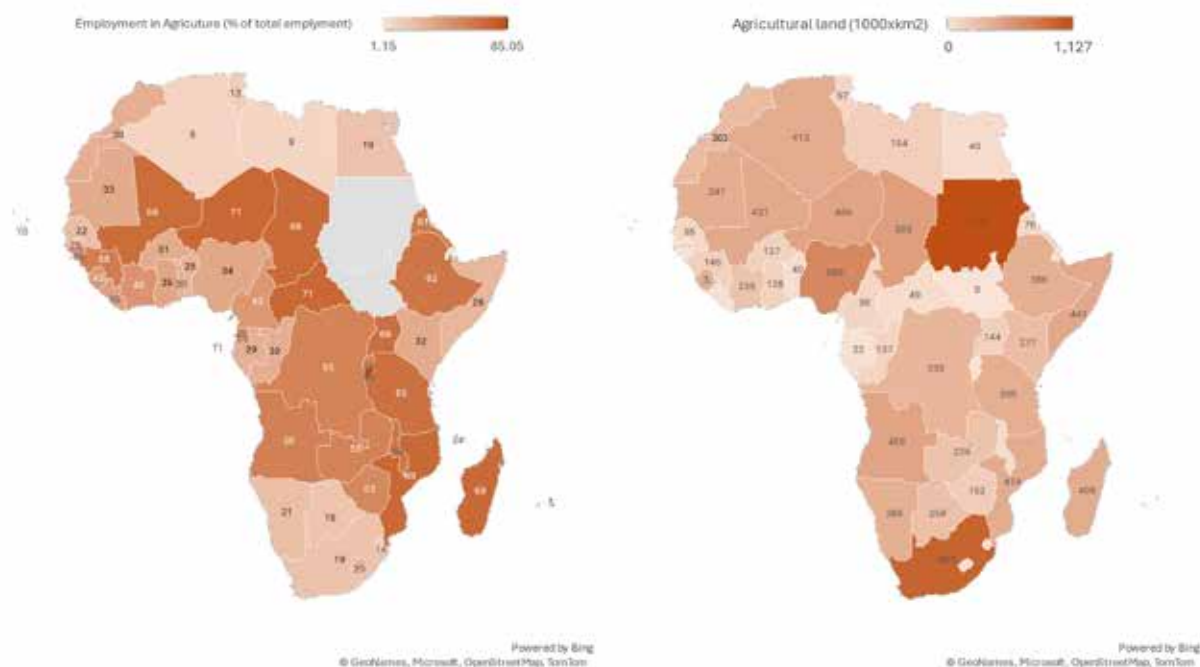


Figure 3.7: Mapping agricultural land and agriculture employment percentage across Africa

Source: RCREEE Analysis

3.2 Current barriers limiting solar deployment in agriculture

Despite appealing economics and vast technical potential, solar-powered agriculture remains marginal across most of Africa. The reasons for this are systemic, interconnected and

mutually reinforcing, spanning financial structures, regulatory architecture, technical capacity, supply chain integrity, social norms and institutional coordination. Addressing one in isolation produces limited results; only integrated action across all dimensions can unlock the transition at scale.

Demand Side (Farmers) Barriers:

- **High upfront costs:** Prohibitive initial capital expenditure for irrigation and cold storage.
- **Low credit access:** Agriculture receives less than 10% of commercial lending; perceived as 'high risk'.
- **Consumer culture and preferences:** Cultural preference for 'fresh' produce over refrigerated foods.
- **Farmer mindset and social norms:** Solar irrigation adoption depends critically on the individual farmer's willingness to invest in unfamiliar technology.
- **Gender inequities:** Women face greater barriers to information, credit, and technical skills.
- **Climatic interference:** Dust, cloud coverage, and high temperatures reduce PV system output.
- **Low awareness and irrigation familiarity:** 60-70% of farmland remains rainfed-dependent.
- **Seasonal incomes and credit mismatch:** seasonal cashflows sit against rigid repayment cycles.
- **Farmer segmentation:** subsistence smallholders, market-oriented smallholders, cooperatives/FPOs, women/youth enterprises, commercial farms, processors, aggregators and public institutions. Each segment needs a different solar solution and financing pathway.

Supply Side (Companies/ Service Providers) Barriers

- **Sub-standard equipment:** Flooding of markets with inferior or second-hand PV panels, pumps and value chain equipment.
- **Skills shortage:** Severe shortage of trained technicians for maintenance and repair in remote areas.
- **Inadequate after-sale services and maintenance issues:** Systems abandoned due to lack of local support and spare parts.
- **Import dependence and underdeveloped value chains:** Africa relies heavily on imports, with an estimated 80% of its solar panels originating from China, making it vulnerable to supply shocks.
- **Logistics and density:** Dispersed farms and poor road networks inflate distribution and service costs.
- **Inadequate suppliers liquidity:** Solar providers often lack the working capital or liquidity needed to scale innovative financing models.
- **Performance limitations:** Solar machinery (e.g., mills) often lacks sufficient throughput for peak demand.
- **Low market density:** The dispersed nature of smallholder farms makes it expensive for private companies to establish viable distribution and service networks in rural areas.

Financial Barriers

- **High cost of capital and macro risks:** High Weighted Average Capital Cost (WACC) and Foreign Exchange (FX) volatility raise import costs and weaken project bankability.
- **Fragmented market and missing middle:** Commercial capital concentrates on large-scale industrial projects.
- **Information asymmetry:** Farmers lack real-time data on quality-differentiated pricing for their produce.

Policy Barriers

- **Isolated policy:** Disconnected energy, water, and agricultural policies.
- **Cross-ministerial fragmentation:** Lack of clear mandates and coordination across Ministries of Water, Energy, and Agriculture.
- **Bureaucracy:** Lengthy licensing delays (18 months to 3 years) and fragmented approvals.
- **Testing and certification gap:** Absence of continental testing and verification infrastructure.
- **Electricity selling barriers:** Farmers lack the legal right to sell surplus energy.
- **Subsidies dependence and early withdrawal:** Nigeria Electrification Program (NEP) has caused immediate slumps in mature markets.
- **Poor grid infrastructure and off-taker risks:** Ageing, congested grid infrastructure and poor state-owned utility 'off-takers' limit the integration of renewables.
- **Market/offtake barriers:** Farmers adopt productive-use technologies only if there are buyers, aggregation, storage/transport, grading standards and price discovery.



3.3 Mission 300: Anchoring Solar Agriculture in the National Energy Compacts

3.3.1 What is being done?

Before turning to the enablers, it is worth fixing the baseline: African governments have already signed the commitments this chapter needs. All Mission 300 National Energy Compacts place distributed renewable energy and clean cooking at the last mile (Pillar 3), and several mention agriculture explicitly: Sierra Leone binds access policy to the 'Feed Salone' agenda with a pro-poor design for marginalised and female-headed farming households. Ghana elevates the productive use of energy to a compact objective with a USD 4.4 billion plan; Cameroon's charcoal-substitution strategy extends the same logic into rural biomass value chains; and Uganda's Green Energy Facility and Guarantee Fund, Article 6 carbon

finance and ~2,712 planned mini-grids give the cooperative irrigation model profiled above its national-scale channels.

3.3.2 What needs to be done?

The distance between pledge and implementation is measurable on every axis. Energy for production: only 4% of Africa's arable land is irrigated against 52% in India and 2-5% of SSA cropland, while Sub-Saharan Africa heads toward USD65 billion in food imports in 2025.

- **Value preservation:** 37-40% of perishables are lost between harvest and processing (a USD 4 billion annual cost) even as the cold-chain market it should feed grows toward USD 14.85 billion by 2029.
- **Capital:** agriculture generates ~15% of GDP but receives around 10% of commercial credit (as little as 2% in some markets), a USD 75-200 billion annual financing gap.
- **Institutional:** None of the compacts that name agriculture yet carries quantified, dated agri-PUE reform actions in its CPR reporting.

Table 6: Mission 300: Progress, Gaps and Priority Enablers for Scale-Up

National Energy Compact commitments	Where the continent stands	Gap to close	Closing enabler
Pillar 3: ~half of the 300 m connections via mini-grids and standalone solar	Cold-chain absence costs USD 4 billion/year ; milling and processing still largely diesel-powered	Agri anchor loads written into few mini-grid tenders: viability left on the table	Infrastructure: Agri-Hub co-location with anchor offtakers (mills, dryers, cold rooms)
Compact private-capital targets (Uganda ~USD 9.4 billion; Zambia USD 9.5 billion)	Agriculture receives <10% of commercial credit ; financing gap USD75-200 bn/yr	No structured farm-gate channel from compact finance to agri-solar assets	Financial mechanisms and investment landscapes: FI-led, public-capital-anchored and cooperative-led pathways
Clean-cooking and value-chain targets (e.g., Zambia 8.9%→40%)	37-40% of perishables lost in the 'first mile' ; cold-chain market to USD 14.85 billion by 2029	Cold-chain and processing infrastructure absent at the farm gate	Solar cold storage and agro-processing measures; Cooling-as-a-Service models
Jobs, gender and youth mainstreamed across all 35 compacts	1.5-3.3 million potential direct jobs ; up to 1.7 million solar-specific by 2030	Agri-solar technician and cooperative training pipeline is thin	Enabling skilling and workforce capacity building through knowledge hubs such as STAR-C
Water-resource governance embedded in national plans	55 million ha convertible from rainfed to irrigated; near-zero-marginal-cost pumping invites over-extraction	No integrated WEFE monitoring to keep the resource sustainable	NSAC WEFE-nexus mandate; 'Sustainable Water Management' with water user associations and remote monitoring

Source: National Energy Compacts submitted by African countries

The practical implication for the roadmap that follows is one of interlock rather than invention. The proposed National Solar-Agriculture Committee (NSAC) should work hand-in-glove with each country's Compact Delivery and Monitoring Unit, so that agri-solar goals feed directly into each country's national energy compact targets: solar pumps deployed, cold chains commissioned, mills electrified. Embedding productive use in compact monitoring gives ministries of agriculture a seat at the energy delivery table, and gives financiers a single, credible national pipeline through which the compacts' private-capital targets can flow to the farm gate.

3.4 Priority enablers to accelerate deployment

Overcoming the systemic, interconnected and mutually reinforcing barriers to solar-powered agriculture requires moving beyond a narrow focus on technology to a comprehensive systems approach. These actions need to span regulatory architecture, technical capacity, financial structures and social norms to unlock the transition at scale.

Creating an enabling environment is not merely a marginal technological upgrade but a structural necessity for Africa's future food security. This multi-layered ecosystem needs to simultaneously address early-stage quality and regulatory foundations to unlock the private finance required for large-scale technology transfer.

3.4.1 Regulatory, institutional and legal framework

The transition toward solar-powered agriculture requires a robust

government-led opening of the market. The government's primary role is a strategic enabler that creates a working environment for private sector leadership. While the private sector drives innovation and scaling, the state must provide the necessary policies, regulations, and laws to de-risk investments and build consumer trust.

The primary value of regulatory reform is the transformation of solar-agriculture projects into bankable investments by resolving institutional bottlenecks. Currently, the transition is significantly hindered by fragmented governance, where the mandates of the Ministries of Water, Energy, and Agriculture often overlap or conflict with each other. Conflicts involve trade-offs where policies promoting rapid solar adoption for food security risk groundwater over-extraction and compete for fertile land usage.

Therefore, adopting a holistic Water-Energy-Food-Ecosystems (WEFE) nexus approach is essential to overcome these gaps. Success requires establishing a dedicated coordination body, the National Solar-Agriculture Committee (NSAC), with clear institutional mandates to coordinate policy, planning, finance, and implementation across ministries and stakeholders.

The NSAC is proposed to function as the central steering mechanism for the national solar-agriculture agenda and oversee implementation of the following enabling measures by different Ministries:

Enabling roles and responsibilities of ministries

3.4.1.1 Ministry of Energy : infrastructure and standards

The proposed enabling roles of this Ministry involves ensuring grid readiness, technical stability, and regulating the "prosumer" market.

- **Grid integration and mini-grid regulations:** Establish clear procedures for permitting, tariff setting, and interconnection for both isolated and interconnected mini-grids, alongside a compensation framework that protects decentralised energy providers when the national grid extends into their territory.
- **Reform net metering and feed-in tariffs (FiT):** Update grid-connection laws to allow farmers to act as 'prosumers,' enabling them to sell surplus power back to the grid for additional, diversified income.
- **Reform grid integration and market access:** Prioritise policies that maximise productive on-site use of solar energy for irrigation, agro-processing and cold-chain infrastructure, while enabling cluster-level load aggregation and mini-grid anchor-load models. Where reliable grid infrastructure exists, farmers and rural enterprises should also be able to

participate in net metering, feed-in tariff or other distributed energy mechanisms to monetise surplus electricity.

- **Simplify licensing:** Implement fast-track and simplified licensing procedures for farm-scale solar installations to reduce entry barriers for smallholders.
- **Streamline and digitalise permitting:** Transition to digitalised permitting processes to eliminate lengthy bureaucracy, shorten time-to-market, and prevent costly licensing delays.
- **Enforcement of national technical standards:** Enforce mandatory equipment certification (e.g., IEC or STAR-C standards) to block substandard or second-hand components from entering the market, thereby protecting technology's reputation and long-term viability.
- **Testing and certification facilities:** Establish African-based regional and national technical testing laboratories and centres equipped to conduct performance, durability, and safety testing on solar components before they are cleared for market entry. Governments should leverage the ISA STAR-C network as specialised expertise hubs to harmonise quality control standards and certify that equipment meets international performance benchmarks.
- **Farmer Cooperative PPA Templates:** Develop standardised Power Purchase Agreements (PPAs) for groups of smallholder farmers acting as a collective offtake; provide legal aid and cooperative formation support to structure contracts.

Long-term sustainability of the above actions will depend on preventive maintenance, availability of spare parts,

local service networks, and clear maintenance responsibilities to ensure continued system performance.

Special focus:

- Quality control and continental testing infrastructure
- Technology transfer and local manufacturing
- Off-takers, mini-grids and the electricity selling opportunity

3.4.1.2 Ministry of Agriculture: demand resource management

The proposed enabling role of this Ministry involves driving the adoption of technology while ensuring the sustainability of natural resources.

- **Increase awareness and behavioural change:** Launch mass education campaigns and practical field demonstrations to prove the reliability and cost-effectiveness of solar-agri technologies over diesel for all stakeholders.
- **Sustainable water management:** Integrate remote monitoring systems and support water user associations (WUAs) to ensure that solar-powered pumping does not lead to groundwater depletion, aligning with digital monitoring tools like Water Accounting Plus (WA+).
- **Productive use clusters:** Identify and promote Agricultural Commercialisation Clusters (solar hubs) to aggregate productive energy demand, attract private investment in distribution infrastructure, and establish strong market linkages that connect farmers with processors, cold-chain facilities and buyers.
- **Solar cold storage and agro-processing:** Integrate solar-powered cold rooms, dryers and mills into irrigated value chains to reduce post-harvest losses; Cold Hub-type models have extended shelf life from 2 days to 21+ days.
- **STAR-C knowledge hubs:** Leverage ISA STAR-C centres (Ethiopia, Senegal, Côte d'Ivoire, Ghana, Cameroon, Somalia) as regional tech-transfer nodes to train technicians and disseminate operation and maintenance knowledge.
- **Agri-industrial anchor offtakers:** Promote the deliberate co-location of mini-grids with agri-industrial anchor offtakers such as mills, dryers, cold rooms, water treatment facilities and electric pump systems to create stable electricity demand and improve project economics. This model enables farmers and rural enterprises to become productive energy users while supporting sustainable mini-grid operations. Complementary public and social

procurement programmes, such as sourcing processed agricultural products for schools, nutrition programmes, hospitals and other public institutions, can further strengthen market demand, improve the commercial viability of rural enterprises and enhance farmer incomes.

3.4.1.3 Ministry of Finance: fiscal incentives and de-risking

The Ministry manages the financial enabling environment and the transition from fossil fuel dependency.

- **Enforce stable fiscal incentives:** Implement predictable VAT and import duty exemptions for certified solar-powered agricultural systems, including PV modules, inverters, batteries, pumps and productive-use equipment, to reduce upfront investment costs. These incentives should be tied to recognised technical standards, product certification and verified productive-use applications to ensure quality, protect consumers, and prevent the misuse of fiscal benefits by substandard or non-agricultural imports.
- **Fossil fuel subsidy shift:** Redirect unsustainable diesel and kerosene subsidies toward one-time capital grants for solar technology, creating a budget-neutral opportunity to enhance national energy security.
- **Phase out subsidy dependence:** As illustrated in the Nigeria Electrification Program (NEP), early withdrawal of subsidies led to a slump in programme implementation (sale of equipment such as solar pumps). Such instances demonstrate the need for predictable phase-out plans for subsidies and for creating a sustainable market for productive use appliances.

- **Deploy risk mitigation instruments:** Facilitate blended finance mechanisms and first-loss guarantees to lower the high cost of capital (WACC) and attract private commercial lenders.
- **Technology transfer:** Promote local manufacturing and in-country assembly by incorporating technology transfer requirements into public procurement and encouraging joint ventures between foreign original equipment manufacturers (OEMs) and African manufacturers. Technology transfer should extend beyond manufacturing to include the establishment of quality assurance and certification systems, testing laboratories, technician training, after-sales service networks, and local maintenance capabilities to ensure the long-term reliability, performance and sustainability of deployed solar technologies.

Once the necessary policies and regulations are aligned, the ultimate step in reducing transaction costs is the implementation of a ‘Single-Window’ Clearance System. This centralised administrative portal allows developers and investors to manage land use, environmental permits, grid connection approvals, and construction licences through a single-entry point. By standardising approval timelines and providing a ‘one-stop-shop’ service, governments can significantly lower development risks, attract large-scale private capital, and ensure that solar-agriculture projects move rapidly from planning to operational status.

Effective reform is already being demonstrated across the continent:

- **Ethiopia** has successfully standardised procurement guidelines validated by multiple ministries, which have enabled public investment and ensured that technology meets defined performance standards.
- **Nigeria** is shifting away from state-led models through the Electricity Act 2023, which enables private participation and mini-grid development.
- **Rwanda and Kenya** have introduced net metering guidelines, allowing farmers to transition from mere consumers to active participants in the energy market by selling surplus energy back to the grid.

Key lessons from solar-agriculture initiatives across Africa show that agile, simple programme design is essential to avoid bureaucratic delays, while strong local coordination and private-sector participation are critical for achieving scale. Furthermore, Africa’s vast diversity means ‘one-size-fits-all’ approaches are ineffective; instead, transformation must be incremental and supported by heavy investment in capacity building at both the national and grassroots levels. Finally, while inclusivity is vital

for assisting farmers in the transition to commercial agriculture, projects face a significant sustainability risk if climate-smart practices are abandoned once external incentives are withdrawn.

3.4.2 Financial Mechanisms and Investment Landscapes

While agriculture contributed an average of 15% to total GDP across Africa in 2024, it received a disproportionately low share of commercial credit, around 10% and dropping to as low as 2% in certain countries. This highlights a significant financing gap of USD 75 billion – USD 200 billion annually that significantly restricts investment and growth within the sector. While commercial bank lending to agriculture remains limited, farmers and

agribusinesses currently rely on a combination of informal and alternative financing mechanisms. These include household savings, family and community lending networks, rotating savings groups, microfinance institutions (MFIs), cooperative financing arrangements, trader and aggregator credit, contract farming schemes, and support from donor-funded and development finance programmes. However, these sources are often insufficient, short-term, expensive, or inaccessible to many smallholders, limiting their ability to invest in productivity-enhancing technologies such as solar irrigation, cold storage, and agro-processing equipment. As a result, a significant financing gap persists, particularly for small and medium-scale agricultural enterprises seeking to adopt clean energy solutions.

The economic case for solar technologies is compelling. An analysis of replacing diesel agricultural pumps with solar pumps in Ethiopia and Uganda, set out in full in [Annex I](#), shows significant cost reductions and attractive payback periods over the project lifetime.

Despite this, macro-financial barriers and severe capital deficits significantly hinder the widespread adoption of solar technologies.

Table 7: Financing barriers and corresponding solutions

Macro-Financial Barrier	Corresponding Market-Based Solution
Perception of agriculture as high-risk: Financial institutions reject smallholders due to a lack of traditional land collateral and poor credit histories.	Collateral reforms: Enables commercial banks to accept the solar assets themselves as security. Cooperative group lending: Facilitates pooled collateral through farmer cooperatives.
Dominance of cash-based sales: High upfront costs limit technology access to only the top 6% of wealthier farmers who have cash.	Pay-as-you-go (PAYGO)/lease-to-own: Allows instalment payments aligned with harvest cycles. Fee-for-service/cooling-as-a-service (CaaS): Removes asset ownership entirely; farmers pay a daily fee for service rather than buying hardware.
Supplier liquidity and working capital constraints: PAYGO providers lack the balance sheet liquidity to sustain long-term consumer credit.	Securitisation: Bundles small, dispersed PAYGO loans into large-scale, tradable investment products to unlock capital. Results-based financing (RBF): Rewards developers and solar companies with financial incentives after verified delivery/sales.
Currency mismatch and FX volatility: International debt is in hard currencies (USD/EUR) while revenues are local, worsened by high FX volatility.	Local currency hedging (e.g. TCX): Uses cross-currency swaps to transfer FX risk away from local borrowers, allowing DFI loans in local currency. Hard currency access: Delivers targeted reforms that give hardware importers the forex liquidity they need.
High interest rates and WACC: Lending rates are fragmented, running up to 53%, and the African WACC sits 3–5x higher than in developed markets, driven by sovereign risk.	Blended finance: Combines public concessional capital/donor subsidies with private investment to reduce all-in local currency interest rates. Carbon finance: Monetises verified emission reductions to provide an additional revenue stream and offset high financing costs.
The sovereign ceiling: Financial rules that cap a project's credit rating at the level of the country's weak sovereign rating.	Blended finance and risk shifting: Uses institutional guarantees (like EU guarantees via TCX) to lower hedging costs and improve the project's overall risk-return profile.

Source: ISA & RCREEE Analysis

The institutional framework for these interventions focuses on three primary pathways:

- **FI-led models:** encourage local banks to develop tailored agricultural loan products
- **Public-capital-anchored models:** DFIs provide first-loss capital to attract private lenders
- **Cooperative-led models:** utilise collective guarantee mechanisms to reduce individual default risk

The success of these pathways depends critically on the depth of financial institutions, the operational strength of cooperatives, and the maturity of the local supplier ecosystem. To systematically open the market for solar agricultural financing, the following guidelines need to be implemented:

- **For the short term:** Reorient existing fossil fuel and electricity subsidies towards solar CAPEX during the early stages to reduce upfront investment costs, while establishing quality standards to strengthen financier confidence. In parallel, mainstream solar-powered and climate-smart agricultural technologies into existing

agricultural development, irrigation, mechanisation and rural infrastructure support programmes so that farmers can access integrated financial assistance through both energy and agriculture sector initiatives.

- **For the intermediate term:** Establish aggregation channels to reduce procurement costs and deploy targeted derisking mechanisms to incentivise private distributors. Furthermore, implement robust risk guarantees to protect commercial lenders from default while deploying digital platforms for PAYGO tracking to build reliable credit profiles for smallholders.
- **For the long term:** Launch carbon finance initiatives to monetise emission reductions from diesel-to-solar transitions. Additionally, fully implement net-metering to allow farmers to sell surplus energy, creating a secondary revenue stream for loan repayment.

3.4.3 Case study: Solar for Agriculture in Uganda

Uganda was selected as a case study because agriculture is the backbone of its economy, contributing approximately 25% to the country's total GDP and employing 66% of the working population in 2024. Although 80% of its land is arable, only about 35% is currently under cultivation. Furthermore, while the country has vast freshwater resources covering 15% of its surface, the ratio of irrigated land is significantly low at only 0.5%. Uganda also possesses high solar irradiation (5.1 kWh/m²/day), making it an ideal environment for solar-powered productive use.



Table 8: Solar for Agriculture initiatives in Uganda

Parameter	Description
Location	Uganda: Horticulture Sector (national coverage with focus on tomatoes, onions, and leafy vegetables)
Partners	▪ International partners: Global Green Growth Institute - GGGI (Implementation) and the Government of Denmark (Funding). ▪ Technology providers: SunCulture (Tulima Solar), which committed USD 10 million to reach 10,000 farmers. ▪ Financial institutions: aBi Finance (Wholesale lending) and various participating commercial banks. ▪ Farmer-based organisations and cooperatives: ZAABTA and Prosper Mama Africa, together reaching nearly 30,000 farmers. ▪ Governmental partners: Ministry of Water and Environment (MWE) and the Ministry of Agriculture, Animal and Fisheries (MAAIF).
Programme	Two-year project deploying solar-powered irrigation systems (SPIS) for smallholder farmers lacking national grid access, using a multi-stakeholder partnership model including technology demonstrations, cooperative aggregation, and linked financing.
Problem	▪ Reliance on rain-fed agriculture, leaving farmers vulnerable to droughts or floods. ▪ Lack of grid access for farmers in remote rural areas. ▪ Dependence on volatile diesel fuel.
Challenges	▪ Limited awareness of SPIS for farmers. ▪ Lack of technical expertise capable of designing, installing, and professionally repairing these systems in remote rural areas. ▪ Limited access to finance, specifically for the high upfront cost of SPIS. ▪ Perception of agriculture as high-risk by local financial institutions, which frequently require collateral smallholders cannot provide. ▪ High-interest rates for solar equipment. ▪ Lack of specific planning tools to monitor groundwater levels, which poses a long-term risk of over-pumping if the 'free' energy from solar is not regulated.
Actions	▪ Partnership-based business model between key stakeholders to reduce risks. ▪ Demand aggregation: Organising farmers into large groups, instead of individual purchases, to leverage collective bargaining. ▪ Green taxonomy: Development of a green taxonomy for agribusiness investments. ▪ Technological Integration: Deploying Solar Powered Irrigation Systems (SPIS). ▪ Green Financing: Establishing a USD 32 million Green Finance Fund to provide concessional loans for climate-smart technologies and SPIS. ▪ Technical Training: Providing four tailored training programmes for farmers, SPIS technicians, financial institutions, and government representatives. ▪ Lease-to-own: Deploying schemes to manage high upfront costs. ▪ Tax and regulatory reform: Applying tax exemptions and regulatory engagement to streamline approval processes.
Lessons learned	▪ The multi-stakeholder partnership model is vital for reducing transaction risks and ensuring reliable market access for farmers. ▪ Practical technology demonstrations and field training are critical for overcoming farmer scepticism and increasing awareness. ▪ Demand aggregation through cooperatives is an effective mechanism to make high-CAPEX solar hardware more affordable for small-scale producers. ▪ Linking solar irrigation to offtake contracts with agribusinesses stabilises farmer income and accelerates loan repayment.

Parameter	Description
Impact figures	▪ 193%: Average productivity increase across surveyed farmers. ▪ Productivity statistics: 427% Tomatoes, 571% Onions, 283% Bananas and 553% Cabbages. ▪ Harvest cycles: rise to 3-4 during the rainy season instead of only one per season. ▪ USD 42 million: Climate-smart agriculture finance mobilised, directly supporting thousands of smallholders to transition from subsistence to commercial farming. ▪ 40%: Reduction in solar pump purchase price through cooperative aggregation rather than individual purchase. ▪ Climate Resilience: Farmers are now better protected against droughts, ensuring consistent food production and improved household income.

Source: ISA & RCREEE Analysis

3.4.4 Replicability Assessment

The Uganda model demonstrates strong replicability potential across Africa, subject to adaptation of the cooperative structure to local social norms and land tenure systems. The key replicability conditions are: (1) presence of a willing anchor agribusiness or cooperative as the offtake guarantor; (2) availability of a wholesale finance institution willing to on-lend to farmers; (3) a technology provider with demonstrated local after-sales capacity; and (4) clearances and regulatory certifications allowing collective solar system ownership by farmer groups.

Countries with high replication potential in the near term include Kenya, Rwanda, Ghana, Mozambique and Zambia, all of which combine strong cooperative traditions, active agribusiness sectors and improving solar irrigation regulatory environments.

3.5 Way Forward

Africa's solar-based agriculture future depends on harnessing its abundant solar resources to drive sustainable development. The roadmap in this section provides a multistakeholder-based framework to accelerate the productive use of solar energy in the

agriculture sector as a national driver for energy and food security. Backed and guided by Africa's leadership, its main target is to establish a solar-agri market while driving agricultural productivity, green job creation, and climate resilience. The roadmap has been developed on six interconnected pillars:

- 1 Policy framework
- 2 Institutional architecture and governance framework
- 3 Legal and regulatory framework
- 4 Financing frameworks and instruments
- 5 Skilling and workforce capacity building
- 6 Operational infrastructure

The framework of the roadmap includes actions and roles for ministries of energy, finance, agriculture, water, regulators, private developers, financiers, and delivery units to work simultaneously.

3.5.1 Policy framework

The foundation of the strategic roadmap is anchored on high-level political mandates, subsidies restructuring, and innovative finance design. The ecosystem spans multiple governance structures, spearheaded by the Head of State and Cabinet, and driven by Ministries of Energy, Finance, and Agriculture, alongside regulatory bodies, private developers, financiers, and dedicated delivery units.

By ratifying a unified national agri-solar vision, governments signal long-term stability to the market, establishing the legislative frameworks and regulatory reforms required to de-risk private investment and unlock agricultural productivity.

Key policy priorities:

- High-level political commitment:** Formalise and announce the national Agri-solar vision, establishing binding, long-term targets for the Productive Use of Energy (PUE) in the agricultural sector to secure institutional accountability and international investor confidence.
- Regulatory reform:** Draft and enact comprehensive regulations specifically tailored for farm-scale PUE.
- Institutional coordination:** Establish inter-ministerial frameworks linking the Ministries of Energy, Finance, and Agriculture for demand aggregation, data collection, and market intelligence.

3.5.2 Institutional architecture and governance framework

The deployment of solar technologies for the PUE in agriculture requires a highly coordinated, multi-sectoral governance structure. To eliminate institutional friction, a permanent National Solar-

Agriculture Committee (NSAC) will serve as the hub steering body. Under this committee, clear, non-overlapping boundaries are established among the Ministries of Energy, Finance, and Agriculture, alongside private developers, financiers, and farming cooperatives.

This governance model systematically assigns responsibilities for demand aggregation, centralised data collection, and market intelligence to remove asymmetric information and de-risk private sector market entry.

Table 9: Institutional roles and responsibilities

Entity	Roles and Responsibilities
National Solar-Agriculture Committee (NSAC)	Coordinates inter-ministerial policies, unifies conflicting agendas, and monitors the overall execution of the roadmap. - Convenes monthly inter-ministerial reviews. - Monitors cross-sectoral KPI alignment. - Acts as the final dispute resolution body. - Aggregates high-level national progress metrics and hosts the unified solar-agri investor portal.
Ministry of Energy and Regulatory Bodies	Ensures grid readiness, technology integration, and system quality control. - Executes grid and mini-grid integration policies. Implements net metering and FIT reforms. - Manage Single-Window Digital Permitting and Licensing. - Enforces tech standards for PUE technologies and testing centres. - Drafts standardised PPA and contract templates. - Collects data on grid capacity, decentralised generation assets, and mini-grid site technical availability.
Ministry of Agriculture	Drives localised technology adoption based on required demand while protecting natural resources. - Enforces Sustainable Water Management laws. - Structures cooperative clusters and aggregates demand, ensuring creation of a market for agricultural produce. - Coordinates agri-industrial hub co-location. - Integrates PUE into food value chains. - Drives farmer awareness, capacity building, and behavioural change. - Collects data about farm-level energy needs, water consumption, soil profiles, and regional crop processing yields.

Entity	Roles and Responsibilities
Ministry of Finance	Manages macro-financial viability, capital allocations, and investor risk-mitigation. ▪ Secures PUE incentive, e.g. stable VAT and import duty exemptions. ▪ Manages the gradual shift of fossil fuel subsidies to solar CAPEX. ▪ Deploys risk-mitigation instruments (blended finance, guarantees, FX hedging via TCX). ▪ Incentivises technology transfer to reduce import dependence. ▪ Coordinates with international lenders/DFIs to track capital flows, subsidy efficiency, and macro-financial risk metrics.
Private sector developers and financiers	Prepares market entry strategies, deploys capital, and adapts commercial models. ▪ Complies with new regulatory and technical standards. ▪ Launches commercial deployment (e.g., PAYGO, CaaS models). ▪ Provides market-driven operations and maintenance (O&M). ▪ Translates raw government data into localised commercial market intelligence and customer risk profiles.
Farming cooperatives and delivery units	Aggregates end-user participation, ensures community buy-in, and enforces loan compliance. ▪ Acts as collective off-takers via standardised PPAs. ▪ Manages shared community solar/irrigation assets. ▪ Coordinates peer-to-peer training and local asset maintenance. ▪ Shares localised crop, yield, and cooperative financial repayment data back into the Ministry of Agriculture's tracking systems.

Source: ISA & RCREEE Analysis

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3.5.3 Legal and regulatory framework

A robust, transparent legal and regulatory framework is the primary mechanism for shifting solar agriculture from donor-funded pilots into a commercially bankable market. To avoid overlapping authorities, laws and regulations are divided into two parallel, coordinated tracks:

- Energy, grid integrity and market structure (led by the Ministry of Energy/Regulators)
- Resource (agriculture and water) management (led by the Ministry of Agriculture)

Table 10: Laws and regulations

Track	Laws and Regulations
Energy, grid integrity and market structure	▪ Grid and mini-grid interconnection code. ▪ Grid extension compensation law. ▪ Prosumer net-metering and FiT decrees. ▪ Fast-track licensing regulations. ▪ Digital licensing mandates using a single window. ▪ Mandatory PUE equipment quality standards. ▪ Testing facility accreditation.
Resource (agriculture and water) management	▪ Groundwater extraction and WA+ regulations. ▪ Water user association (WUA) legal frameworks. ▪ Standardised cooperative PPA framework. ▪ Agri-industrial co-location and zoning laws. ▪ Fiscal regulations for PUE technology (VAT exemptions).

Source: ISA & RCREEE Analysis

3.5.4 Financing frameworks and instruments

To unlock commercial investment and overcome the high WACC in the region, a structured, de-risked financial ecosystem shall be established. By strategically combining public concessional capital, fiscal policy reforms, and development finance instruments, the framework lowers market entry barriers for private lenders and ensures long-term affordability for end-users.

Key financial pillars and strategic interventions

- Provide stable fiscal incentives and import reforms, e.g. VAT and import duty exemptions for all verified solar (PUE) hardware.
- Redirect fossil fuel and grid subsidies, in phases, into targeted, one-time capital grants for climate-smart solar agricultural technologies.
- Plan to phase out subsidy dependence by creating sustainable and commercially viable markets for productive use appliances.
- Promote blended finance and institutional risk mitigation, e.g. first-loss guarantees and local currency hedging facilities.
- Taper subsidies through a targeted, declining framework as market scale and commercial financing maturity increase.
- Integrate digital payment collection platforms (such as PAYGO tracking systems).
- Embed mandatory technology transfer clauses within public procurement frameworks to incentivise international OEMs to form joint ventures with domestic manufacturers, promoting local assembly and reducing future hard-currency import dependence.

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3.5.5 Skilling and workforce capacity building

To ensure the long-term operational viability and maintain the financier's trust, a standardised, multi-tiered workforce development and community capacity framework shall be established. By aligning technical training with international performance benchmarks and institutionalising farm-level behavioural change, the framework bridges the critical gap between technology deployment and field-level sustainability.

- **Policy makers and government officials:** Capacity building focused on WEFE Nexus integration planning, policy alignment, and cross-sectoral regulatory frameworks.
- **Farmers and agriculture cooperatives:** Targeted community education via radio spots, travelling roadshows, and agricultural extension officers to demonstrate the long-term cost-effectiveness of PURE, highlighting the financial and nutritional benefits of solar-powered irrigation over rain-fed or diesel-powered alternatives.
- **Developers and technicians:** Technical training to enhance local capacity for operation, maintenance (O&M), and robust after-sales services, alongside support for local manufacturing and assembly to build regional value chains.
- **Financial institutions and commercial banks:** Institutional capacity building on risk mitigation frameworks, technical asset appraisal for solar technologies, and the implementation of innovative financing models like pay-as-you-own (PAYO).
- **Farmer cooperatives support:** Strengthening farmer cooperatives and establishing business development support for them (to run processing units/cold storage solutions, etc for example), enabling linkages to markets/ public procurement opportunities, logistics, etc., for processed crops.

Key capacity priorities

- Leverage ISA STAR-C to train local engineers and technicians on advanced solar PUE technologies.
- Run mass field demonstrations to prove to farmers that solar is more reliable, water-efficient and cheaper over time than diesel.
- Set up community-level networks to teach smallholders basic preventative maintenance and smart water management.
- Integrate agri-solar skills into national vocational education and maintain a registry of certified training schools.
- Require private solar developers to hire certified local technicians for all installation and maintenance (O&M) contracts.
- Regularly update training programmes based on real-time feedback from the industry to fix skill gaps and adopt new technologies.

3.5.6 Infrastructure

Upgrading independent off-grid infrastructure is a critical priority for driving the Productive Use of Energy (PUE) in agriculture, providing reliable energy where the national grid is unavailable. This strategy shifts from isolated solar pumps to decentralised mini-grids and standalone systems that are physically co-located with high-load, agri-industrial assets such as automated mills, solar dryers, and collective cold storage.

This ‘agri-hub’ model creates a predictable local baseload that makes off-grid infrastructure commercially viable for private operators without

a utility connection. To maximise investment efficiency, geospatial resource maps will overlay solar irradiance data with groundwater availability and crop needs to designate optimal ‘Off-Grid PUE Zones,’ while an integrated IoT digital monitoring layer manages remote asset performance and load distribution.

Regardless of phase or country context, three cross-cutting factors determine whether agri-solar transitions succeed at scale:

Political will and inter-ministerial coordination.

Farmer-centred design and behaviour change.

Data, monitoring and adaptive management.

3.5.7 Timeline for implementation

The following roadmap translates the enablers and evidence above into a structured, time-bound action plan. Actions are organised into three phases across five years, assigned to specific lead actors, and tied to concrete deliverables.



ACTOR	IMMEDIATE — Establish foundations Priority actions to unlock deployment	MEDIUM TERM — Build systems & scale Deepen coordination across actors	LONG TERM — Sustain & optimise Embed enabling environment at scale
Head of State / Cabinet	Announce national agri-solar strategy and vision. Set binding long-term targets for Productive Use of Energy (PUE). Establish cross-sectoral steering committees.	Formalize legislative frameworks to support scaled adoption. Align national budget with energy-food security goals.	Solar agriculture a standing GDP, NDC & SDG measurable. Ensure continued inter-ministerial accountability and international investor confidence.
Ministry of Agri · Water	Upgrade land/water laws to enable agrivoltaics and adopt digital monitoring (WA+). Launch gender-inclusive farmer demonstrations, capacity building and workforce certification.	Establish developer-led agri-hubs to aggregate smallholder demand. Site-level pipeline: pumps, cold chain, agri-voltaic; scale mobile pump leasing ecosystems.	Integrate solar cooling and processing into 6+ major value chains, reaching 100,000 smallholders. Consolidate international partnerships for continuous technological innovation.
Ministry of Energy & Regulator	Adopt mandatory STAR-C technical standards. Launch equipment testing centres. Draft agri-voltaic tariff rules. Draft mini-grid regulations. Draft standardised PPA templates.	Roll out net-metering and feed-in tariffs. Connect mini-grids to nearby agri-processing and cold-chain hubs. Single-window permits; mobile-money disbursement live. Operationalise at least 3 continental testing centres.	Harmonise cross-border solar PUE standards and energy trading rules continent-wide. Bulk co-op applications via digital portal. Sandbox becomes regional standard.
Farmers Cooperative & Smallholders	Organise into clusters for collective bargaining. Recognise solar agri as complementary to grid Participate in field trials to prove solar's reliability over diesel. Launch initiatives for PUE value chain integration.	Open agri-feeder loss maps; onboard farmers. Manage shared community assets and begin selling surplus electricity back to the grid.	Fully transition from subsistence to commercial farming with embedded climate-smart practices. Asset-transfer protocols for grid-arrival.
Developers & Private Sector	Market scoping & willingness-to-pay surveys. Launch 5–10 replicable pilot projects (2–5 MWp total capacity). Integrate mini-grids with PUE technology. Domestic manufacturing; local assembly.	Scale PAYGO and “Cooling-as-a-Service” models. Shift from simple assembly to local component manufacturing (frames, mounting structures, cables, and controllers).	Self-sustaining; co-ops hold equity stakes. Mature a competitive manufacturing sector achieving >30% local content across the solar agriculture value chain. Ensure a fully certified, skilled workforce.
Ministry of Finance / Financier / DFI / ISA	Activate sovereign–DFI partnership framework. Design agri-adapted instruments; local-currency via TCX + Subsidy + PAYGo + lease-to-own + diesel phase-down. Secure stable VAT and import duty exemptions.	First milestone-based DFI disbursement. Reallocate 15% of fossil fuel subsidies to solar CAPEX. Deploy risk-mitigation (guarantees) and FX hedging.	DFI exits as domestic agri-banks take over. Scale continentally; Article 6 credits flow. Institutionalise local currency financing and monetise CO₂ reductions via verified carbon credits.

Figure 3.8: Roadmap for Agri-solar integration: phased actions and responsibilities across key stakeholders

Source: ISA Analysis

Deployment of agrivoltaics projects

at scale in Africa will depend on the scale of agricultural development within each country. Agrivoltaic systems are most suitable where agriculture is already well established and cultivated land is under productive use, as they integrate solar PV with existing farming systems rather than creating new agricultural land. In many African countries, where irrigated agriculture remains limited and agricultural expansion is still a priority, investments in irrigation and agricultural productivity

may need to precede large-scale agrivoltaic deployment. By contrast, countries with intensive agricultural systems and high competition for land, such as India, Bangladesh and Vietnam, demonstrate how agrivoltaics can optimise land use while supporting both food production and clean energy generation.

Realising the full potential of agrivoltaics in Africa will require coordinated action across government, industry, financial institutions and development partners. However, implementation pathways should reflect national context: countries with well-established, irrigated agricultural systems can likely scale agrivoltaics faster than those where agricultural development itself remains the immediate priority. [Annex II](#) presents a phased implementation roadmap.





Solar based e-mobility

4.1 Why solar based e-mobility matters for Africa?

Africa's mobility systems are likely to become electrified over time, with **solar generation potentially playing an important role in supplying charging demand across grid-connected, mini-grid, off-grid, and behind-the-meter applications**. Rather than relying solely on **grid-connected charging infrastructure**, **electric mobility** in Africa can expand through a hybrid model in which distributed, i.e. off-grid, solar energy powers charging solutions.

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The hybrid model creates three pathways for solar-powered electric mobility

- **Grid-connected solar:** feeding central power grids and enabling conventional EV charging in urban centres.
- **Mini-grid and off-grid solar systems:** enabling EV charging in areas where grid capacity is absent or insufficient.
- **Behind-the-meter solar:** allowing fleet operators and battery swap providers to deploy charging stations within urban or semi-urban areas.

Solar-powered electric mobility is particularly well suited in Africa for three reasons

- **There is huge untapped solar potential in Africa.** Africa holds some of the strongest solar resources globally, but accounts for only a small share of global installed solar generation capacity to date. This gap between potential and deployment represents both a challenge and a significant opportunity.
- **Solar systems are well suited to Africa's light vehicle fleet.** Rapid urbanisation and the dominance of motorcycles and three-wheelers create uniquely favourable conditions for distributed solar charging as the small battery sizes of these vehicles are well suited to low-capacity distributed solar systems.
- **The economics are increasingly compelling.** Distributed solar is increasingly reaching cost parity with diesel generation in Africa, and falling battery costs are enabling cost-effective solar storage while narrowing the total cost of ownership gap between electric and fossil fuel vehicles in key high-mileage segments.

This chapter seeks to answer the question: how can solar generation, both utility-scale and distributed, enable electric mobility to scale in African transport systems? The analysis focuses on the vehicle segments where electrification is already commercially viable and where solar integrated charging can support competitive deployment: electric two and three-wheelers and battery swap networks, electric urban logistics fleets, electric buses, and electric passenger cars. Heavy freight vehicles are not addressed. The electrification of heavy trucks presents distinct technical and economic challenges, including significantly higher battery capacities, limited available models and constrained financing, which place this segment outside the near-term deployment horizon on which this analysis focuses. Globally, however,

rapid progress continues on heavy-freight electrification, including falling e-truck costs in leading markets such as China. Technology diffusion into Africa could happen over the medium to long term.

4.1.1 Enabling energy security

Africa's rapidly expanding vehicle fleet presents a critical window to scale electric mobility before growth in vehicle ownership locks in fossil fuel vehicles and fuelling infrastructure. Currently, vehicle ownership rates on the continent are low compared to other locations. As Figure 4.1 illustrates, on average, registered vehicle ownership across most of sub-Saharan Africa currently sits below 30 vehicles per 1,000 people, compared with 160 for India, 210 for China, and 485 for Indonesia. However, ownership rates have begun to rise due to increasing population and urbanisation. Over the next three decades, Africa's urban population is expected to double from 700 million to 1.4 billion, making it the continent with the second largest urban population after Asia. The speed of this growth will determine whether Africa's expanding vehicle fleet turns electric or stays fossil-fuel dependent, which makes now, while ownership rates are still low and infrastructure is not yet locked in, a critical window for intervention.

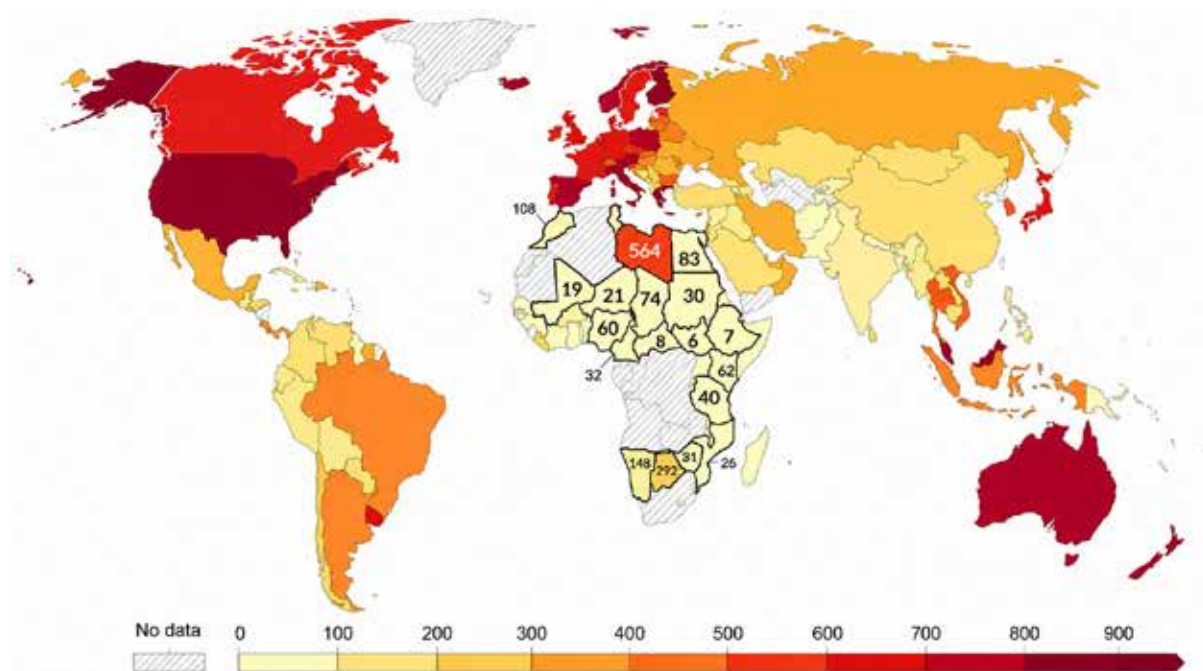


Figure 4.1: Registered vehicles per 1,000 people (2025)

Source: World Health Organization - Global Health Observatory (2026); Population based on various sources (2024)

The economic case for electric mobility in Africa is strengthening fast, driven by dramatic falls in the cost of both batteries and solar generation. Global lithium-ion battery pack prices have fallen 93% since 2010, from over USD 1,400/kWh to around USD 100/kWh in 2025, while solar installed costs have declined 87% over the same period, falling a further 11% in 2024 alone. In China, EV cost parity with fossil fuel equivalents has already been reached across most vehicle segments, a trajectory that African markets will increasingly benefit from as global manufacturing scale continues to drive down costs. Policy engagement is broadening in parallel: at least 13 African countries have introduced electric mobility strategies, fiscal incentives, or regulatory interventions, reflecting motivations ranging from energy security and fuel import reduction to urban air quality and climate commitments, with Ethiopia becoming the first country in the world to ban ICE vehicle imports in January 2024. Selected national electric mobility policies and incentives are summarised in **Annex III**. Yet uptake remains early-stage; electric cars accounted for less than 1% of total car sales in Africa in 2024, and while two-wheeler sales grew nearly 40% year on year, they reached only around 9,000 vehicles across the entire continent, still just 0.5% of total two-wheeler sales.

Improving economics and growing policy activity have not yet translated into deployment at scale.

Three core structural characteristics of Africa's mobility landscape determine where electrification is most economically viable, where it faces the greatest constraints, and why solar integrated charging is emerging as a key enabler.

1) Fuel import dependence makes solar-powered electrification an energy security priority

Transport systems across the continent remain heavily dependent on imported fossil fuels, creating structural exposure to fuel price volatility and foreign exchange pressure that directly affects transport operators. Electric vehicles and batteries are themselves import-intensive, so near-term foreign exchange savings depend on vehicle and battery import costs, financing, local assembly, the electricity generation mix, and battery replacement. Even so, the fossil fuel imports avoided outweigh the incremental imports of EVs, batteries, chargers and power systems. As Fi illustrates, fuel imports accounted for an average of 23% of total merchandise imports across sub-Saharan Africa in 2023, with significant variation across countries. This dependence is most notable for net fuel importers with limited domestic refining capacity that face the full cost of refined petroleum products at world market prices, paid in foreign currency. The vulnerability this creates has been emphasised by the disruption to global oil markets following the conflict in the Middle East and the closure of the Strait of Hormuz in early 2026, which triggered immediate fuel price increases across African markets. Industry experts operating across the continent report rising government and operator interest in electric mobility as a direct consequence, a dynamic that reflects the underlying energy security logic driving electrification as much as climate or cost considerations.



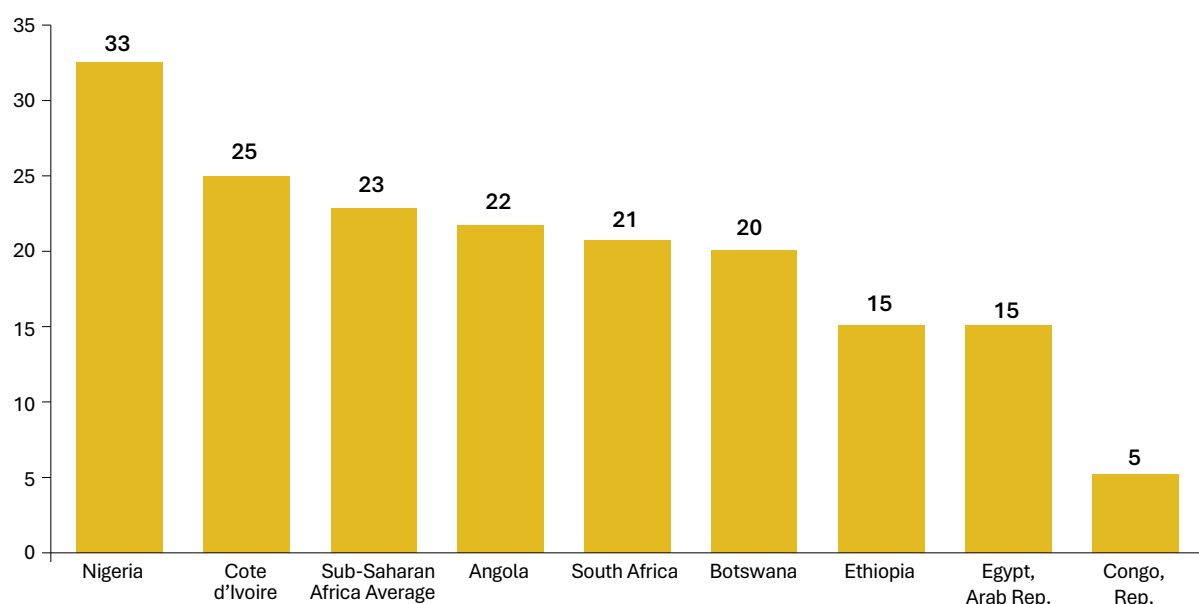


Figure 4.2: Fuel imports as a % of merchandise imports, select countries (2023)

Source: World Bank

2) Informal, price sensitive operators make low running cost solar charging essential

Urban mobility across the continent is delivered through informal public transport including motorcycles, minibuses, shared taxis, and small logistics vehicles, operated by independent owners and drivers. The decline of formal public transport in the 1990s, including the withdrawal of subsidies for state-run bus networks, drove the rise of informal public transport. These networks have since become the predominant mode of transport in many urban and semi-urban areas, offering flexible, efficient transport to millions with minimal public investment. This sector operates on constrained margins, with fuel costs representing the dominant variable expense. The motorcycle taxi, known as a boda boda in East Africa, okada in Nigeria and zemidjan in West Africa, is among the most emblematic examples of this model, providing first and last-mile connectivity across urban areas. Key features of how this sector operates include:

- Riders pay daily vehicle rental to the owner and retain remaining fare revenue after fuel costs.
- Fuel accounts for nearly all daily operating costs for most riders.
- Where fares are regulated or constrained by competition, operators cannot pass through fuel price increases, leaving them directly exposed to fuel price volatility.

Vehicle choice in this context is therefore largely determined by economics. According to the United Nations Environment Programme, second-hand vehicles comprise 60% of vehicles registered annually in Africa. These vehicles are typically old and fossil-fuelled, affordable precisely because of their low capital cost. Electric vehicles therefore compete not just against new internal combustion engine vehicles but also against depreciated secondhand units, with operators weighing only the difference in fuel and maintenance costs rather than the full purchase price. This structural dynamic means that the economic case for electric mobility depends critically on delivering low running costs, not merely a lower vehicle price, a condition that solar-integrated charging is increasingly able to meet, as examined in Section 2.

3) Two mobility markets imply different solar charging and electrification pathways

African mobility systems are split between two markets requiring differentiated approaches:

- The first is a large, fragmented network of individually owned light vehicles, motorcycles, shared taxis, and small commercial vehicles, in which Africa accounts for approximately 20% of the world's registered motorcycles

despite holding just 2% of its car fleet. Individual ownership, point-to-point operation, and high daily utilisation make this segment structurally well-suited to electrification, given its modest battery sizes and limited charging infrastructure requirements.

- The second is a smaller fleet-based sector that includes buses, minibuses, and larger logistics vehicles on fixed routes between urban centres, ports, and commercial hubs. Electrification here requires coordinated infrastructure, financing, and operational reform that informal operators have limited influence on. Ride-hailing, similar to Uber or Lyft, represents an emerging middle ground, where higher utilisation and fleet financing improve the economics, though it remains a small share of the overall market.

These two markets are likely to electrify at different speeds and through different mechanisms. This sequencing logic, which shapes the business model archetypes, is examined in the sections that follow.

The following section will examine how three pathways for the deployment of solar-powered electric mobility (grid connected solar, off grid/mini-grid solar and behind-the-meter solar) can offer solutions to the structural challenges noted above.

4.1.2 Pathways and applications of solar-powered e-mobility in Africa

Solar-powered electric mobility in Africa is already being deployed through three complementary pathways: grid-connected solar, mini-grid and off-grid solar, and behind-the-meter solar. Two conditions underpin the opportunity particularly for the mini grid and off grid pathways. First, solar accounted for less than 4% of electricity generation in Africa in 2025 while it holds some of the world's strongest solar resources Figure 4.3. Second, grid reliability across much of the continent remains insufficient to support conventional EV charging, creating demand for decentralised alternatives.

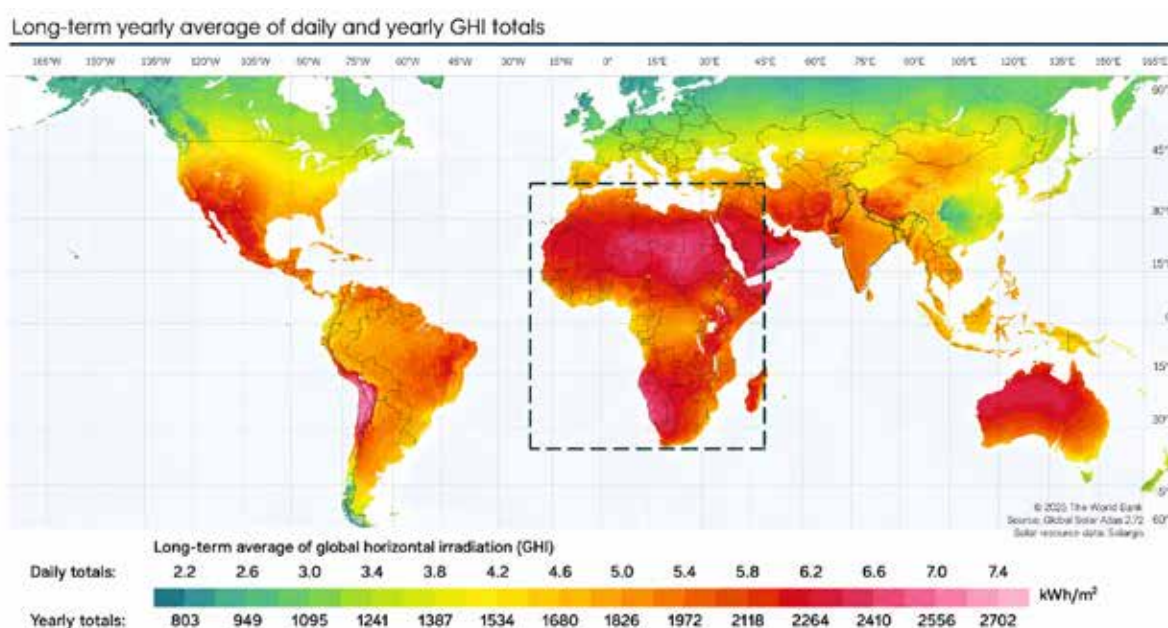


Figure 4.3: Irradiation varies across the globe

Source: World Bank

Operating projects across each pathway already demonstrate feasibility.

- **Grid-connected** solar charging is operating in Kenya and Egypt, where contrasting fuel price and grid conditions illustrate the range of market economics.
- **Mini-grid and off-grid** solar are scaling in Nigeria, where fuel subsidy removal and chronic grid unreliability have accelerated the commercial case for independent charging systems.
- **Behind-the-meter** solar is operating in Rwanda and Kenya, where operators including Ampersand and CrossBoundary Energy have demonstrated viable swap station and depot charging models at scale.

The following sub-sections discuss each pathway in more detail.

4.1.3 Grid-connected solar unlocks EV charging for passenger vehicles and larger fleets as grid quality improves

Solar is beginning to reshape Africa’s electricity mix, though from a low base. As aforementioned, solar accounted for less than 4% of Africa’s electricity generation in 2025, while gas remained the dominant source at 42%. Renewables, including wind, hydropower and bioenergy nonetheless overtook coal for the first time in 2025, reaching 26% of total generation. However, as shown in Figure 4.4 below, solar panel imports are now accelerating. According to Ember, 16 African countries imported a record **15,000 MW of solar panels** from China in the 12 months to June 2025, with the potential to add at least 5% of a country’s electricity generation. Figure 4.4 below shows that imports have continued to increase, exceeding 26,000 MW by year-end 2025, a 162% increase from 2023.

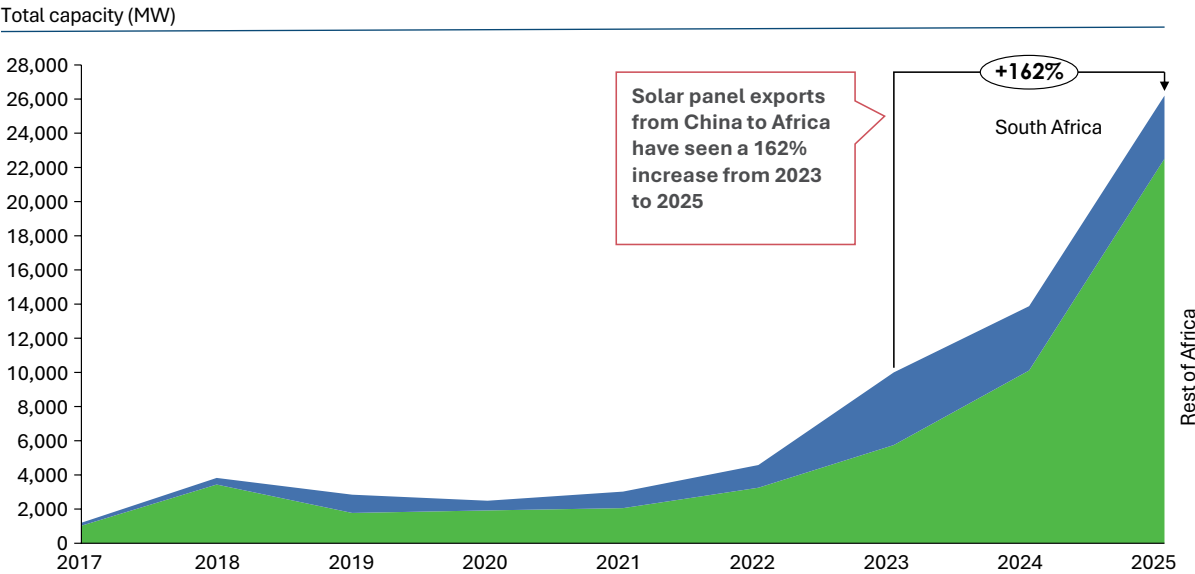


Figure 4.4: China solar PV export data, by location (2017-2025)
Source: Ember (2026) China's Solar PV Exports

Unlike behind-the-meter and off-grid charging models, which require fleet operators to invest directly in generation and storage, grid-connected charging draws on shared system infrastructure and does not require dedicated on-site supply. However, depot charging, bus charging and fast charging still depend

on substantial site-level electrical upgrades, such as increased transformer capacity, sanctioned load increases, and utility approvals. Where grid reliability is adequate and renewable penetration is rising, this becomes the primary route to large-scale electrification of passenger cars, minibuses, and buses, likely remaining the dominant pathway across most African markets as grid quality and clean generation continue to improve.

Kenya and Egypt illustrate the two ends of the spectrum across which grid-connected electric mobility economics play out in African markets:

- Kenya combines a predominantly low-carbon grid (renewable sources supply over 90% of generation) with high imported fuel costs and a dedicated off-peak e-mobility tariff.
- Egypt, by contrast, has heavily subsidised fuel prices that compress the operating cost advantage of electric vehicles.

Figure 4.5 to 4.7 compare total cost of ownership across two-wheelers, four-wheelers and buses in Kenya and Egypt.

Total cost of ownership USD (LHS), Cost in \$ per km (RHS)

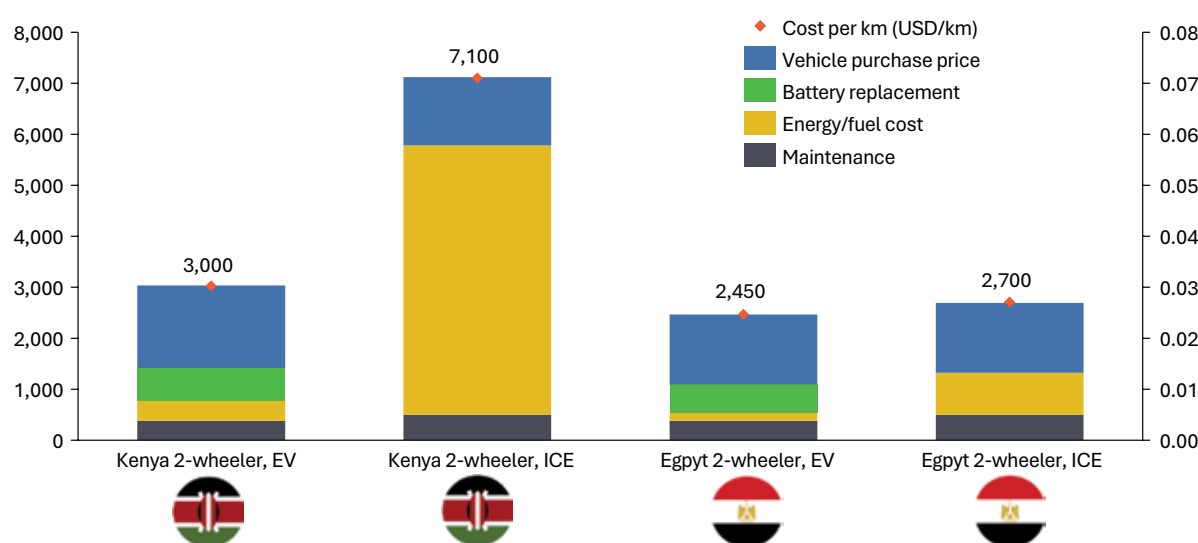


Figure 4.5: Total cost of ownership for electric and petrol models for two wheelers, Kenya and Egypt (2024)

Source: Egypt ERA (2024) Electricity Tariff; Stima Tracker (2026) Electricity cost in Kenya; Awad et al (2025) Electric Vehicle Adoption in Egypt: A Review of Feasibility, Challenges, and Policy Directions; EV24 Africa (2026) Electric Cars in Kenya: Availability, Costs and Charging in 2026; Autobarn (2025) Should You Buy a Car with High Mileage? Here's What Matters More; Elkafoury et al (2016) Assessment Approach of Life Cycle of Vehicles Tyres on Egyptian Road Network

Note: Key assumptions: this model presents a 5-year total cost of ownership comparison using grid charging only, with all costs expressed in USD and no currency fluctuation assumed over the period. Energy and fuel prices are held constant with no escalation or subsidy changes modelled. EV battery replacement is applied at mid-life where applicable, and maintenance costs are assumed flat annually with no major repair events. Second-hand ICE vehicles are assumed at a lower purchase price but carry the same ongoing fuel and maintenance costs as new vehicles. Costs are presented in nominal undiscounted terms over the vehicle lifetime, consistent with the simplified TCO approach used in comparable African EV studies. Vehicle lifetimes are assumed at 5 years for 2/3-wheelers, 10 years for 4-wheelers, and 15 years for buses and minibuses. Electric four-wheeler models in Kenya and Egypt both based on price of BYD Dolphin respectively.

Total cost of ownership USD (LHS), Cost in \$ per km (RHS)

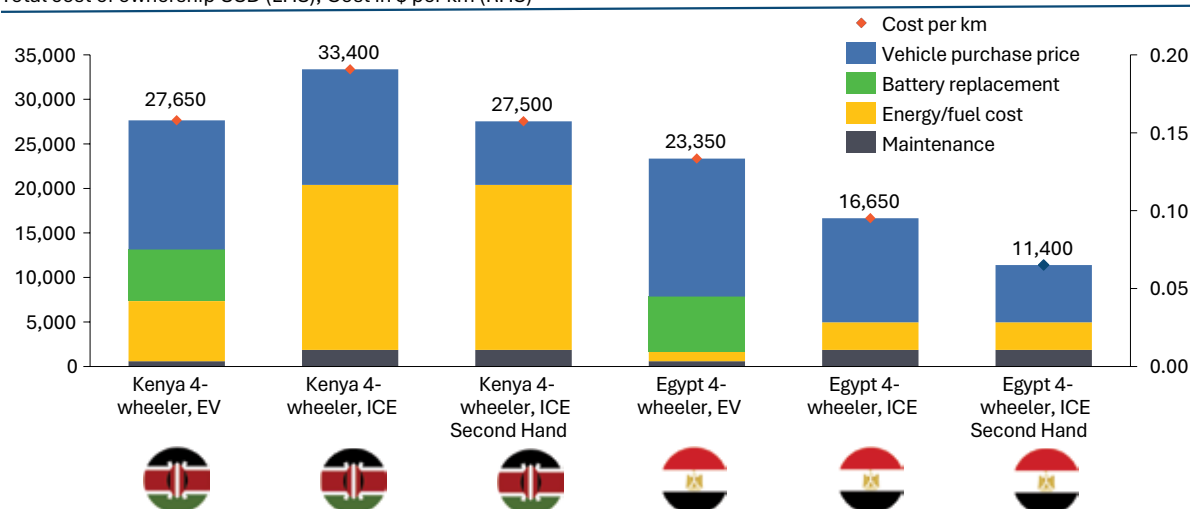


Figure 4.6: Total cost of ownership for electric and petrol models for four wheelers, Kenya and Egypt (2024)

Source: Egypt ERA (2024) Electricity Tariff; Stima Tracker (2026) Electricity cost in Kenya; Makena, E. (2024) Electric Buses are Reshaping Nairobi's Public Transport, Andariya; Ramadan et al (2023) Life Cycle Cost Analysis of Electric-Powered Buses in Public Transportation in Egypt.

Note: Key assumptions: this model presents a 5-year total cost of ownership comparison using grid charging only, with all costs expressed in USD and no currency fluctuation assumed over the period. Energy and fuel prices are held constant with no escalation or subsidy changes modelled. EV battery replacement is applied at mid-life where applicable, and maintenance costs are assumed flat annually with no major repair events. Second-hand ICE vehicles are assumed at a lower purchase price but carry the same ongoing fuel and maintenance costs as new vehicles. Costs are presented in nominal undiscounted terms over the vehicle lifetime, consistent with the simplified TCO approach used in comparable African EV studies. Vehicles are assumed at 5 years for 2/3-wheelers, 10 years for 4-wheelers, and 15 years for buses and minibuses. Bus specifications modelled: Egypt - 12-metre full-size city bus (approximately 40-45 seats), representative of Mwasalat Misr fleet operating under Cairo Transport Authority; Kenya, a 36-seat electric bus supplied by BasiGo.

Total cost of ownership USD (LHS), Cost in \$ per km (RHS)

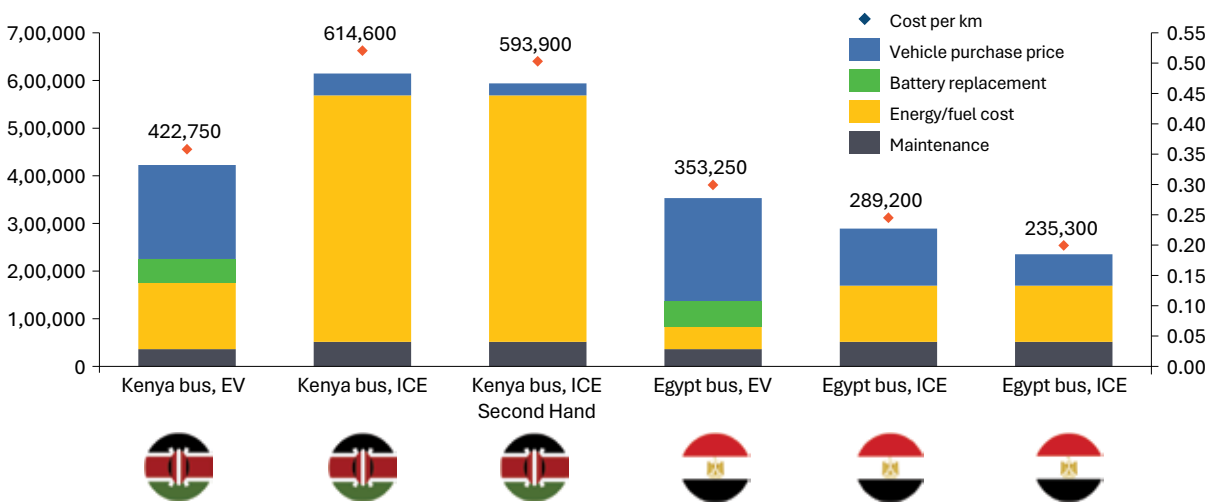


Figure 4.7: Total cost of ownership for electric and petrol models for buses, Kenya and Egypt (2024)

Source: Egypt ERA (2024) Electricity Tariff; Stima Tracker (2026) Electricity cost in Kenya; Makena, E. (2024) Electric Buses are Reshaping Nairobi's Public Transport, Andariya; Ramadan et al (2023) Life Cycle Cost Analysis of Electric-Powered Buses in Public Transportation in Egypt.

Note: Key assumptions: this model presents a 5-year total cost of ownership comparison using grid charging only, with all costs expressed in USD and no currency fluctuation assumed over the period. Energy and fuel prices are held constant with no escalation or subsidy changes modelled. EV battery replacement is applied at mid-life where applicable, and maintenance costs are assumed flat annually with no major repair events. Second-hand ICE vehicles are assumed at a lower purchase price but carry the same ongoing fuel and maintenance costs as new vehicles. Costs are presented in nominal undiscounted terms over the vehicle lifetime, consistent with the simplified TCO approach used in comparable African EV studies. Vehicles are assumed at 5 years for 2/3-wheelers, 10 years for 4-wheelers, and 15 years for buses and minibuses. Bus specifications modelled: Egypt - 12-metre full-size city bus (approximately 40-45 seats), representative of Mwasalat Misr fleet operating under Cairo Transport Authority; Kenya, a 36-seat electric bus supplied by BasiGo.

The above figure illustrates that relative fuel prices and secondhand vehicle availability are the two variables that determine whether grid-connected electric mobility is commercially viable in each market today. Key insights are that:

- In Kenya, where fuel import costs are high and the grid is predominantly renewable, electric vehicles offer a decisive cost advantage across two-wheeler and bus segments.
- In Egypt, subsidised fuel prices eliminate that electric advantage. Here, ICE vehicles (particularly second-hand ones) are cheaper than new electric options across all segments except two-wheelers.
- This dynamic is not unique to these two countries; it characterises the broader continental picture, where the

commercial case for grid-connected EV charging is strongest in high fuel-cost, low-carbon grid markets, and weakest where fuel is subsidised.

- The EV cost advantage for four-wheelers is less pronounced than for other segments because passenger cars accumulate significantly fewer kilometres annually than buses or motorcycle taxis, which operate continuously on high-demand urban routes, providing the bulk of Africa's informal transit networks.

Recent subsidy reforms in Nigeria and Ethiopia demonstrate that this picture is not static: as governments remove fuel subsidies, the operating cost advantage of EVs improves materially, and both markets are beginning to see increased operator interest in electrification as a direct consequence.

Table 11 illustrates an indicative view of how selected African markets fall across these two dimensions of fuel subsidy status and zero-carbon electricity share. The table can be used to understand which markets have conditions that are currently suited to pursue a grid-connected solar pathway, i.e. those with conditions like **Kenya** where fuel costs are high and there is

a pre-existing pathway to building out renewable generation on grids. This would include **Rwanda, Ethiopia, and**

Ghana. Less suited are locations with fuel subsidy that also lack strong renewable energy build-out, such as Algeria and Libya.

Table 11: Fuel Subsidy Status, Low-Carbon Electricity Share, and EV Operating Cost Advantage

Country	Fuel subsidy in place in Q1 2026	Share of electricity generation from low carbon sources (2025)	Indicative assessment of operating cost advantage of grid-connected EVs over ICEs
Kenya	No	90%	High
Rwanda	Yes	50%	Moderate
Ethiopia	No	100%	Moderate to high
Ghana	No	36%	Moderate
Nigeria	No	31%	Moderate
South Africa	No	18%	Low
Egypt	Yes	13%	Low
Algeria	Yes	1%	Very low
Libya	Yes	0.1%	Very low

Source: World Bank (2025), Global Landscape of Fuel Subsidies and Price Controls, supplemented by IMF (2026), Sub-Saharan Africa Regional Economic Outlook (for Rwanda and Kenya), and Addis Insight (2025), Ethiopia's Government Officially Ends Fuel Subsidy for Ethiopia; Ember (2026), Electricity Data Explorer. For the share of electricity generation from low-carbon sources, low-carbon sources include wind, solar, hydropower, bioenergy, nuclear, and other renewables. The year referenced is 2025 for Kenya, Rwanda, Ethiopia, Nigeria, South Africa, and Egypt, and 2024 for Ghana, Algeria, and Libya.

A final consideration for this pathway is that grid reliability and access remain a further constraint to the development of grid-connected e-mobility. As noted in the starting of this chapter, the IEA found in 2024 that approximately 600 million people in sub-Saharan Africa, 47% of the population, lacked access to electricity, with electrification barely keeping pace with population growth. Even where grid connections exist, reliability is frequently insufficient for dependable vehicle charging.

In the near-term, the two pathways examined below, behind-the-meter and off-grid solar, allow light vehicles to scale without waiting for grid investment and reliability conditions to mature.

4.1.4 Mini grids and off-grid solar can make EV charging economically viable in areas without reliable grid access

In off-grid and mini-grid solar systems, solar generation and battery storage operate independently from the grid, supplying power directly to charging equipment or battery swap stations. Historically, this route was not economically competitive as the high upfront cost of solar and battery systems made diesel and petrol gensets the default choice for off-grid power across sub-Saharan Africa. However, two structural shifts are changing this.

- First, fuel costs have risen sharply in recent years. This reflects wider macroeconomic factors, including oil price volatility and currency depreciation, as well as fossil-fuel subsidy reform in selected African markets including Nigeria, Angola, Ghana, Kenya and Tanzania. The most significant impact was in Nigeria, where the removal of the petrol subsidy in May 2023 caused prices to rise more than fivefold from USD 0.4/litre to over USD 1.14/litre by 2024.
- Second, the cost of solar panels and lithium battery storage has continued to fall, causing solar and battery off-grid economics to improve.

The combined effect has been illustrated by modelling first developed by SEforAll in 2024, focused on Lagos State, and conducted in partnership with the Lagos State Government. The study examined the financial competitiveness of diesel gensets against equivalent solar and battery systems for backup power provision across residential, commercial and market sectors. The study found that the primary barrier to solar adoption was the significant upfront investment rather than long-run cost competitiveness.

Across both segments in Figure 4.8, solar-plus-battery systems now undercut diesel gensets on total cost over the modelled period, a reversal made possible by Nigeria’s subsidy removal and the sustained decline in solar and battery costs. The required system size scales considerably with the vehicle: a two-wheeler requires a 2.5-kW system with 3.3 kWp of solar and a 10-kWh battery, while a four-wheeler requires nearly four times the solar

capacity and three times the battery storage, a scale difference with material commercial implications. These figures are illustrative and Nigeria-specific; the economics will vary across markets according to local fuel prices, financing conditions, and solar irradiation. Further, it is important to note that in many rural areas, transport demand may be too dispersed to support a standalone charging asset. EV charging can be a productive anchor load for a mini-grid only where vehicle routes, volumes, ability to pay, and station utilisation are established.

The direction, however, is clear: **as fuel costs rise and technology prices continue to fall, the economic viability of off-grid solar charging is expanding across both markets and vehicle segments.**

This trajectory is corroborated by continent-wide analysis showing that battery electric vehicles paired with solar off-grid charging will achieve lower total cost of ownership than fossil fuel equivalents across all passenger vehicle segments in Africa by 2040, with two-wheelers reaching this threshold by 2030. Financing cost, not technology cost, is identified as the primary remaining barrier. Off-grid solar charging is therefore not an interim or niche solution, but a pathway where commercial viability is strengthening as technology costs fall and where targeted financing interventions can accelerate deployment ahead of the technology-only timeline.

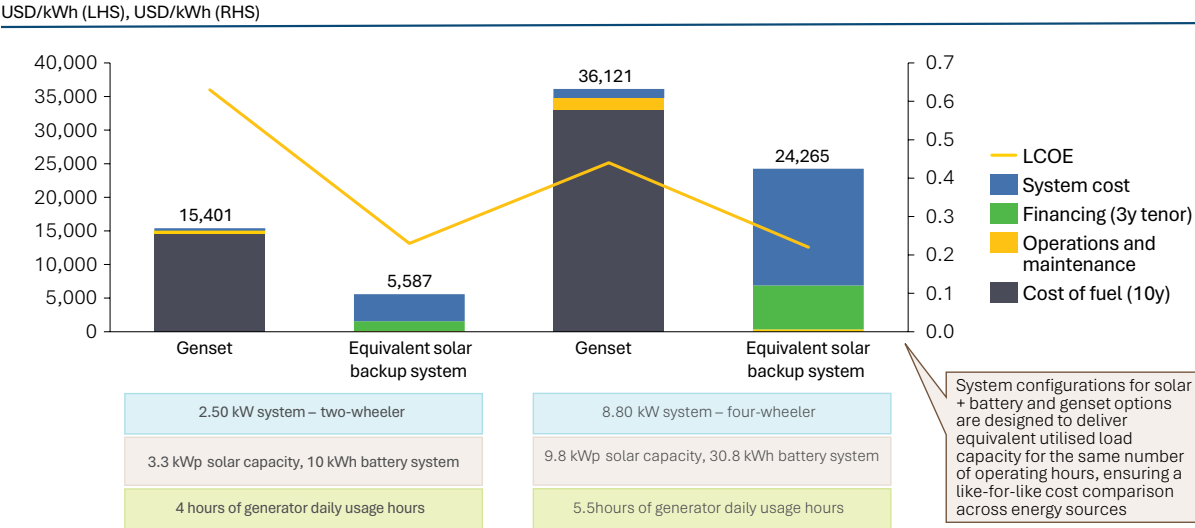


Figure 4.8: LCOE comparison of off-grid solar and batteries compared with diesel gensets

Source: SEforALL (2024) *Beyond Gensets: Advancing The Energy Transition in Lagos state*; National Bureau of Statistics (NBS) *PMS & AGO Price Watch Reports 2025*; BNEF (2025) *Lithium-Ion Battery Pack Prices Fall to USD 108 Per Kilowatt-Hour, Despite Rising Metal Prices*; World Bank (2024), *Official Exchange Rate, Period Average: Nigeria*, via CEIC Data

Note: For both vehicle segments, a load factor of 80% is applied to reflect the continuous and intensive nature of vehicle charging, which differs from the intermittent backup power use assumed in the original SEforAll model. Daily generator usage is 4 hours. Solar panel specification: 545W monocrystalline panels. Battery specification: 12V 2.5kWh lithium-ion (Prag). All NGN figures converted to USD using the World Bank official exchange rate period average for Nigeria in 2024 of NGN 1,487 per USD.



4.1.5 Behind-the-meter solar enables commercial fleet and swap station charging

Behind-the-meter solar refers to on-site solar generation installed at a depot, commercial premises, or battery swap station, which feeds power directly to charging equipment and connects to the national grid as backup if needed. Behind-the-meter solar and mini-grid solar share the same core components, on-site solar generation, battery storage, and power management hardware, and are procured from the same supply chains, making their per-kilowatt capital

costs broadly comparable. The key difference is that behind-the-meter systems connect to the national grid as backup rather than operating in full isolation. The cost modelling in Figure 4.8 for mini-grid versus diesel generation can therefore serve as a reasonable proxy for behind-the-meter solar charging economics, adjusted for the specific load profile of the charging application and the availability of grid backup to manage demand peaks.

For electric two- and three-wheelers, which dominate Africa's early electrification wave, this form of solar-based EV charging suits particularly well, since solar-powered battery swap stations can operate in locations where energy access is limited or difficult. The small batteries in vehicles require only low-capacity solar installations to charge, removing the need for major grid infrastructure upgrades to enable charging. Typical urban trip distances mean range is rarely a limitation for these vehicles, and where it is, battery swap networks address it by allowing riders to exchange depleted batteries rather than waiting for vehicles to charge.

The commercial deployment of behind-the-meter solar in battery swap station operations remains limited in scale but is advancing. Ampersand, operating electric motorcycles commercially across Rwanda and Kenya, is the leading example. The scale of uptake is reflected in over 20,000 daily swaps now delivered across Kenya and Rwanda. Ampersand has since extended its model to incorporate solar generation, partnering with CrossBoundary Energy in October 2025 to commence commercial operations of a solar-powered swap facility in Nairobi, the first project of its kind to receive a solar-to-charging-station license from Kenya's Energy and Petroleum Regulatory Authority.

For a detailed case study on renewable energy-integrated battery swapping infrastructure in Kenya, including behind-the-meter solar and battery swap station models, see **Annex IV**.

However, wider replication across the continent has been constrained by market conditions. Ampersand's model depends on high fuel prices, sufficient rider density to sustain battery swap station utilisation, supportive policy, and access to blended finance for battery and charging infrastructure. The conditions that have enabled its success in Rwanda, a small, geographically cohesive urban environment and strong government policy commitment, are more difficult to replicate in larger, more fragmented markets. Where fuel prices are lower or transport networks more dispersed, the investment case weakens materially without financial support.

Behind-the-meter solar also faces structural limitations when applied to larger vehicle segments. Unlike two- and three-wheelers, whose modest daily energy demands can be met by a small solar installation, four-wheelers, minibuses, and commercial freight vehicles require energy volumes that

make the economics of behind-the-meter solar fundamentally different. Research on minibuses electrification in sub-Saharan Africa finds a mean daily energy demand of approximately 87 kWh per vehicle, and that even a well-optimised solar-plus-storage installation of 9 kWp and 60 kWh of battery storage per vehicle reduces grid dependency by only 66%, leaving substantial grid reliance. The capital cost of a solar and storage system scaled to this level of demand can be prohibitive for informal operators, who typically lack access to the financing structures required to make such investment viable. Studies examining minibuses electrification across Cairo, Nairobi and Cape Town find that new sources of finance to cover upfront investment in charging infrastructure and vehicles are essential, and that tax relief alone is insufficient to make electric buses price-competitive. For this reason, behind-the-meter solar appears to be the most commercially actionable pathway for two- and three-wheelers in the near term, while larger vehicle segments require either grid-connected charging or dedicated structured financial support to make the economics work.

4.2 Current barriers limiting potential of solar-powered e-mobility

The question is no longer whether solar-powered electric mobility will scale, but rather how to unlock and accelerate this transition through targeted interventions, particularly in the case of the more nascent behind-the-meter solar. This section sets out the barriers constraining the scale up today, and what financing, policy, and infrastructure enablers can help to overcome these.

Several interconnected barriers continue to limit the large-scale expansion of solar-powered electric mobility across Africa. Macroeconomic conditions represent the binding constraint, with financing, infrastructure, policy, and skills barriers compounding the challenge in most markets.

1) Macroeconomic and financing conditions are the binding constraint

Macroeconomic and financing conditions are the primary barrier preventing widespread uptake of solar-powered e-mobility. Interest rates in local currency markets across much of sub-Saharan Africa remain prohibitively high, making the upfront capital costs of EVs and charging infrastructure prohibitive for most operators. Most solar and electric vehicle components are imported and priced in US dollars, meaning developers and operators borrowing in local currency are exposed to both high domestic interest rates and exchange rate depreciation, a dual risk that raises the effective cost of capital and weighs disproportionately on capital-intensive low-carbon technologies. Where financing

is available in foreign currency, exchange rate risk materially weakens the economic case for electrification and shifts the residual risk onto operators least able to absorb it. At the sovereign level, large-scale vehicle imports create balance of payments pressure that constrains government ambition. This is a genuine tipping-point problem: without coordinated intervention at the level of sovereign credit, concessional capital, and currency risk instruments, macroeconomics will continue to prevent deployment in all but the most favourable markets.

2) Low fossil fuel prices and a large informal secondhand market make economics challenging in some countries

Fuel price variation compounds the financing challenge and creates starkly different economic conditions across markets. In Kenya, high retail petrol prices generate a strong operating cost differential that justifies higher EV upfront costs. In Egypt, subsidised fuel eliminates that differential entirely. This dynamic is enhanced further by the structure of informal transport markets: electric vehicles compete not against new ICE vehicles but against heavily depreciated secondhand units, with operators weighing only the difference in running and maintenance costs rather than full purchase price. The cheaper the incumbent vehicle, the lower an EV's running cost must be to compete.

3) Costly charging infrastructure and grid unreliability limit solar charging deployment

Scaling solar-powered electric mobility requires vehicles that can charge and charging that is reliably powered. Both conditions remain challenging across most of the

continent. Both conditions remain challenging across most of the continent. On infrastructure, charging networks and battery swap systems require substantial upfront capital that most operators cannot access. Even small-scale behind-the-meter solar installations for two-wheelers are difficult to finance without concessional support or public anchor demand; fleet depot charging for buses requires investment at a scale that is rarely accessible to informal operators. The result is a severely underdeveloped charging network: in 2024, only 17% of African countries had ten or more public charging stations.

On power supply, the absence of reliable grid infrastructure means that where charging points do exist, they frequently cannot operate dependably. As noted, as of 2024, 47% of Africa's population lacked access to electricity. Where grid access exists, reliability frequently falls short of the standards required for dependable vehicle charging.

4) Policy and regulatory framework uncertainty raise investment risk

Many countries lack the right EV policy and regulatory frameworks to attract investment. The most critical gap is harmonised charging standards and grid connection protocols to ensure interoperability between EVs and charging solutions. These are absent in most markets, creating stranded-asset risks and market fragmentation that raise investment risk even where the underlying economics are favourable. Other enabling policy instruments such as EV and charging equipment import duty reductions and preferential charging electricity tariffs are lacking in most countries too. Where adopted, these instruments have demonstrated a measurable impact on EV economics and risk premiums. In Kenya, for example, dedicated e-mobility tariffs have had a notable effect on EV deployment.

5) Workforce and skills gaps constrain the pace of scaling

Even where economics are favourable and financing is available, a shortage of trained EV technicians and experienced electric mobility entrepreneurs constrains how quickly deployment can scale. The sector remains at an early stage across most African markets, and the pool of operators with experience in electric fleet management, battery maintenance and solar-integrated charging systems is small as a result. Early deployments in Kenya and Rwanda are beginning to generate the knowledge base and local expertise that will be essential for replication across other markets, but deliberate investment in workforce development and technical training programmes will be required to ensure skills capacity does not become a bottleneck as deployment accelerates.

4.3 Mission 300: Grid and Market Foundations for Solar e-Mobility

4.3.1 What is being done?

While few dedicated e-mobility actions have been taken across the continent, the overall electrification agenda is unfolding towards creating more favourable conditions for EVs. For instance, Nigeria pairs its renewables shift (22% to 50%) with cost-reflective tariffs and a 7.32-million-meter closing programme: the commercial substrate for grid-connected charging. Kenya, at 93% renewable consumption, and Rwanda are the two markets with battery-less

vehicle financing frameworks, and both hold compacts targeting universal access. Zimbabwe's 100 MW net-metering commitment creates the regulatory keystone for behind-the-meter charging; Ethiopia's 95%+-renewable, GERD-anchored grid offers the continent's cleanest charging electrons; Namibia's cost-reflective tariff regime shows what a commercially priceable charging environment looks like; and the mini-grid pipelines of Zambia (regulations due December 2026) and Uganda (~2,712 sites) define where swap stations can anchor rural load.

4.3.2 What needs to be done?

What the compacts do not yet do is mention e-mobility explicitly: in most of the published compacts, transport electrification is absent from the reform-action lists. Governments may consider assessing e-mobility reform actions and building their linkage to the Mission 300 goals: duty and VAT treatment for electric two- and three-wheelers, legal frameworks permitting battery-less vehicle sale and financing (today an active policy gap outside Kenya and Rwanda), dedicated charging-tariff categories, and the inclusion of charging and swap infrastructure in national geospatial electrification plans.

Table 12 Mission 300: Progress, Gaps and Priority Enablers for Scale-Up

National Energy Compact commitments	Where the continent stands	Gap to close	Closing enabler
Grid build-out & renewables-share targets (Nigeria 50%, Kenya 100%, Zambia 33% non-hydro)	EV fleets nascent: Kenya (the continent's leader) reached 24,754 registered EVs by end-2025	Charging demand missing from load forecasts and geospatial electrification plans	Coordinated delivery across government, utilities and the private sector enabling addition of charging demand into load forecasts and geospatial plans
Pillar 4: guarantees, FX tools and transparent pipelines for private capital	Charging and swap networks financed at commercial rates with full FX exposure	No dated e-mobility reform actions, hence no compact financing or monitoring line	Concessional finance and currency-risk instruments and alternative financing models
Tariff and net-metering reform (Zimbabwe 100 MW; Nigeria cost-reflective + social tariff)	Dedicated e-mobility tariffs rare (Kenya's EPRA off-peak tariff the exception); BaaS law only in Kenya & Rwanda	Legal frameworks for battery-less vehicle sale/financing and charging tariff categories	Targeted regulatory instruments such as BaaS legal framework, duty/VAT reform, dedicated charging tariffs: Kenya's 2023 Finance Act and EPRA tariff as templates
Energy-security logic of every compact (reduce fuel imports)	Transport fuel has a huge share in merchandise imports across SSA; battery packs down 93%, solar down 87% since 2010	Transport-energy linkage missing from compact planning despite settled economics	Concessional finance and currency-risk instruments, such as DFI local-currency debt, first-loss structures
Jobs and skills mainstreaming in compacts	EV technician shortage already constrains otherwise viable markets	EV systems absent from TVET curricula outside East Africa	Workforce development enabler; apprenticeships in operator networks; leveraging STAR-C network

Source: National Energy Compacts submitted by African countries

Once inside the compact, charging infrastructure becomes part of the monitored national pipeline that Mission 300-aligned capital is mandated to fund.

4.4 Priority enablers to accelerate deployment

Scaling solar-powered electric mobility across Africa is achievable, but requires targeted intervention on financing, policy, and infrastructure. Macroeconomic and financing enablers are preconditions: without them, the remaining enablers cannot operate effectively.

1) Concessional finance and currency risk instruments are the precondition for scale

Solar charging infrastructure and electric vehicles in Africa are developed and financed predominantly by private operators, fleet companies, swap station networks, and independent charging providers, typically independent of grid infrastructure and covering both vehicle acquisition and charging assets. The single biggest constraint on scaling these models is the cost of borrowing. Development finance institutions can address this directly by providing loans in local currency, offering guarantees that protect investors against currency depreciation, and absorbing early-stage losses to make projects attractive to commercial lenders. This last approach, where a development bank absorbs the riskiest portion of a financing package to make the remainder bankable for private investors, has worked for both Ampersand and BasiGo and represents a replicable model. BasiGo secured USD 17.5 million in debt facilities from BII and the US DFC, while Ampersand raised USD 7.5 million in debt from Cygnum Capital's Africa Go Green Fund alongside equity from impact investors. The International Solar

Alliance's proposed Africa Solar Facility is well positioned to play this role at scale across solar-integrated mobility projects. However, these interventions address the financing symptoms rather than the underlying conditions: where fuel subsidies compress the operating cost case for EVs, or where sovereign credit constraints limit government ambition, the investment case will remain challenged regardless of the financing structures available.

2) Alternative financing models must reduce the upfront cost barrier for operators

Removing the battery from the upfront vehicle purchase price through Battery-as-a-Service models reduces EV acquisition costs and has been demonstrated at scale by Ampersand in East Africa and SUN Mobility in India. Pay-as-you-drive models, as deployed by BasiGo for a bus fleet of over 100 units in Kenya, allow operators to acquire electric vehicles at comparable cost to diesel equivalents. Leasing structures for charging infrastructure, mirroring the power purchase agreements that have driven commercial solar deployment across Africa, can remove capital barriers for battery swap station operators, as CrossBoundary Energy has demonstrated in its partnership with Ampersand in Nairobi. However, battery-as-a-service models require a supportive legal framework permitting vehicles to be sold and financed without batteries; this is an active policy gap in most African markets outside Kenya and Rwanda. Second and third-life battery reuse in charging infrastructure remains an underexplored cost-reduction lever that warrants further applied research.

3) Targeted regulatory instruments must enable EV uptake

The regulatory levers with the most direct near-term impact are harmonised battery and charging standards across regional economic communities and targeted import duty exemptions for EVs and charging equipment.

- The priority should be **harmonised charging standards and grid connection protocols** across regional economic communities, ensuring interoperability of EVs and charging solutions. Without these, incompatible battery formats create stranded-asset risks and market fragmentation that deter investment even where underlying economics are favourable, as is currently the case in most markets.
- In addition, fiscal frameworks can incentivise EVs by introducing **import duty exemptions and VAT reduction**. These reduce upfront capital cost, the primary constraint for informal operators.
- **Well-designed, time-of-use commercial charging tariffs**, cost- and time-reflective, can present an additional, more optional benefit.

Case studies from Rwanda and Kenya illustrate the impact the latter two measures can have on costs and sales. Rwanda introduced zero import duties, zero VAT, and zero excise duty on EVs and charging equipment, reducing the effective cost of an EV, in addition to a ban on new petrol motorcycle registrations in Kigali. Kenya removed excise duties and zero-rated VAT on EVs, batteries, and charging equipment, and introduced an e-mobility electricity tariff that allowed charging below the standard domestic rate from March 2023. In Kenya, this contributed to an 188% increase in EV charging consumption in 2025.

4) Coordinated delivery across government, utilities and the private sector is essential

Early deployments consistently demonstrate that electric mobility requires coordination, combining policy support, utility engagement, private sector operation, and development finance. No single operator can simultaneously address vehicle affordability, charging infrastructure, grid connection, and workforce training. Effective electrification of transport requires deliberate coordination between fleet operators, utilities, and planning authorities. Without it, the risk is that grid connection delays, competing infrastructure priorities and misaligned investment timelines create bottlenecks that slow deployment even where the commercial case is clear. Development finance institutions, utilities, and national delivery units must operate in alignment, with the ISA well positioned to facilitate knowledge transfer from markets with demonstrated early success. In Rwanda, early government action on EV tariff design and import duty

exemptions has supported faster deployment than in most comparable markets, demonstrating that targeted policy instruments, rather than any single technology or operator, are among the most transferable lessons for other markets.

5) Workforce development must begin now to avoid becoming a bottleneck

Scaling solar-powered electric mobility requires a workforce that does not yet exist at sufficient scale across most African markets. EV maintenance and battery management demand skills that differ materially from conventional vehicle servicing, and technician shortages are already constraining deployment in otherwise viable markets. Technical and vocational training aligned to EV systems, apprenticeship frameworks embedded in operator networks, and business development support for operators considering electrification are medium-term investments that must begin now to keep pace with deployment. East Africa's early deployments have begun to generate the knowledge base and trained workforce that will be essential for replication elsewhere: the ISA and development finance institutions are well placed to fund programme establishment at scale, drawing on models already piloted in Kenya and Rwanda.

4.4.1 Case study on Kenya: building a solar-powered electric mobility ecosystem

Kenya has emerged as sub-Saharan Africa's most advanced electric mobility market, demonstrating that a combination of a low-carbon grid, targeted fiscal policy and catalytic development finance can support private operators with locally adapted business models.

The challenge: Kenya spends over USD 5 billion annually on fuel imports, leaving urban transport operators directly exposed to global oil price volatility. The backbone of urban mobility, motorcycle taxis and informal minibuses, operates on constrained margins in which fuel is the dominant variable cost. At the same time, with 90% of electricity generated from renewable sources, Kenya's grid offers one of the lowest-carbon charging environments on the continent, creating a structural opportunity to decouple transport from fossil fuels provided the right policy and financing conditions could be established.

What Kenya's government put in place: Three regulatory instruments introduced between 2023 and 2026 were critical.

1. The Energy and Petroleum Regulatory Authority introduced a dedicated off-peak e-mobility electricity tariff in April 2023, directly reducing the cost of charging and improving swap station economics.

2. The 2023 Finance Act cut excise duties on EVs from 20% to 10% and zero-rated VAT on EV components.
3. In February 2026, the Ministry of Roads and Transport launched Kenya's National Electric Mobility Policy, the first comprehensive regulatory framework for the sector, extending incentives to electric buses, motorcycles, and lithium-ion batteries.

Key stakeholders across the government and private sector:

- **Government:** The Ministry of Roads and Transport provided policy direction and established the E-Mobility Taskforce in 2023 to coordinate implementation across government. The Energy and Petroleum Regulatory Authority set the e-mobility tariff and charging standards.
- **Public utility:** Kenya Power expanded the public charging network from approximately 67 stations in 2024 to over 300 by June 2025.
- **Private operators:** Ampersand, BasiGo, Roam and Spiro, drove on-the-ground deployment of electric motorcycles and buses through locally adapted vehicle and financing models.
- **Development finance institutions:** including the IFC, Africa50 and the US Development Finance Corporation provided the catalytic capital that made early-stage deployment bankable.

Impact: Kenya's registered EV fleet reached 24,754 vehicles by end 2025, an enormous jump from the 796 in 2022, the year before the first policy was introduced. Electric two-wheelers account for approximately 94% of the total. The pace of adoption is accelerating: electric motorcycles captured 15.3% of all new motorcycle registrations in 2025, up from 7.1%

in 2024 and just 0.5% in 2021. Electric mobility consumption on the national grid grew by 300% in the financial year to June 2025, demonstrating that deployment is translating into actual charging activity at scale. Public transport electrification is also advancing, with BasiGo operating over 100 electric buses in Nairobi and targeting 1,000 across East Africa by 2027. This progress has not been frictionless: operators and riders continue to report that charging and swap infrastructure struggles to keep pace with fleet growth, particularly outside Nairobi, and upfront vehicle cost remains a barrier for lower-income riders despite duty exemptions.

Kenya's experience demonstrates that a replicable sequencing exists, in which a low-carbon grid, a targeted electricity tariff, duty exemptions and catalytic development finance together create the conditions for private capital to follow at scale. However, these conditions do not travel uniformly across the continent: Nigeria has a comparably strong fuel-price signal but a far less reliable, thermal-heavy grid, making solar-plus-storage charging infrastructure the more relevant model there rather than grid charging; Francophone West and Central Africa benefits from currency stability under the CFA franc but a thermal-dominated regional grid; and in lower-access markets such as the DRC, grid-based charging is not available at the scale Kenya enjoys. The transferability of this model therefore depends above all on whether the macroeconomic and financing conditions examined in this section can be replicated, and whether governments are willing to introduce the secondary policy instruments that have proved decisive in Kenya.

4.4.2 Policy priorities by vehicle segment and charging pathway

The nature of support required differs materially across the three charging pathways, grid-connected, mini-grid/off-grid, and behind-the-meter, and by vehicle segment and geography.

- **For two- and three-wheelers,** battery swap networks are scaling commercially in East Africa but remain underdeveloped across West, Central and North Africa - the task here is reducing barriers to private investment through lower import duties on solar components, streamlined licensing for swap stations, and access to affordable local currency financing for network operators.
- **For buses and commercial fleets,** depot charging represents the most critical near-term intervention: the commercial case is proven and operators are willing to invest, but grid connection processes across most African markets are slow, opaque and not designed for the concentrated loads that depot charging creates – the ask is that governments and utilities establish fast-track grid connection processes for EV depots, with standardised technical requirements and transparent timelines.

- **For public charging hubs,** concessional finance is needed to bridge the gap between current commercial viability and the long-term enabling effect on fleet electrification, particularly in markets where anchor demand from buses and fleets is not yet sufficient to attract private capital alone.

4.5 Way forward

The policy priorities outlined above are grounded in business models

already demonstrating commercial viability across African markets. The three solar charging pathways (grid-connected, mini-grid and behind-the-meter solar) give rise to distinct business model archetypes: public charging hubs, depot-based charging and battery swap networks. These archetypes differ in their capital and grid infrastructure requirements, maturity, financing structures, and target vehicle segments. They suggest a sequencing logic for electrification across the continent, with battery swap networks as the most commercially advanced model operated through distributed light vehicle systems today, and others following as grid quality and policy frameworks mature.

Archetype	Capital intensity	Grid dependency	Current maturity	Primary vehicle segment
Battery swap networks Behind-the-meter and mini-grid solar	Low to medium Modular, scalable	Low Can be self-sufficient	High Scaling with private capital	Electric 2 and 3-wheelers
Depot-based solar charging Behind-the-meter solar	Medium Requires depot infrastructure	Low Can be self-sufficient	Emerging Dependent on operator scale	Light commercial urban logistics
Public charging hubs Grid-connected solar	High Public infrastructure needed	High Requires reliable grid connection	Early stage Needs policy and public financing	Buses in the near-term, passenger cars in the long-term

Figure 4.9: Archetype outline for business models of charging infrastructure
Source: ISA & ETC Analysis

Archetype 1: Battery swap networks for electric motorcycles and three-wheelers

Operators own and manage a network of solar-charged battery swap stations, charging riders a per-swap fee rather than requiring upfront battery purchase. This converts a capital cost into an operating cost, dramatically lowers the entry barrier for riders, and sidesteps range anxiety entirely by decoupling vehicle range from battery size. Solar integration at battery swap stations reduces electricity costs and improves operational reliability where grid supply is intermittent, making the model viable across both urban and peri-urban settings without dependence on grid

infrastructure. The model also embeds a Battery-as-a-Service structure: riders never own the battery, paying instead for energy access on a per-use basis, which keeps the cost of entry comparable to a conventional petrol motorcycle while delivering materially lower running costs. The structural separation between vehicle ownership and energy infrastructure ownership enables two distinct investor and operator types to participate, improving the overall capital efficiency of the model and making it attractive to private capital without requiring public financing or policy support.

Two operators illustrate how this archetype works in practice at scale. Ampersand operates a fully integrated electric motorcycle and battery swap network across Rwanda and Kenya, where riders pay per swap rather than owning a battery, and swap stations are increasingly powered by behind-the-meter solar. The company operates over 5,700 electric motorcycles and delivers more than 20,000 battery swaps daily across the two countries. In addition, Spiro, founded in 2022 and now the largest electric

vehicle company in Africa by deployed fleet, combines locally assembled motorcycles with a proprietary swap network spanning six countries across East and West Africa. From 8,000 bikes and 150 swap stations at launch, the company has grown to over 60,000 motorcycles and 1,200 swap stations, with battery swaps rising from 4 million in 2022 to over 27 million by late 2025. Both companies operate on a Battery-as-a-Service basis, retaining battery ownership and charging riders per swap, which keeps vehicle acquisition costs low and aligns operator revenue with rider usage. This makes the archetype particularly well suited to markets where motorcycles and three-wheelers dominate urban transport and where grid reliability is limited, conditions that apply across a large share of Sub-Saharan African cities today.

Archetype 2: Depot-based solar charging for urban logistics fleets

Depot-based solar charging is an emerging model in which fleet

operators install solar generation and charging infrastructure at a central location, enabling a captive fleet to charge overnight or during off-peak hours at materially lower cost than grid or diesel alternatives.

This model suits operators with predictable routes, centralised vehicle management, and sufficient balance sheets to finance upfront infrastructure. Unlike battery swap networks, it requires no public charging infrastructure and no separation of vehicle and energy ownership: the fleet operator controls both. The trade-off is that capital requirements fall on the operator rather than being distributed across a swap network, making the model more dependent on operator scale and access to finance. Where these conditions are met, behind-the-meter solar integration at the depot can significantly reduce operating costs and insulate operators from fuel price volatility.

Dedicated depot charging at scale remains the least developed of the three archetypes in Africa, though early signals are emerging. In Kenya, Roam has partnered with cold-chain logistics startup Keep It Cool to integrate locally assembled electric motorcycles with solar-powered cold storage hubs, combining clean transport with solar-powered refrigeration across Nairobi, Kisumu, Nakuru and Mombasa. While this is not a direct example of depot charging, it illustrates the commercial logic of integrating behind-the-meter solar with captive electric fleets in goods delivery, and points to the direction of travel as urban logistics volumes grow. As fleet operator economics strengthen and



energy tariff structures become more supportive, this archetype is likely to follow the path established by battery swap networks, scaling first in markets where both conditions are met.

Archetype 3: Public or shared charging hubs, including electric buses

Shared charging infrastructure serving multiple operators or vehicle types represents the most capital-intensive deployment model, but one with strong potential where public transport operators or municipalities can anchor demand.

Electric buses require high-power charging at depot or terminal points, and the infrastructure investment required places this archetype firmly in the domain of grid-connected solar rather than behind-the-meter or mini-grid solutions. The model most closely resembles conventional transport infrastructure provision, and, for that reason, its viability depends more directly on supportive public policy, regulated tariff frameworks, and access to patient capital than the two archetypes preceding it. Two contrasting examples illustrate the range of approaches through which this model is beginning to emerge.

Cape Town's Arrowgate Depot represents a municipality-anchored model. Equipped with Autel Energy MaxiCharger DC Fast units operating on a solar-grid hybrid system, the depot is the largest public electric bus charging hub in South Africa and among the most significant in Africa, with capacity to support 120 electric buses. The project is led by Golden Arrow Bus Services, one of Cape Town's primary public transport operators, with infrastructure investment supported by the city and national government frameworks, making it a strong example of public procurement driving shared charging deployment.

BasiGo illustrates a privately built variant of the same archetype. Founded in

Kenya in 2021, BasiGo leases electric buses to independent operators and transport cooperatives under a Pay-As-You-Drive model. It has built Kenya's first DC fast-charge network for electric buses, a privately financed network of depots located along bus routes with dedicated grid connections. Critically, BasiGo's CCS-2 chargers are open to any compatible passenger car or truck, giving the network a publicly accessible character despite being commercially driven. The model demonstrates that shared charging infrastructure does not require public procurement to deliver public access, but that a privately financed operator, built around its own bus fleet, can open its network to serve a broader market.

Taken together, these three archetypes suggest a sequencing logic for electrification across Africa. Battery swap networks are viable and scaling now with private capital; depot charging is emerging where fleet operators have sufficient scale, and public charging hubs for buses and eventually passenger cars require stronger policy frameworks and public financing, meaning their scaling is more dependent on the enablers discussed in Section 3. This sequencing, from distributed light vehicle models toward larger shared infrastructure, is likely to define Africa's electrification pathway over the next decade.

Figure 4.10 translates this sequencing into the priority actions required from each actor: near-term actions largely unlock the swap network archetype already scaling today, medium-term actions build the systems (grid connection, tariff structures, financing instruments) that depot charging and public hubs depend on, and long-term actions embed the fully harmonised regulatory and financing environment (including cost-reflective tariffs, currency clauses, integrated grid infrastructure) needed to sustain the model at scale.



ACTOR	IMMEDIATE — Establish foundations Priority actions to unlock deployment	MEDIUM TERM — Build systems & scale Deepen coordination across actors	LONG TERM — Sustain & optimise Embed enabling environment at scale
Head of State / Cabinet	Declare e-mobility national priority with measurable targets Set national EV fleet procurement target as demand signal	Establish national e-mobility strategy with targets & timelines Set a national EV fleet procurement target for government vehicles	E-mobility embedded in national development plans Government fleet fully electrified as anchor demand signal
Ministry of Energy & Transport	Draft e-mobility regulation Introduce EV import duty exemptions & VAT waivers	Commission demand mapping & least-cost charging plan Ring-fence EV budget	Fully harmonised national EV regulatory framework in place EV import duty and VAT exemptions embedded in fiscal policy
Energy Regulator / Standards	Introduce EV-specific electricity tariffs Streamline charging licence process	Set battery safety & performance codes Mandate swap station standards Establish dedicated EV desk; portfolio tariff process	Cost-reflective tariffs with inflation adjustment & currency clause approved National skills standards set for EV & solar occupations
EV Delivery Unit / REA	Establish national EV delivery unit with ring-fenced mandate Establish cross-ministerial e-mobility task force	Track interoperability KPIs; battery compliance portal Coordinate between ministries, utilities & operators Manage charging concession pipeline	Deploy charging hubs; integrate with grid feeders & smart substations Self-sustaining coordination architecture with institutionalised knowledge transfer
Private Sector / Operators	Advocate for import duty exemptions on EVs and solar components Adopt interoperable battery platforms; open swap networks to multi-brand EVs	Manage fleet charging; report utilisation & grid demand Build solar swap stations & depot charging Engage in EV regulation consultations; self-regulate	Hire 70%+ local staff with certified training Run women's entrepreneur programme Self-sustaining commercial e-mobility ecosystem
Financier / DFI / ISA	Approve blended finance framework with multi-year commitment Approve performance-based grant framework	Structure subsidy instruments; set credit terms Develop financial models; site selection Aggregate developer assets; standardise contracts	Deploy credit and loans at scale Co-finance solar charging infrastructure Approve cost-reflective tariffs with currency clause

Figure 4.10: Roadmap for Solar based E-mobility: phased actions and responsibilities across key stakeholders

Source: ISA & ETC Analysis



Utility-scale solar, regional interconnections, and One Grid Africa

5.1 Why utility-scale solar matters for Africa?

Utility-scale solar projects, i.e. ground-mounted projects with a nameplate capacity of more than 5 MWac (LBNL), represent a critical enabler of Africa's socio-economic development and a viable pathway for accelerating the continent's energy transition. **Given the scale of such projects (typically ranging from tens to hundreds of megawatts),** these projects supply the large volumes of electricity required to simultaneously electrify households, public services, and productive sectors. **Crucially, they deliver power to industrial consumers at the scale and the reliability demanded for heavy industrial operations.**

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The economic case: plunging LCOE and storage costs

Substantial improvements in cost competitiveness of solar PV modules have cemented utility-scale solar power's position as a primary development engine. Between 2015 and 2024, Africa's weighted-average Levelised Cost of Electricity (LCOE) for utility-scale solar dropped by over 67%, falling from 225 USD/MWh to just 74 USD/MWh. Within this context, several African nations, including Egypt and South Africa have

successfully secured exceptionally low power purchase tariffs in the range of 25–30 USD/MWh, highlighting the region's immense potential for low-cost clean energy procurement.

The business and technical case is further strengthened by the precipitous decline in BESS costs. Globally, the levelised cost of storage has fallen to 65 USD/MWh. This translates to an additional premium of just 33 USD/MWh to store 50% of a solar power plant's daytime generation, yielding a highly competitive combined dispatchable cost of 76 USD/MWh. With IRENA projecting an additional 32% reduction in the firm LCOE of solar PV between 2025 and 2030, utility-scale solar coupled with storage is rapidly outcompeting conventional baseload generation technologies.



Figure 5.1: Utility-scale solar and dispatchable solar price developments
Source: IRENA

Market deployment and geographic disparities

Utility-scale projects currently comprise the dominant share of Africa's total installed solar capacity. Figure 5.2 highlights the installed solar capacity across the top 10 African markets. These leading markets account for 19 to 20

GW of the continent's 22.2 GW total capacity, with utility-scale projects constituting between 55% and 70% of this footprint. Momentum continued through 2025, where utility-scale installations accounted for 56% (4.5 GW) of all newly installed capacity. Moreover, over 45 African countries were actively constructing or implementing utility-scale projects in 2025, representing a cumulative pipeline of 9 GW.

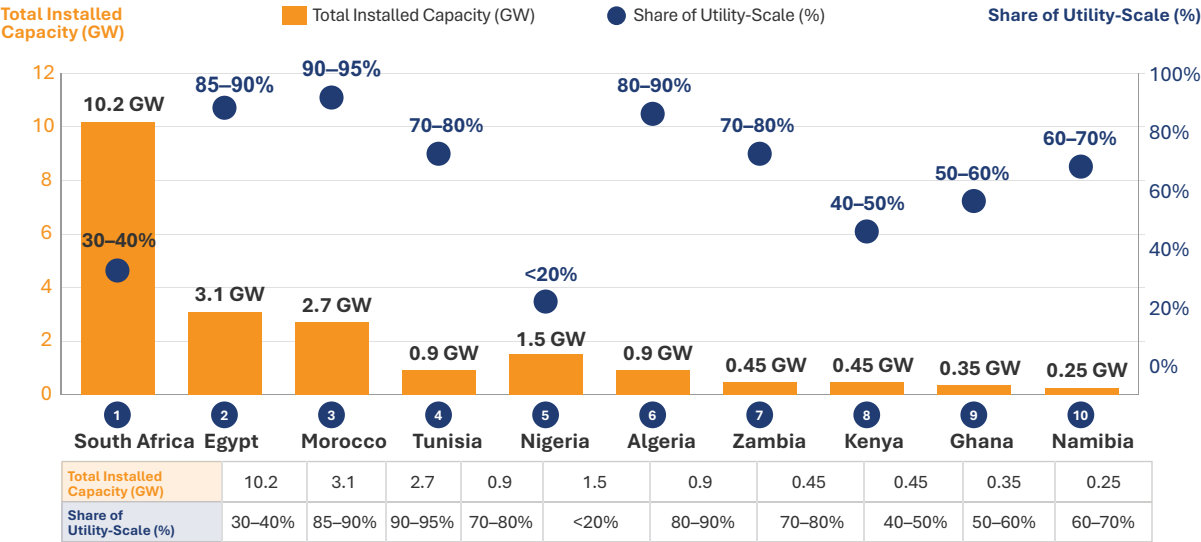


Figure 5.2: Total installed solar capacity in leading African countries and share of utility-scale projects by 2025
Note: Figures are best estimates based on multiple sources including AFSIA, Global Solar Council, Reuters, Africa Energy Portal and national industry reports.

Source: Africa Solar Industry Association (AFSIA) – Africa Solar Outlook 2025; Global Solar Council – Global Market Outlook 2025; Reuters – Africa Primed for Solar Breakthrough (Feb 2026); Africa Energy Portal – Africa's Solar Surge 2025.

Nevertheless, significant implementation disparities persist across the continent. Notably, around 70% of utility-scale solar capacity under construction in 2025 is concentrated in just five countries, while nine African countries have yet to deploy any utility-scale solar projects, despite broadly comparable solar resource potential

across the continent. This disparity highlights the need to better understand the underlying structural constraints limiting large-scale deployment, as well as to identify and leverage successful approaches from countries that have effectively mobilised their solar potential.

Against this backdrop, this chapter provides African policymakers and grid stakeholders with a comprehensive blueprint for deploying large-scale solar energy projects.

5.2 Barriers for deployment of large-scale utility projects

This section examines the challenges constraining the deployment of large-scale projects across Africa, despite the continent's abundant solar resources and the continued decline in global PV costs. The barriers are categorised into three groups, macroeconomic, policy and regulatory, and utility-level, and their interdependencies are analysed to illustrate how they collectively create compounded obstacles to project implementation.

5.2.1 Macroeconomic level

Many African countries continue to face elevated debt vulnerabilities due to a combination of substantial development financing needs, persistent fiscal pressures, and the adverse effects of recent global shocks. The economic impacts of the COVID-19 pandemic, geopolitical disruptions, rising borrowing costs, exchange rate fluctuations, and slower growth have constrained debt sustainability in several economies, increasing the burden of debt servicing and limiting fiscal space for development priorities. Around 21 countries are either in, or at risk of, debt distress, with debt levels exceeding 60% of GDP. Concurrently, many countries across Africa face high borrowing costs and, consequently, elevated debt-service obligations. This is reflected in the number of countries

where debt-service payments account for more than 10% of government revenues. High debt levels and associated servicing costs significantly undermine countries' ability to finance critical infrastructure investments.

Depreciating local currencies are also a widespread feature across the African continent. Statistics indicate that around 29 African countries have experienced steep currency depreciation in recent years. High debt-service costs, weak foreign exchange reserves, and significant trade imbalances or persistent trade deficits largely explain this decline. Currency depreciation poses substantial risks to project development. Investors typically respond to such risks by demanding higher returns, which in turn increases financing costs and further constrains infrastructure development.

5.2.2 Policy and regulatory level

a) Institutional arrangements

Weak governance structures pose substantial challenges to tapping into Africa's solar potential. In many African countries, institutional arrangements remain unclear, particularly regarding the distribution of roles and responsibilities among relevant stakeholders and the establishment of effective coordination mechanisms. For instance, responsibilities for policy development, target setting, resource assessment, and project development are not clearly defined in several countries. Meanwhile, given that multiple institutions are typically involved in solar project development, the absence of coordination mechanisms further complicates implementation and slows progress.

b) Procurement Processes

Insufficiently developed and unclear procurement processes also hamper investment in Africa's solar sector. Across the continent, several countries face challenges related to low transparency in procurement and bidding processes, with some scoring poorly on corruption perception indices.



Such non-transparent and non-competitive processes not only increase costs and burden public budgets but also significantly undermine investor confidence and interest in the market.

c) Land access, permitting, and allocation

Disputes over land rights and access pose significant risks to solar project development. Across Africa, several countries have experienced considerable delays due to conflicts over land ownership, as well as issues related to local community displacement and compensation. These challenges further complicate project development processes and deter investor interest in large-scale solar deployment.

5.2.3 Utility level

Challenges also extend to the operational level. Across Africa, most electricity utilities face significant

financial challenges that severely affect their financial health. Electricity grids across the continent experience some of the highest transmission and distribution losses globally, including both technical and non-technical losses such as electricity theft.

These losses substantially reduce utilities' revenues, which are already constrained by highly subsidised electricity tariffs set below the cost of service. This creates a vicious cycle: revenue shortfalls limit utilities' ability to invest in the grid upgrades and digital solutions needed to reduce losses, which only deepens the shortfall.

Furthermore, grid integration of variable renewable sources requires flexible grid to respond swiftly to output variations and maintain grid reliability. However, underinvestment in grid upgrades also constrains improvements in grid flexibility, thereby hindering the integration of renewable energy sources and compounding the effects of utilities' poor financial health.

5.2.4 Barriers prevalence across Africa

Previous sub-sections highlighted the key barriers hindering the expansion of utility-scale solar projects across the continent. This sub-section further examines the distribution and prevalence of these barriers across different regions.

Examining how these barriers vary by region sheds light on the stark differences in utility-scale solar investment across Africa.

Figure 5.3 illustrates the varied landscape of deployment bottlenecks across the continent by scoring the severity of key regulatory, technical, and financial barriers across five African sub-regions. The radar chart reveals distinct regional risk profiles. North Africa is overwhelmingly constrained by deeply entrenched, subsidised tariffs that distort market pricing, while Central Africa faces systemic infrastructural and governance headwinds, peaking at maximum severity scores for transmission and distribution (T&D) losses, opaque procurement, weak institutional arrangements, and limited grid flexibility.

In contrast, West Africa's primary vulnerability is anchored in depreciated local currencies and high T&D losses, whereas East Africa shows a higher relative exposure to land access constraints. Southern Africa maintains a more balanced but elevated risk profile, with currency depreciation and utility debt as its dominant financial constraints. Together, these patterns demonstrate that scaling utility-scale

renewable energy requires highly localised regulatory and technical interventions rather than a uniform, continent-wide approach.

5.2.5 Compounded impact of barriers

Utilities across many African countries face weak financial positions reflected in low creditworthiness. Addressing this challenge typically requires sovereign guarantees to de-risk investments; however, many governments are unable to issue such guarantees due to already high debt levels.

In parallel, underdeveloped investment environments, particularly weak regulatory and institutional frameworks, slow down project development processes, further increasing investment risk and associated financing costs.

As a result, low creditworthiness, limited fiscal space to provide sovereign guarantees, and lengthy and non-transparent project development procedures combine to create a high-risk investment environment. This ultimately leads to elevated financing costs and reduced investor interest.

At the same time, financially constrained utilities and governments are unable to invest in necessary grid upgrades and critical infrastructure. This underinvestment in grid modernisation results in ageing systems with limited flexibility and insufficient capacity to integrate higher shares of renewable energy.

Taken together, these interconnected challenges contribute to the persistent underutilisation of Africa's significant solar energy potential.

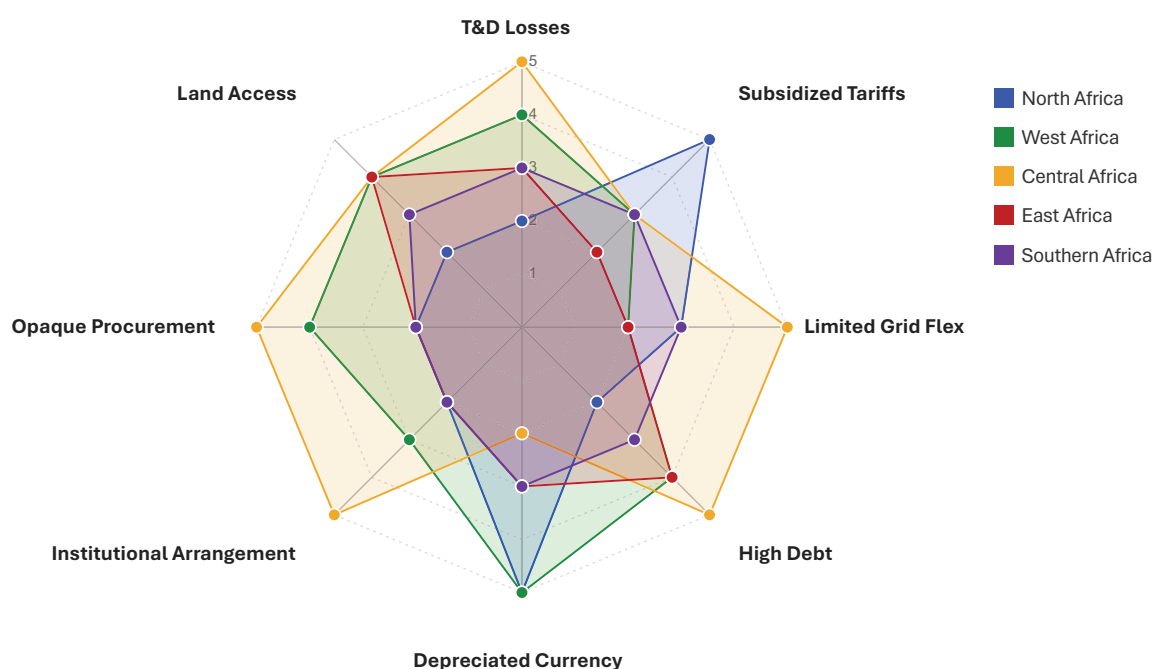


Figure 5.3: Regional comparison of solar energy barriers in Africa

Source: ISA & RCREEE Analysis

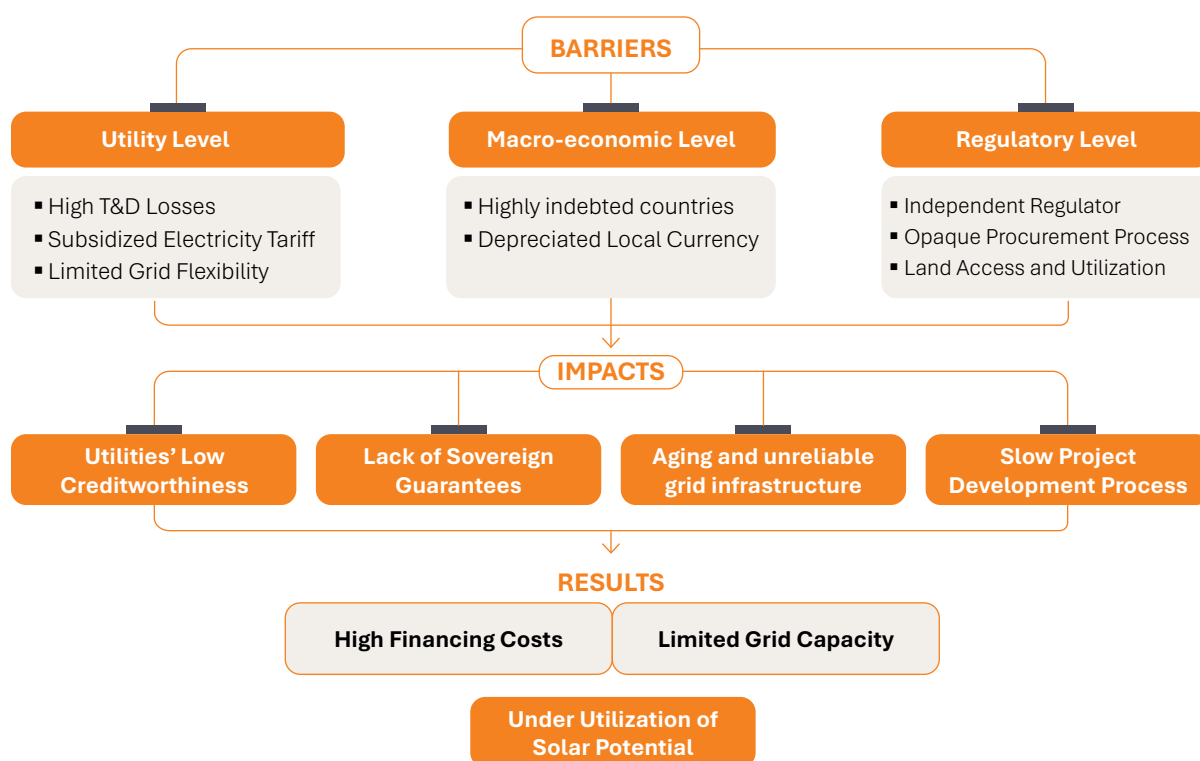


Figure 5.4: The impact of barriers on the utilisation of solar

Source: ISA & RCREEE Analysis

5.3 Mission 300: compact commitments behind utility-scale solar and One Grid Africa

5.3.1 What is being done?

The reform agenda that follows does not start from zero: Pillars 1 and 2 of every National Energy Compact commit to least-cost planning, competitive procurement and deeper power-pool participation. Mozambique (3.1 GW including Mphanda Nkuwa, regional dispatch by 2028) and Tanzania (JNHPP evacuation lines due Q3 2026 under an Independent Power Transmission model) carry the flagship hydro-plus-transmission projects. Kenya plans a 5,952 MW multi-technology build-out with interconnector trade rising to 1,000 MW; Guinea already exports to three neighbours while committing to halve commercial losses; Zimbabwe hard-

wires its SAPP-hub role through the MOZISA interconnection. On the supply frontier, Zambia's 3,000 MW solar programme, Gabon's 300 MW of solar-plus-storage, Botswana's pivot from 97% coal to 50% renewables with export ambitions and Namibia's SADC-conduit positioning show utility-scale solar and regional trade being planned as one system.

5.3.2 What needs to be done?

The gap is between what is signed and what is being delivered:

The paradox is precise: the technology has never been cheaper, and the capital has rarely been more expensive. Africa's utility-scale LCOE fell 67% in a decade to 74 USD /MWh - 25-30 USD /MWh in the best auctions - yet clean-energy projects borrow at 15-18% against 2-5% in advanced economies. The outcome is concentration: 70% of capacity under construction in five countries, nine countries with none, and more than two-thirds of the utilities that must sign the PPAs unable to cover their costs. Every link in that chain is addressed by a signed compact commitment; none closes without the enablers that follow.

Table 13: Mission 300: Progress, Gaps and Priority Enablers for Scale-Up

National Energy Compact commitments	Where the continent stands	Gap to close	Closing enabler
Pillar 1 and 4: Competitive procurement and transparent pipelines in every compact	More than 50% of capacity under construction sits in 2 countries	Procurement frameworks, standardised PPAs and published pipelines unbuilt in most markets	Institutional mandates, competitive e-procurement, standardised PPAs, published pipelines
Pillar 5: Cost-reflective tariffs, loss reduction, viable utilities	More than two-thirds of utilities below cost recovery; only 4 of 32 rated sovereigns investment grade (UNDP 2025)	Offtaker bankability: escrow, partial risk guarantees, FX cover still scarce	Escrowed payment streams, partial risk guarantees, FX facilities; tariff reform sequenced from C&I
Pillar 2: Regional integration and power trade (WAPP, EAPP, SAPP, CAPP)	Pools operational but cross-border volumes thin; interconnectors under-financed	Harmonised grid codes, wheeling frameworks and bankable interconnector finance	Storage, interconnection and grid codes; power-pool market operations
Competitive procurement commitments bank the technology dividend	LCOE down 67% to 74 USD/MWh ; best auctions at 25-30 USD/MWh; storage premium just 33 USD/MWh	Affordable technology, expensive capital: clean energy borrowing at 15-18% vs 2-5% in advanced economies	PRGs, escrow, FX facilities, green bonds/debt swaps
Land, permitting and institutional reform actions in compacts	Land disputes and opaque permitting add years to project timelines across the continent	Development timelines price into capital costs and deter entrants	Clear institutional mandates and streamlined, digitalised permitting; e-procurement transparency

Source: National Energy Compacts submitted by African countries

For utility-scale developers and their financiers, the compacts function as a de-risking instrument in their own right: a published, government-signed pipeline with reform milestones that can be priced, monitored through twice-yearly Compact Progress Reports, and enforced through the visibility that slippage creates.

5.4 Priority enablers to accelerate deployment

Following the identification of the root causes behind low investment mobilisation for utility-scale projects across Africa, this section outlines interventions to address these constraints and reverse the prevailing investment trends. It also presents selected case studies from across the continent demonstrating the practical application and effectiveness of these interventions.

To operationalise these interventions, this report proposes an Integrated Strategic Framework for Implementation (Figure 5.5). This framework adopts a phased, tiered approach to market reform. As illustrated below, it begins by laying a critical foundational base (the Enabling Environment), which is an absolute prerequisite for subsequent interventions. Building upward upon this stable regulatory and institutional foundation, the framework sequences targeted Risk Mitigation Solutions and Capital Crowding-in mechanisms, ultimately culminating in the deployment of advanced Technical Levers.

Strategic Solutions Framework

Three Pillars for Accelerating Utility-Scale Solar Deployment in Africa

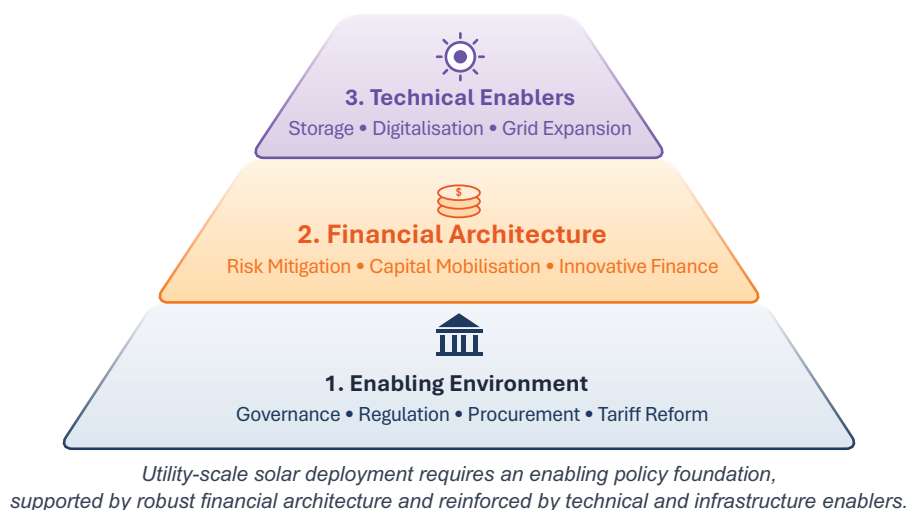


Figure 5.5: Strategic Solutions Framework

Source: ISA & RCREEE Analysis

The following subsections detail each layer of this framework, supported by regional case studies demonstrating successful real-world application.

5.4.1 Enabling environment

Establishing an enabling environment represents the primary intervention within the reform agenda and serves as a foundational enabler for other proposed solutions. Strengthening power system governance depends on addressing the following two key pillars.

a) Institutional Arrangements

Designing a well-functioning institutional framework is essential to facilitate the utilisation of Africa's solar energy potential. This requires identifying key roles and responsibilities related to renewable energy development and mapping them to the appropriate institutions based on their mandates. Such clarity helps avoid overlapping roles, streamline coordination among stakeholders, and strengthen accountability mechanisms.

Collectively, these improvements strengthen the investment environment by building greater confidence in the regulatory and institutional framework.

While institutional arrangements vary across countries, Egypt's renewable energy governance framework offers one example, outlining the key roles and responsibilities needed across the project development cycle. As such, it provides a useful blueprint that other countries can adapt and tailor to their specific institutional and regulatory contexts.



Box 1: Egypt's integrated institutional governance for renewable energy**Key insight**

Egypt has established an integrated governance structure to support renewable energy development. This framework defines key responsibilities and distributes them across institutions in accordance with newly introduced legislation and existing laws.

Key institutions and roles**1. Ministry of Electricity and Renewable Energy**

Drives overall sector coordination, target setting, and strategic oversight.

2. New and Renewable Energy Authority

Conducts technical resource assessments and allocates the required land for project development.

3. Egypt ERA

Approves project tariffs, establishes connection fees, and issues operational licences.

4. Egyptian Electricity Transmission Company

Acts as the primary market counterparty by signing Power Purchase Agreements (PPAs) with developers.

5. Ministries of Finance and Investment

Provides essential sovereign guarantees and streamlines the investment approval procedures.

**Key takeaway**

Clearly defined institutional roles and strong coordination between renewable energy authorities across the project lifecycle are critical to attracting investment and accelerating the development of utility-scale solar projects.

b) Regulatory reforms

Several regulatory reforms are well positioned to advance solar deployment across Africa, depending on the maturity of the regulatory framework. Broadly, these reforms can be categorised into two main areas:

I. Market unbundling

Enabling private sector participation presents an opportunity to improve power system operational efficiency and reduce the cost of service. Many African countries still rely on vertically integrated market models,

where a single public utility is responsible for generation, transmission, and distribution, an arrangement often prone to inefficiencies.

Introducing private sector participation, typically through public–private partnerships (PPPs), allows private actors to participate in various segments of the power system. In some cases, legal amendments may also be required to formally enable private sector participation in power system operations.

Private sector involvement, driven by performance incentives and profit motives, often brings improved efficiency, compliance, and technical expertise. However, the success of such participation depends on establishing transparent procurement procedures and well-designed contractual frameworks.

Box 2: Market unbundling and private participation in Uganda**Strategy**

Enabling private sector participation via concession agreements.

**Implementation**

Uganda's Electricity Act of 1999 introduced a comprehensive power sector reform programme that unbundled the state-owned Uganda Electricity Board into distinct generation, transmission, and distribution entities to improve sector efficiency. As part of this effort, a 20-year concession agreement was awarded to Umeme Ltd. to operate the distribution network under a performance-based regime with strong incentive mechanisms.

**Result**

By embedding strict, performance-based incentives linking the financial returns to operational efficiency, the intervention successfully reduced distribution losses from ~40% in 2005 to 16.5% in 2023-24.

II. Decentralised Private Procurement Models

Beyond structural unbundling, private sector involvement can be mobilised through decentralised generation models. Key examples include the Captive Model and Direct Supply/Corporate PPAs.

- **Captive Model:** A consumer (or consortium of consumers) finances and owns a solar facility to supply part or all their electricity

demand. These facilities can be grid-tied (ensuring supply reliability) or off-grid (requiring a backup generator or storage). For grid-tied captive systems, regulators must define clear grid integration mechanisms, such as Net Metering or Net Billing.

- **Direct Supply/Corporate PPAs:** This involves a bilateral contractual arrangement between a private solar developer and an industrial facility, commercial entity, or designated economic zone. The developer provides technical expertise and upfront capital, while the off-taker secures clean electricity, often financed entirely through the operational savings generated against volatile grid tariffs.

Table 14: Comparison of Corporate and Captive Solar Investment Models.

Aspect	Corporate Model	Captive Model
Ownership	Independent developer owns the project	Electricity consumer owns or co-owns the project
Off-taker	Commercial and industrial consumer under a PPA	Project owner consumes the electricity
Delivery Arrangement	On-grid (open access/wheeling) or off-grid/private network	On-grid (wheeling) or on-site/off-grid
Typical Applications	Industrial parks, SEZs, mines, and large commercial consumers	Manufacturing facilities, mines, and large commercial establishments
Main Advantage	Reduces dependence on utility off-taker risk and mobilises private investment	Provides energy cost savings and supply security through self-generation
Key Requirements	Corporate PPAs, direct sale regulations, grid access rules, and network charges	Captive generation regulations, licensing requirements, and grid-use rules where applicable

Source: ISA & RCREEE Analysis

The strategic advantage of these decentralised solutions is their ability to bypass traditional utility bottlenecks. They enable utility-scale solar to directly power productive commercial and industrial facilities, thereby driving economic growth independently of the national electricity utility's creditworthiness.

c) Financial reforms

Tariff reform is an indispensable intervention for achieving a financially sustainable power sector. Cost-reflective tariffs enable utilities to recover the cost of service and prevent the accumulation of debt. This, in turn, improves utilities' financial position, enhances liquidity, and strengthens creditworthiness.

Over time, various mechanisms have been developed to enable tariff reforms while addressing affordability concerns. Given that electricity tariffs are closely linked to access and affordability, and therefore politically sensitive, mechanisms such as lifeline tariffs,

targeted subsidies, and cross-subsidisation can improve public spending efficiency while continuing to protect low-income households from higher tariffs.

5.4.2 Financial architecture

Innovative financing practices have played a key role in addressing persistent financial barriers in emerging markets. Widely implemented globally, including across Africa, these practices can broadly be categorised into the following areas:

a) Crowd-in capital

A range of financial solutions under this category supports project development through various mechanisms. These instruments can either directly secure funding for projects or facilitate investment mobilisation at the country level. Specifically, they can:

- Directly secure funding through blended finance, concessional financing, government asset recycling, and carbon markets.
- Free up public budgets for infrastructure investments through mechanisms such as climate-debt swaps.
- Mobilise capital (at lower cost possibly) through green bonds.

As demand for energy infrastructure continues to grow amid significant financial constraints, several African countries have pioneered innovative financing mechanisms to mobilise investment and attract private capital. Box (3) highlights several successful case studies that demonstrate the practical application and impact of these approaches.

Box3: Innovative financing mechanisms supporting climate resilience in Africa



Kenya: Transmission PPP

Executed continent's first Independent Power Transmission initiative via a consortium (Africa50 and India Power Grid Corp). This proves PPPs can successfully resolve critical infrastructure bottlenecks beyond generation.



Gambia: Government Asset Recycling

Leased the fully developed Senegambia Bridge to Africa50 for ~USD 100 million over a 25-year period. This allowed the government to monetise a mature asset and reinvest proceeds into new infrastructure without acquiring additional sovereign debt.



Rwanda: Carbon Markets

Leveraged mitigation potential via the Clean Development Mechanism and Voluntary Carbon Market. To date, Rwanda has verified over two million carbon credits and established a robust national framework.



Egypt: Climate-Debt Swaps

Negotiated with creditors to redirect debt repayments to climate infrastructure, providing fiscal space. A recent landmark agreement with Germany allocated EUR 50 million toward wind energy projects.



Nigeria: Green Bonds

Issued Africa's first sovereign green bond in 2017 to connect with environmentally focused investors. The initiative successfully raised over USD 80 million, with consistent oversubscription demonstrating strong market demand.

b) Risk-mitigation solutions

These solutions address three main types of risks:

I. Political risks

Political Risk Insurance (PRI) protects project developers and investors from risks arising from political events, such as conflict, expropriation, or nationalisation. These instruments are typically provided by multilateral institutions such as the Multilateral Investment Guarantee Agency of the World Bank Group.

II. Commercial

Partial Risk Guarantees (PRGs) protect investors against the risk of government or national utility default in fulfilling contractual obligations. These guarantees are commonly provided by institutions such as the World Bank. In addition, Letters of Credit (LCs), issued by commercial banks, provide payment security to investors in case of default or liquidity constraints.

III. Currency

Currency-related mechanisms address risks associated with exchange rate volatility and local currency depreciation. These include:

- Foreign exchange liquidity or hedging facilities, such as The Currency Exchange Fund, which mitigate currency depreciation risks through hedging mechanisms.
- Local currency debt syndication, which reduces exposure to foreign exchange risks by financing projects in local currency.

These risk-mitigation instruments play a critical role in improving investor confidence, lowering financing costs, and enabling large-scale solar deployment in African markets.

5.4.3 Technical levers

Technical solutions serve a dual role in promoting large-scale utility-scale projects. On one hand, they can augment the impact of previously proposed solutions by improving the financial position of utilities. For instance, digital solutions can reduce non-technical losses, thereby strengthening utilities' revenues and operational efficiency. On the other hand, solutions such as energy storage systems and regional interconnections enhance grid flexibility, enabling higher levels of renewable energy integration.

Taken together, these solutions reinforce each other's impact. Digital solutions enhance grid visibility and controllability, supporting greater renewable integration, while increased renewable utilisation, enabled by storage and interconnection, can reduce generation costs and improve utilities' financial positions.

5.4.3.1 Regional power grid interconnection across Africa

Under the paradigm of power systems with a high share of Variable Renewable Energy (VRE) sources, continental power interconnection is gaining momentum as a viable pathway to resilient, secure, and clean electricity supplies. **Continental power interconnection refers to integrating electricity grids over large geographical areas, either as intracontinental or intercontinental, thereby facilitating the sharing of vast grid resources.** As a result, grid operators can access a broader pool of ancillary services, strengthening the ability to respond to unforeseen events. In the same context, continental interconnection also enhances VRE integration. By connecting multiple countries with diverse generation mixes, demand patterns, and climatic conditions, interconnected grids enable electricity trade across regions. This smooths variability in renewable energy generation across the wider system, facilitating the balancing of supply and demand and resulting in enhanced system flexibility.

The strategic imperative for interconnection across the African continent serves as the fundamental engine for large-scale solarisation, transforming the inherent variability of renewable energy into a stable, continental asset. For instance, the larger geographic balancing area allows utilising the flexible hydropower of the Nile or Congo basins to balance the hourly fluctuations of solar generation in the Sahara or the Kalahari.

Regional interconnections across the continent

The West African Power Pool (WAPP): Benin, Côte d'Ivoire, Burkina Faso, Ghana, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo

Central Africa Power Pool (CAPP): Angola, Burundi, Cameroon, Republic of the Congo, Central African Republic, Chad, Democratic Republic of the Congo, Gabon, Equatorial Guinea, and São Tomé and Príncipe

Southern African Power Pool (SAPP): Angola, Botswana, Democratic Republic of the Congo, Eswatini, Lesotho, Mozambique, Malawi, Namibia, South Africa, Tanzania, Zambia, and Zimbabwe

Eastern Africa Power Pool (EAPP): Burundi, Djibouti, Democratic Republic of Congo (DRC), Rwanda, Egypt, Ethiopia, Kenya, Sudan, Tanzania, Uganda, and Libya.

North African Power Pool (COMELEC): Algeria, Libya, Mauritania, Morocco, and Tunisia.

Regional grid integration across Africa relies on five key power pools that each offer distinct resource complementarities.

- In **Southern Africa**, the Southern African Power Pool demonstrates the dynamic benefits of competitive day-ahead electricity trading by linking thermal and coal capacity in South Africa with major hydroelectric resources such as Mozambique's Cahora Bassa and Zambia's Kariba Dam.
- The **Eastern Africa** Power Pool holds immense potential to balance variable renewable generation by pairing Ethiopia's massive hydro capacity, centered around the Grand Ethiopian Renaissance Dam, with Kenya's baseload geothermal energy via the 500 kV Ethiopia–Kenya high-voltage direct current interconnector, while simultaneously linking to Southern Africa through the Tanzania–Zambia interconnector.
- In **West Africa**, the West African Power Pool utilises the 225 kV Côte d'Ivoire–Liberia–Sierra Leone–Guinea transmission backbone to transport abundant coastal hydro resources to landlocked Sahelian nations that otherwise depend on costly thermal generation.
- The **Central African** Power Pool holds over half of the continent's hydroelectric potential, anchored by the Democratic Republic of Congo's Inga Dam complex, though it remains the least interconnected pool and represents a massive opportunity for future cross-border export corridors.
- **North Africa's** Comité Maghrébin de l'Électricité exhibits the highest electrification rates on the continent, relying on cross-border gas-to-power infrastructure and synchronised connections with Europe, such as the Morocco–Spain subsea cable, while actively developing regional solar export capacity.

Continental power interconnection aligns with the **African Union's One Grid for Africa** initiative. Based on the 2019 Agreement establishing the African Continental Free Trade Area (AfCFTA), the initiative seeks to harmonise regulatory frameworks and physical infrastructure to ensure energy security. By 2030, this integrated transition would provide the reliable electricity African nations need to participate effectively in global green value chains and protect domestic economies from price spikes.

Work is underway to realise the One Grid for Africa initiative, known as the Africa Single Electricity Market (AfSEM). The AfSEM Policy Paper outlines an actionable governance framework and a phased implementation roadmap, defining the institutional structure and key operational principles of the market.

On the infrastructure side, progress is being made to interconnect regional power pools, notably linking the Eastern Africa Power Pool (EAPP) with the Southern African Power Pool (SAPP). Completion is expected by 2027, following the finalisation of the 613 km Zambia–Tanzania interconnection segment, building on the earlier completion of the 508 km section.

A definitive case study for this continental vision is the **Cairo-to-Cape Town power corridor**. This link serves as the strategic bridge between the Eastern Africa Power Pool (EAPP) and the Southern African Power Pool (SAPP), creating a continuous energy highway. With this connection, which becomes technically viable upon the completion of the Zambia-Kenya interconnection, a country with significant hydro assets can import solar power from a neighbouring country during peak sunlight hours and export stored hydropower at night, effectively extending the ‘solar day’ into 15 hours.

Moreover, Africa has the potential to interconnect with neighbouring continents, for instance by developing subsea interconnectors to link the Maghreb with Europe and integrate African solar abundance into the Mediterranean and European markets. These cross-border links are essential for creating the technical ‘inertia’ required to support high penetrations of renewable energy without compromising grid frequency or stability.

On this note, Egypt emerges as a tri-continental energy bridge, leveraging its strategic geography at the crossroads of Africa, Europe, and Asia. This readiness is underpinned by a robust extra-high voltage (EHV) transmission backbone that has been systematically modernised to ensure grid stability and high-capacity throughput. Building upon long-standing successful interconnections with neighbouring countries in the Mashreq and Nile Basin, the national grid demonstrates the technical maturity required to anchor a synchronised African transmission network.

Challenges facing interconnection projects

Despite significant resource potential, African grid interconnection is severely constrained by physical, financial, regulatory, and political barriers. A primary physical bottleneck is the lack of robust national backbone infrastructure and high grid losses, which directly reflect Africa’s low global Electricity Supply Security score. This infrastructure gap contributes to frequent outages and unreliable service across the continent. Financial illiquidity presents another critical hurdle, as deep utility debt burdens, commercial payment default

risks between state-owned power companies, and non-cost-reflective tariffs limit utility liquidity.

Furthermore, regulatory fragmentation across regional economic communities creates operational friction, such as mismatched national market rules, unharmonised wheeling tariffs, and delayed adoption of unified regional grid codes, which prevent seamless transmission synchronisation across borders. These issues are further compounded by geopolitical volatility and localised security threats, which routinely delay cross-border interconnector construction and introduce continuous operational risk to multi-country energy trade agreements.

Recommendations for facilitating the interconnection projects

- African nations need targeted structural reforms to overcome these hurdles and align with global best practice, and ISA is well placed to lead that work. Through its flagship One Sun, One World, One Grid (OSOWOG) initiative, it is building the pieces intra- and intercontinental grid integration needs: governance and operational frameworks, integrated power system planning, enabling technologies, and the knowledge-sharing and consensus-building that hold the rest together. With more than 125 member countries across multiple continents and deep technical expertise, ISA already offers a coordination platform other stakeholders would otherwise have to build from nothing and stands ready to work with bodies such as the EU and AU on the preparatory groundwork transcontinental interconnection requires.
- Regional planning authorities must prioritise high-voltage transmission lines and utility-scale battery storage together: grid stability at higher renewable shares depends on both moving in step, not one racing ahead of the other.
- Regional economic authorities must move quickly to harmonise market mechanisms: standardised wheeling tariffs, binding dispute resolution, and grid codes that are actually enforced rather than merely agreed on paper.
- Development institutions and governments should deploy blended finance, political risk insurance, and targeted liquidity facilities, of the kind the African Development Bank and World Bank already offer through Mission 300, to de-risk cross-border projects and backstop off-taker default.
- Finally, utilities need to modernise digitally: smart meters, automated distribution management, and centralised regional control centres capable of routing power across borders and keeping pace with rising demand.

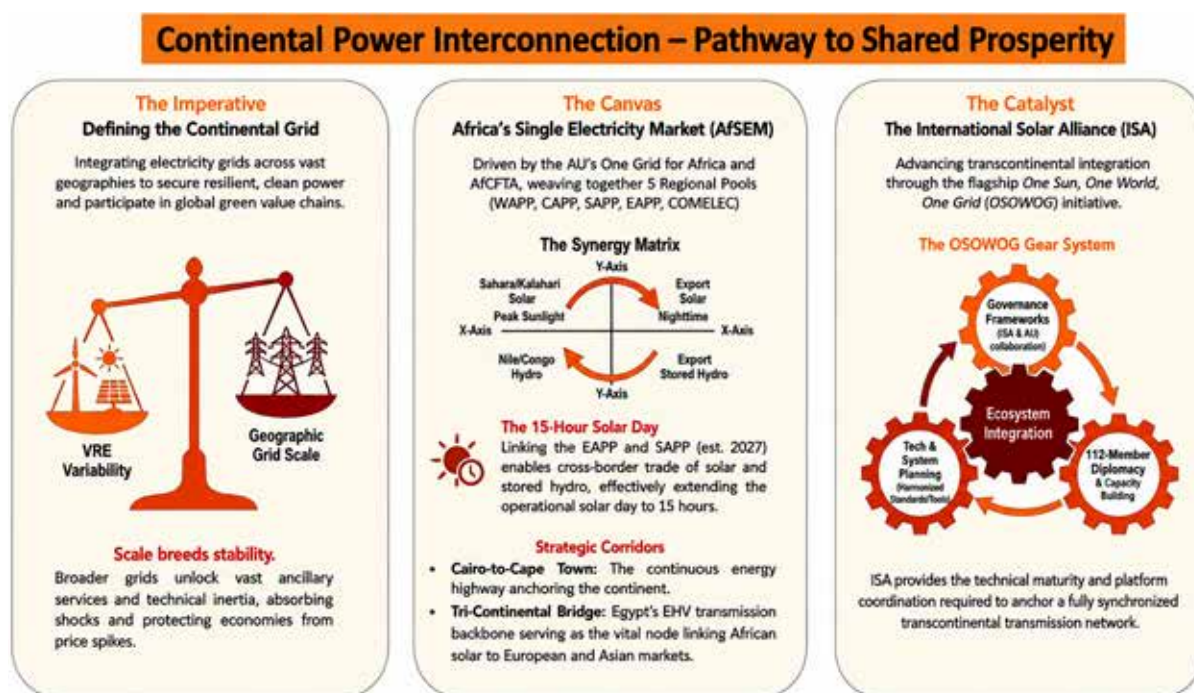


Figure 5.6: Continental Power Interconnection – Pathway to Shared Prosperity

Source: ISA & RCREEE Analysis

5.4.4 Enablers interplay

The previous sections set out benchmarking insights and actionable recommendations for scaling large-scale solar in Africa, each considered on its own. This section brings them together and shows how the package compounds: each intervention reinforces the others.

Gradual tariff reform, paired with greater private sector participation, strengthens power sector finances and utility

creditworthiness. A well-functioning institutional environment speeds up project development and makes the investment climate more attractive. And innovative, sustainable financial instruments open access to cheaper financing while shielding investors from a range of risks.

Together, these three, stronger creditworthiness, faster development, cheaper financing, pull down the cost of capital, and with it the cost of service.

Once capital is mobilised and technical capacity built, grid modernisation and flexibility solutions such as storage and interconnection become realistic investments. These technical upgrades improve system operations and expand grid capacity, clearing the way for more renewable energy on the system.





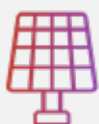
Figure 5.7: Policy and financial enablers for large-scale renewable energy projects in Africa

Source: ISA & RCREEE Analysis

The box below shows this in practice. These real-world examples confirm that the reform package outlined here is not a theoretical construct: it has already been applied, and it has worked.

Box 4: Benban Solar Park, Egypt

The Benban Solar Park, located in Aswan-Egypt, is one of the world's largest solar complexes and a cornerstone of Egypt's Sustainable Energy Strategy. Wide-ranging regulatory reform and a robust risk-mitigation framework made it possible.



Project Overview

- 1.65 GW operational capacity across 37.2 km² (1.8 GW total potential).
- Cut critical historical dependence on fossil fuels (>90% of mix).
- USD 2.5 billion investment central to achieving Egypt's renewable energy targets.



Enablers

- Energy (electricity and fuel) subsidy reforms.
- Structured Public Private Partnership (PPP) models.
- Foreign exchange risk mitigated by indexing tariffs 70% to the USD.
- USD 210 million PRI.
- Bankable 25-year PPAs with state-owned EET as sole off-taker.



Stakeholders

- Government of Egypt: Policy framework, infrastructure, and final off-taker.
- EBRD and IFC: Spearheaded debt financing (USD 1.13 billion and USD 653 million, respectively).
- MIGA: Provided USD 210 million in political risk insurance to protect private lenders.



Impacts

- Generates ~4 TWh of clean electricity annually to power >1 million homes
- Prevents 2 million tonnes of greenhouse gas emissions each year
- Created 10,000 construction jobs and established a local solar training hub

5.5 Way forward

Drawing on the enablers and case studies set out in this chapter, this section proposes a National Solarisation Roadmap to guide policymakers in accelerating utility-scale solar deployment. It is built to

adapt: countries starting from an initial regulatory baseline and countries optimising an already mature market can both use it.

Crucially, it is not a linear, one-off exercise. As Figure 5.8 illustrates, it functions as a continuous, iterative lifecycle. The outputs of each phase directly inform the next, culminating in a feedback loop that ensures policies adapt to shifting market realities, grid capabilities, and technological advancements.

ACTOR	IMMEDIATE — Establish foundations Priority actions to unlock deployment	MEDIUM TERM — Build systems & scale Deepen coordination across actors	LONG TERM — Sustain & optimise Embed enabling environment at scale
Head of State / Cabinet	Declare utility-scale solar a national infrastructure priority Mandate solar parks, transmission corridors & Task Force	Notify first solar park; gazette transmission plan Budget includes MW, jobs, fuel-import savings	Task Force becomes permanent Solar Parks Authority A standing GDP, NDC & SDG measurable
Ministries Energy · Finance · Lands · Environ · Trade	Integrated Resource Plan: capacity & transmission targets Land & fiscal framework; single-window + reverse auction	Bankable pipeline: MW, PPA bands, COD First auctions executed; transparent price discovery	Pipeline anchors green bonds + private capital Auction platform national procurement standard
Energy Regulator	Draft licensing (merchant + PPA routes) Tariff, grid-connection & storage co-location rules; sandbox	Gazette RE Desk; approve first auction tariffs Enforce must-run; accredit IVAs	Bulk portfolio licensing via portal Tariffs converge to globally competitive levels
National Utility/ Solar Parks Authority	Mandate utility to integrate solar in system plan Establish Solar Parks Authority (PMU); 3-track procurement	Energise transmission ahead of first park RTC RE auction; storage co-location mandated	Utility-developer co-management; flexibility at scale Authority autonomous; cross-border auctions
Developers & EPC Contractors	Resource assessment & site due diligence Embed bifacial, trackers, storage-readiness; local supply	Win first auction; sign PPA; financial close Predictive O&M live; local assembly 40%+	Expand portfolio; investment-grade rating AI-driven O&M; export-ready manufacturing
Financier / DFI / ISA	Activate sovereign-DFI partnership framework Design blended-finance instruments; hedging partnership	First milestone-based DFI disbursement Payment-security mechanism live; green bond issued	DFI exits as pension/capital markets take over Securitise assets; Article 6 credits flow

Figure 5.8: Roadmap for Promoting Utility-scale Solar Projects

Source : ISA & RCREEE Analysis



I. Short-term action plan (months 0–24): laying the strategic foundation

The initial two-year window establishes the empirical and strategic building blocks necessary to sustain large-scale deployment.

Phase 1: Planning, assessment, and geospatial zoning The roadmap begins with a rigorous technical and economic diagnosis of the market. This phase evaluates the nation's natural solar potential through detailed resource mapping and geospatial zoning. Simultaneously, system operators must conduct grid integration studies to identify existing network constraints and quantify the infrastructural reinforcements required to accommodate variable renewable energy (VRE) while maintaining grid stability.

These empirical assessments yield multiple deployment scenarios, varying by scale, investment pathway, and grid readiness. By evaluating these scenarios, governments can pinpoint the most viable national approach, forecast the required capital expenditures, and map the associated financing gaps.

- **Lead Institutions:** Ministry of Energy, National Power Company, and Transmission System Operator (TSO).

Phase 2: Policymaking and institutional mandates Grounded in the evidence generated during Phase 1, Phase 2 represents the executive decision-making stage. The highest levels of government (e.g., Head of State, Cabinet, or designated Ministry) formally adopt legally binding renewable energy targets and establish specific performance indicators.

Equally important, this phase dictates institutional accountability.

It designates a lead implementing agency and legally mandates the coordination mechanisms required to align overlapping governmental stakeholders, preventing administrative bottlenecks.

- **Lead Institutions:** The Cabinet and the Ministry of Energy.

II. Medium-term action plan (years 2–5): architecting the enabling framework

The medium-term horizon, typically a two-to-three-year undertaking, serves as the executive pillar of the roadmap. This phase translates high-level strategic objectives into actionable, bankable market mechanisms.

Phase 3: Operationalising the market framework This phase requires establishing consensus across stakeholders to implement four foundational steps:

- **Step 1: Institutional governance:** Defines the specific functions required to operationalise deployment, permanently assigning mandates for sector regulation, system operation, competitive procurement, and investment facilitation. Clear allocation of these responsibilities ensures accountability across the project lifecycle.
 - ♦ **Lead Institution:** Ministry of Energy
- **Step 2: Regulatory and investment design:** Establishes the legal bedrock required to attract private capital. This step removes market barriers and explicitly defines the permitted investment pathways, such as:
 - The Utility-Offtaker Model (Single Buyer)
 - The Corporate Direct PPA Model
 - The Captive Generation Model

For each pathway, regulators must publish clear licensing procedures, standardised tariff arrangements, local content requirements, and specific on-grid/off-grid participation rules.

- ♦ **Lead Institutions:** Ministry of Energy and the National Energy Regulator
- **Step 3: Operational and technical rules:** Deploys the technical mechanisms required to enforce the regulatory framework. This includes drafting modern grid codes, standardising interconnection protocols, and defining operational rules for dispatch, balancing, and curtailment. Furthermore, this step establishes the procedures for issuing Renewable Energy Certificates (RECs) and sets accreditation standards for EPC contractors and service providers.
 - ♦ **Lead institutions:** National Energy Regulator and Grid Utilities (TSO and Distribution System Operators - DSO).



▪ **Step 4: Financial and bankability mechanisms:**

Integrates the de-risking instruments vital for large-scale capital mobilisation. To reduce the weighted average cost of capital (WACC) and mitigate sovereign or off-taker risks, this framework must structure accessible financing mechanisms. These may include concessional credit facilities, sovereign or partial risk guarantees, blended finance structures, and targeted fiscal incentives.

♦ **Lead Institutions:**

Ministries of Energy, Finance, International Cooperation, and Environment; the Central Bank; and Development Finance Institutions (DFIs).

III. Long-term action plan (year 5 & beyond): scaling and adaptation

Phase 4: Monitoring, evaluation, and iterative market adaptation

Consistent with agile policymaking, Phase 4 provides the structural oversight required to track deployment progress against established targets. This continuous phase tracks implementation efficiency, monitors grid performance, and evaluates the true cost-impact of the capital.

The findings generated through this reporting process support evidence-based decision-making and ensure market transparency. Most importantly, it creates a structural feedback loop. Based on Phase 4 data, policymakers will periodically cycle back to the earlier phases, reassessing grid capacity, updating national targets, or amending regulatory instruments, to continuously refine the investment environment.

♦ **Lead Institution:** Ministry of Energy.



Digitalisation of utilities and solar planning tools in Africa

6.1 Why digitisation matters for Africa?

In much of Sub-Saharan Africa, the electricity system fails in ways a household can feel. A metre goes unread for months, and the bill arrives ‘estimated’. **A transformer trips because no one can see where the load has moved, one more symptom of a sector-wide reliability problem.** A solar developer waits two years for a grid-connection study, because the utility has no streamlined process for handling one. Behind each of these sits the same problem: not a shortage of sun or of affordable panels, but power institutions that cannot see, bill, plan or pay reliably. Africa holds among the world’s strongest solar resources and cheapest solar technology, yet **installed solar capacity in Sub-Saharan Africa still sits at ~1% of the global total, and around 600 million people remain without electricity.**

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The binding constraint on solar expansion is no longer the cost of panels or the quality of the resource, both have moved decisively in Africa’s favour, but the financial and operational condition of the utilities that buy, connect, and deliver solar power. More than two-thirds of vertically integrated and distribution utilities in Sub-Saharan Africa cannot cover their operating and debt-service costs from revenue. Critically, the problem is not primarily electricity tariffs (Sub-Saharan tariffs are already higher than in many non-OECD and even

some OECD countries) but revenue leakage and operational inefficiency: high transmission and distribution losses and lower bill collection. As a result, they cannot become the creditworthy offtakers and predictable counterparties that solar investment requires. These are precisely the failures digital systems exist to fix: digitalisation is what converts abundant solar potential into bankable, scalable deployment. It must, however, be understood as an enabler and not a solution in itself: no metre, platform or dataset has ever electrified a household. What digital systems do is complete broken chains: metering, billing and collection turn electricity supplied into revenue collected, revenue into creditworthiness, and creditworthiness into the bankable offtake every solar market in this report depends on.

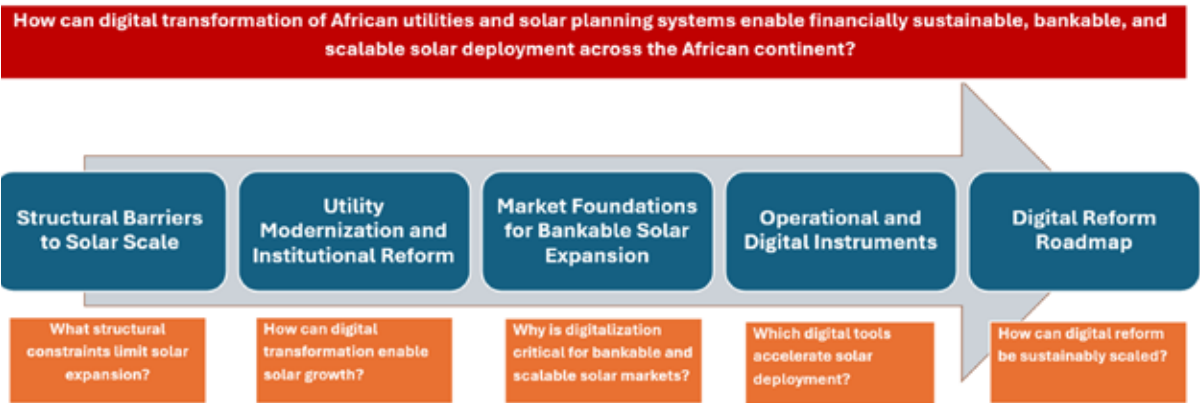


Figure 6.1: Digitalisation as a Strategic Pillar for Solar Deployment
Source: ISA & RCREEE Analysis

Advanced Metering Infrastructure (AMI), Distribution Management Systems (DMS), Outage Management Systems (OMS), SCADA and other advanced applications, Enterprise Resource Planning (ERP), and Commercial Management Systems (CMS) are the baseline toolkit every utility now needs to run its business. Their value, though, lies not in the systems themselves but in what they restore: revenue collected, losses located, outages managed, load made visible, the operating record that makes a utility financeable and its grid able to host more solar at lower reserve cost. Planning digitalisation (geospatial demand mapping, digital asset registries, hosting-capacity analysis, and least-cost expansion modelling) improves the quality of investment decisions. That gap, between

the data-rich, transparent systems solar needs and the low-information systems many utilities still run, is what this chapter calls the digital gap. Where it persists, poor data limits planning, weak visibility raises uncertainty, opaque procurement inflates perceived risk, and weak revenue systems erode off-taker credibility. Investors then price every one of those risks into the cost of capital.

This framing also dictates how success must be measured. A digitalisation programme judged by meters installed or platforms launched can ‘succeed’ while the energy system keeps failing; one judged by collection rates, losses avoided, hosting capacity gained, and financing costs reduced cannot. Digitalisation alone is not sufficient: deployed without tariff reform, utility governance and investment mobilisation, it produces dashboards over a failing system. Combined with them, it is the multiplier that turns each reform into revenue, and revenue into deployed solar.

This is why digitalisation is strategic rather than merely technical. Roughly eight in ten people still without power live in remote, fragile, or conflict-affected areas, where distributed

renewables (mini-grids and standalone solar) are the cheapest way to reach them. Managing that scale of deployment transparently and bankably is only possible on a digital backbone.

The chapter therefore reads every digital tool that follows through the outcome it enables: utility financial recovery in this chapter, utility-scale bankability in Chapter 5, last-mile systems in Chapter 2, and the productive-use and mobility loads of Chapters 3 and 4.

6.2 Barriers: what holds solar back

The barriers to scaling solar in Africa are institutional and informational, and they reinforce one another.

6.2.1 Utility insolvency and revenue leakage

T&D losses exceed 30% in some utilities, against about 11% in South Africa and close to 2% in the world's best systems. One-third of utilities collect less than 90% of what they bill, and some collect below 50%. On the ground this shows up as estimated 'guess' bills, bypassed or tampered metre, and connections that are never billed at all. Unpaid arrears build up until the utility cannot pay its own generators, which is why several African single buyers have fallen behind on their obligations to independent power producers. Nigeria illustrates the scale: of about 13.3 million registered electricity customers, only some 6.1 million are metred, leaving over 7 million on estimated bills.

The dynamic is self-reinforcing. Weak billing starves maintenance, service quality falls, willingness to pay drops, and revenue erodes further. What makes the story recoverable is that fixing it is entirely within reach. From an investor's standpoint, however, the equation is stark: a financially weak utility is an unbankable off-taker, and lenders price its payment risk into every power purchase agreement they sign against it.



Figure 6.2: The utility revenue-deterioration cycle that digitalisation is designed to break

Source: ISA & RCREEE Analysis

6.2.2 Blind networks and low operational visibility

High losses are an information problem before they become an engineering one. Incomplete asset registers, weak feeder-level monitoring, and no real-time view of power flows mean utilities cannot locate where losses occur, assess feeder and substation hosting capacity, or manage the variability that solar introduces. In practice, a developer waits many months for a connection study the utility does not have the data to complete, and feeders trip because no one can see where load sits. Operating blind, utilities interconnect conservatively, delay approvals,

underuse existing capacity and curtail generation, lowering the system value of solar and raising the returns investors demand.

6.2.3 Procurement

Utility-scale solar often stalls not on resource but on procurement. The usual failure modes are familiar: repetitive information requests, inconsistent documents, unclear evaluation criteria, and long silences between submission and award. Developers routinely describe evaluation criteria that shift between rounds and awards that arrive years late. These conditions push transaction costs up and increase the perceived risk of discretionary decisions or renegotiation. Serious bidders respond in one of two ways: they withdraw, or they embed a risk premium in their price. Either way, solar gets scarcer and more expensive than it needs to be.

6.2.4 Fragmented planning data

Solar investment is data-intensive: it needs high-resolution resource data, grid topology and hosting capacity, time-series demand, land-use constraints, and reliability metrics. In

many jurisdictions those datasets are incomplete, siloed across institutions, or simply not public. Two developers survey the same village independently. Ministries plan grid expansion from maps that duplicate each other. Developers redo feasibility studies because there is no trusted baseline. Utilities miss network constraints and hit them at connection stage, producing avoidable curtailment. Planners without credible forecasts overstate reserve margins and hold solar penetration below its economic optimum.

6.3 Mission 300: putting the enablers to work

6.3.1 What is being done?

Mission 300's Pillar 1 rests on least-cost, integrated resource planning, itself a digital exercise. Pillar 3 places distributed renewables at the last mile: about half of Mission 300's connections are expected to come from mini-grids and standalone solar, each an inherently digital asset. Pillar 4 aims to crowd in private capital through transparent pipelines and credible guarantees, and digital procurement is what makes both credible. And Pillar 5 (financially viable utilities) names metering, revenue assurance and loss reduction explicitly.

The enablers suggested above are not abstract good practice: they are the operational content of the compacts.

Table 15 : Mission 300 Digital Enablers and Their Contribution to Energy Access Delivery Pillars

Digital enabler	Mission 300 pillar	How it is being delivered
Smart metering and revenue assurance	Pillar 5: financially viable utilities	Compact commitments on cost-reflective tariffs, loss reduction and mass metering; utility turnaround de-risked by IFC finance and MIGA guarantees.
Forecasting, SCADA and grid visibility	Pillar 1: competitive generation, T&D (with Pillar 2 trade)	Least cost and integrated resource planning and grid rehabilitation written into each compact; regional power pools (WAPP, EAPP, SAPP) to share surplus solar.
Geospatial planning and least-cost electrification	Pillar 3: last-mile DRE and clean cooking	About half of the 300 million connections targeted via mini-grids and standalone solar; geospatial targeting plus the Zafiri equity vehicle to crowd in developers.
Transparent digital procurement	Pillar 4: private-sector participation	Transparent project pipelines, guarantees and FX-risk tools; a 'one World Bank Group' model aligning Bank policy lending, IFC finance and MIGA insurance.
Digital public infrastructure and open data	Cross-cutting (Pillars 1, 4 and 5)	Shared data, payment rails and standardised monitoring; twice-yearly CDMU progress reports and the Global/Africa Solar Facility as the financing-and-data layer.

Source: National Energy Compacts submitted by African countries

Guinea commits to reducing commercial and technical losses from 30% to 8% by 2030; Ethiopia sets the most granular loss-reduction programme on the continent: distribution 22%→13%, transmission 6%→5.5%, commercial 10%→4.5%; Nigeria must close a 7.32-million-metre gap, and its SCADA and NESIP actions are flagged as delayed in the Q1 2026 CPR. Comoros pairs smart metres, mobile-banking payment rails and a

utility ERP with its access targets; Mozambique's National Control Centre with regional dispatch is due in 2028; Namibia commits to robust planning data systems, and the DRC builds the continent's largest access programme on geospatial least-cost electrification. Digital reform is thus no longer a recommendation to governments: it is a set of signed, dated, monitored national obligations.

6.3.2 What needs to be done?

The same compact lens yields a digitalisation gap analysis: what governments have signed, where their systems stand, and what the phased roadmap below must close.

The quantification is stark. Losses of 6.2-38% and collection rates from 36% to 100% describe utilities that lose money on much of what they sell; closing losses toward South Africa's ~12% and eliminating collection leakage would lift utility revenue by up to

181%, turning 9 of 15 loss-making vertically integrated utilities profitable. The compacts have converted this into dated national targets (Guinea's 30%→8%, Ethiopia's 22%→13%, Nigeria's 7.32-million-metre programme), but the Q1-2026 CPR already flags Nigeria's SCADA and NESIP actions as delayed. Digital ambition is signed; digital delivery capacity is the gap.

Table 16 Mission 300: Progress, Gaps and Priority Enablers for Scale-Up

National Energy Compact commitments	Where the continent stands	Gap to close	Closing enabler
Pillar 5 loss and metering targets (Guinea 30%→8%; Ethiopia distribution 22%→13%; Nigeria's 7.32 m-metre gap)	T&D losses of 6.2-38% ; collection rates from 36% to 100%; Nigeria's SCADA and NESIP actions delayed at Q1 2026	Digital delivery capacity - metering rollout, revenue assurance, SCADA execution	'Smart metering and revenue assurance' (Enabler 1) + 'Forecasting, SCADA and grid visibility' (Enabler 2); STAR-C digital-skills tracks
Pillar 1: least-cost, integrated resource planning in every compact	Geospatial least-cost platforms operational in few markets (DRC the leading user)	The data-foundations layer of the roadmap below	'Geospatial planning and least-cost electrification' (Enabler 3); DRC precedent
Pillar 4: transparent, digitally procured pipelines	E-procurement still rare; procurement opacity prices into capital costs	The digital-procurement enabler above, executed on compact deadlines	'Transparent digital procurement' (Enabler 4); e-procurement lowers the cost of capital
Pillar 5 revenue:assurance commitments across all 35 compacts	Closing losses toward ~12% and eliminating collection leakage would lift revenue up to 181% - turning 9 of 15 loss-making utilities profitable	Metering, billing and collection systems unfunded in many utilities	'Smart metering and revenue assurance' (Enabler 1); prepaid/AMI rollouts (Cape Town-Kampala evidence); IFC/MIGA-backed utility turnaround
CDMU standardised biannual data reporting	Fragmented planning data: paper-based procurement persists	The data-foundations layer of the digital stack is missing	'Digital public infrastructure and open data' (Enabler 5) + the four-layer phased roadmap below

Source: National Energy Compacts submitted by African countries

6.4 Priority enablers to accelerate deployment

Each barrier has a corresponding digital lever. Together they describe how a power system moves from fragile and unbankable to investable. African utilities and programmes are already showing, in numbers, what each lever delivers. Order matters as much as the tools. Gains compound when the

foundations are laid first, and stall when advanced systems get bolted onto weak commercial and data fundamentals.

6.4.1 AMI and revenue assurance: building bankable offtakers

The most direct lever addresses the most binding constraint. A utility's creditworthiness, and with it the price at which it can sign solar power purchase agreements, depends on one thing: how much of the electricity it delivers gets converted into revenue. Digital commercial systems close that gap. Smart and prepaid metering, automated billing, and integrated payments narrow the space between energy supplied and revenue collected, while feeder monitoring and loss analytics locate the technical and commercial losses that can then be corrected

remote reading, prepayment, loss localisation and revenue assurance.

The gains are already being banked, and the pattern holds everywhere: results follow when reform starts with the commercial fundamentals (accurate customer records, high-loss feeders and large accounts) rather than with technology for its own sake. Uganda's Umeme reported a 99.0% collection rate in 2023, with energy losses down to 16.2%, on the back of commercial-cycle automation and prepayment. Kenya Power cut system losses from 23.16% to 21.21% in FY2025 (a seven-year low), driven by a smart-metre rollout targeted at large consumers and improved energy accounting. Tanzania's TANESCO expanded prepayment metering to lift collection and clear arrears. Ghana's ECG paired advanced metering with a commercial management system. The contrast with Nigeria's stalled rollout is itself the learning: metre pay off only when the programme is sustained and wired into billing, payment and enforcement, rather than installed and forgotten.

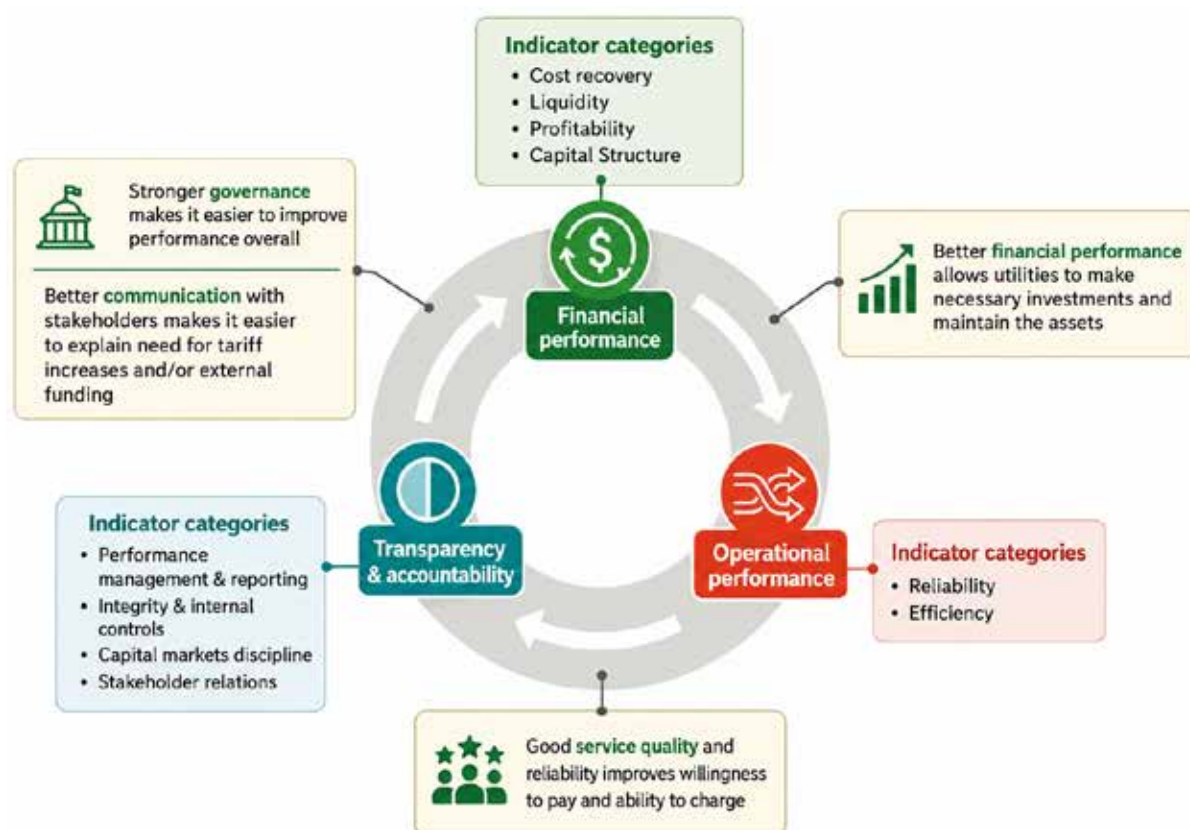


Figure 6.3: How stronger operational and commercial performance creates a virtuous cycle of utility creditworthiness

Source: ISA & RCREEE Analysis

Metering, in other words, is the reform that most directly turns a loss-making utility into a creditworthy off-taker: the single change that does most to make solar financeable, and the reason it now sits inside the financial-viability commitments of every Mission 300 compact.

Uganda's utility reform experience

Uganda's experience demonstrates that utility improvement should be approached as a sequenced reform pathway, rather than as a series of stand-alone digital investments. The evidence in this chapter is strongest for commercial reform, digital payment systems and prepayment, which together have supported consistently high revenue collection. Building on this foundation, reforms addressing loss reduction, governance, tariffs and operational digitalisation can be introduced progressively. The Uganda evidence bears this out: Umeme reported a 99.0% collection rate in 2023 and a five-year moving average of 99.7%, linked to multiple digital payment channels, prepayment and an improved payment culture.

The reform pathway needs to begin with customer information, billing and payment systems, as digital technologies cannot improve utility performance when the underlying commercial data are incomplete, fragmented or inaccurate. Uganda's strong collection performance demonstrates that actions like expanding payment access, strengthening prepayment systems and reinforcing commercial discipline can deliver early and measurable financial results.

Once these initial gains are secured, utilities can direct investment towards targeted metering, revenue protection and feeder-level loss reduction.

Subsequently, as commercial and network data become more reliable, they can strengthen governance, link financing to verified performance improvements and advance broader operational modernisation. A digital systems need to be introduced only after the necessary customer, revenue and data-management foundations have been established.

Lessons for African utilities

The following lessons provide guiding principles for utility reform, while **Table 17** translates them into a proposed sequence of practical actions, objectives and expected outcomes.

1. Utilities should strengthen revenue collection before advancing wider digitalisation, as early commercial improvements can provide the liquidity and institutional confidence needed to support subsequent reforms.
2. Metering should be integrated with the wider commercial system by linking smart and prepaid metres to customer databases, billing systems, payment platforms and revenue-protection processes.
3. Digital investments should be prioritised where measurable financial returns can be achieved, particularly among large customers, high-loss feeders and areas with weak collection performance.
4. Digital reform should be supported by clear responsibilities and tariffs that cover the utility's operating costs. Without these measures, new technologies will not deliver sustainable improvements.
5. Operational modernisation should be introduced progressively, once reliable data, interoperable systems, skilled personnel and clear institutional ownership are firmly established.



Table 17: Roadmap for Utility Commercial, Financial and Operational Reform Based on Uganda's Experience

Reform phase	Strategic objective	Priority actions	Expected outcome
Establish commercial foundations	Establish a reliable commercial and customer data foundation.	- Verifying and updating customer records - Improving billing accuracy - Clarifying accountability for commercial performance - Strengthening customer-service and arrears-management processes	More accurate billing, improved payment tracking and a credible baseline for measuring revenue leakage.
Accelerate revenue collection	Strengthen revenue collection and improve utility liquidity.	- Expanding accessible digital payment channels - Strengthening payment reconciliation - Promoting payment discipline and continuing the targeted use of prepayment systems	Reduced arrears, faster cash conversion and greater predictability of utility revenues.
Scale targeted metering and revenue protection	Enhance revenue protection through targeted metering and consumption monitoring.	- Prioritising large customers, high-loss feeders and areas with weak payment performance - Integrating prepaid or advanced metre with billing, customer and payment platforms - Strengthening metre maintenance and tamper detection	Improved revenue assurance, better detection of unmetered consumption and stronger control over non-technical losses.
Link commercial data to loss reduction	Use improved data to distinguish and address technical and commercial losses.	- Establishing feeder-level energy accounting - Identifying faulty metre, overloaded assets and billing discrepancies - Directing investment towards the areas with the highest losses	More targeted loss-reduction measures, improved network efficiency and better prioritisation of capital expenditure.
Strengthen governance and cost recovery	Institutionalise performance improvements and support long-term financial sustainability.	- Introducing transparent performance reporting - Defining management and regulatory accountability - Linking investment and financing to verified results - Aligning tariffs progressively with efficient service costs	Stronger oversight, improved financial planning and greater capacity to fund maintenance and investment.
Modernise utility operations	Extend digital reform from commercial functions to network management, planning and service delivery.	- Integrating Advanced Metering Infrastructure (AMI), Supervisory Control and Data Acquisition (SCADA), Geographic Information Systems and outage-management systems - Linking digital asset registers and forecasting tools through interoperable platforms - Strengthening cybersecurity - Building staff capacity to operate and maintain digital systems	Improved network visibility, faster outage response, predictive maintenance, better planning and greater readiness for renewable-energy integration.

Source: ISA & RCREEE Analysis

The above roadmap highlights that what matters is not only the installation of metres but the interconnected chain of events these metres set in motion: consumption measured becomes revenue collected, revenue collected becomes creditworthiness, and creditworthiness becomes bankable offtake. This interconnected chain of events runs well beyond the utility's own accounts. A collecting utility is the counterparty that makes utility-scale PPAs financeable without sovereign guarantees. For mini-grid developers, it is the credible partner they need for the day when the main grid arrives at their site. And it is the billing platform on which the productive-use customers of the solar for agriculture chapter (mills, cold rooms and irrigation pumps) and

tomorrow's charging loads get metered, tariffed and financed. Every percentage point of collection recovery translates, at the system level, into a risk-premium reduction shared across every solar market in this report.

6.4.2 Forecasting, SCADA and grid visibility: enabling higher solar penetration

The second lever determines how much solar a system can absorb. As solar's share rises, operators must forecast a more variable net load, hold voltage and frequency within limits, and see congestion in real time: capabilities that manual systems cannot provide. Where that visibility is missing, utilities protect themselves by interconnecting conservatively and curtailing output, stranding capacity and reducing investor returns. Where it exists, the same physical network can host far more solar without adding a single pole or wire. A large share of Africa's near-term solar headroom sits not in new generation but in the digital capability to run the grid it already has.

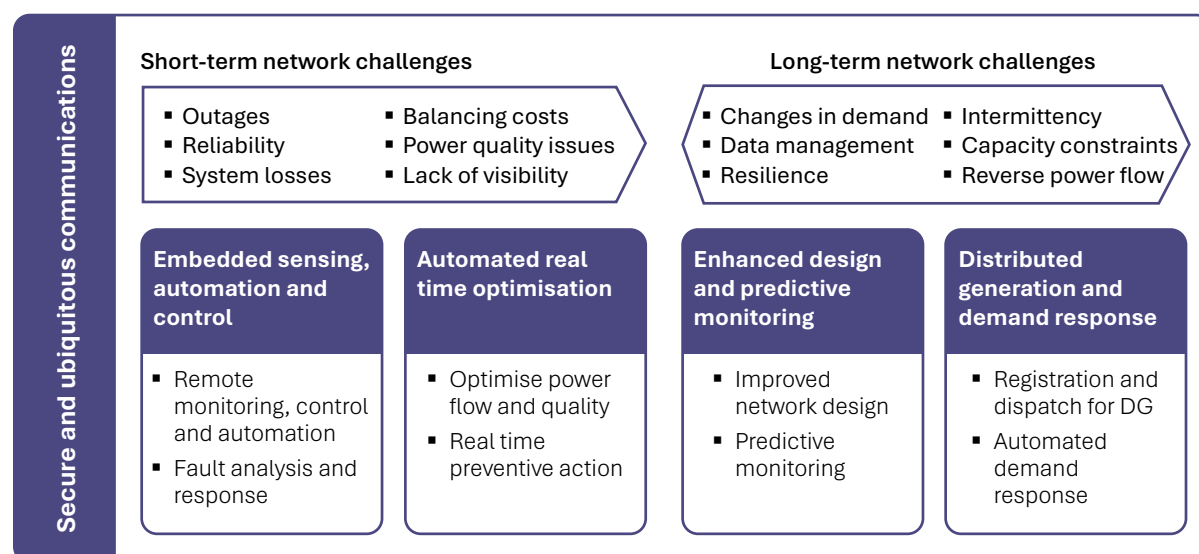


Figure 6.4: Digital solutions addressing short- and long-term grid challenges as solar penetration rises

Source: ISA & RCREEE Analysis

Egypt's 1.8 GW Benban complex runs alongside SCADA and digital grid-control investments that give operators real-time command of large variable flows. In South Africa, Eskom's publicly available Generation Connection Capacity Assessment turns complex network data into a standard, regularly updated map of where transmission capacity exists, letting developers identify feasible connection points early

and steering investment toward the prime Northern, Eastern and Western Cape resource zones. Kenya's rising wind and solar shares toward 2030 have made stronger forecasting and system operation a precondition for maintaining grid stability.

Scaling solar, on the evidence, is as much a matter of the digital control of the grid as of the panels connected to it.

What this investment produces is hosting capacity. And hosting capacity, at system level, is market size. Every megawatt of solar the grid can absorb without instability is a megawatt the utility can competitively procure, which is what converts the economics

of the utility-scale chapter from potential into pipeline. The same visibility determines when grid-connected EV charging becomes dependable, and therefore the long-term pathway on which the e-mobility chapter's buses and passenger fleets rely. It is also what allows regional power pools to trade surplus solar across borders instead of curtailing it. A grid that can see itself is the difference between solar treated as a complication and solar priced as the system's cheapest resource.

6.4.3 Geospatial planning and least-cost electrification: targeting solar where it pays

The third lever is digital geospatial platforms. These platforms move planning from resource screening to system screening: a site with excellent irradiation may still be a poor investment once interconnection distance, congestion, land constraints, and demand are considered. Integrated tools identify the locations that minimise total system cost and answer the prior question of whether grid extension, a mini-grid, or a standalone system is the least-cost route for a given community. That single capability is what allows resources to be spent on connections that last rather than on projects that strand.

Nigeria's USD750 million, World-Bank-backed DARES programme shows the approach end to end: the Odyssey platform integrates VIDA vulnerability maps to identify eligible areas, verify project locations, and calibrate subsidies, with the programme targeting 17.5 million people, already reaching 5.3 million by 2025, and leveraging over USD1 billion of private capital. Rwanda's National Electrification Plan uses

geospatial algorithms to map existing coverage and least-cost expansion pathways, and open platforms such as WRI's Energy Access Explorer standardise these inputs across markets from Nigeria and Kenya to Zambia and Tanzania. At continental scale, ESMAP estimates solar mini-grids could serve roughly 490 million people through more than 217,000 mini-grids by 2030, with costs falling toward USD 0.20/kWh, the same last-mile terrain from which roughly half of Mission 300's connections are expected to come, and where its Zafiri equity vehicle is being deployed to crowd in developers.

The private market has already shown the demand is real when the delivery model is digital: M-KOPA's pay-as-you-go solar (metering usage and collecting small daily instalments over mobile money) has reached over 7 million customers and disbursed more than USD 2 billion in financing across five markets, extending formal credit to households that banks had written off. For a finance ministry, the significance is concrete: data-driven planning is the difference between subsidising sites that fail and directing scarce capital to where it unlocks the most access per dollar.

The deliverable here is avoided misallocation: the single most shared asset in this report. One national geospatial platform answers four chapters' siting questions at once: where grid extension beats mini-grids and where it never will (the last-mile chapter's three-segment logic); where irrigation demand, groundwater and solar resource overlap into viable Off-Grid PUE Zones (the agriculture chapter); where swap stations and charging hubs find anchor demand (the e-mobility chapter); and where utility-scale plants connect at least cost. The result is a dividend every technology that draws on the same map ends up sharing, not one that accrues to any single programme.

6.4.4 Transparent digital procurement: lowering the cost of capital

The fourth lever is transparency. Investors do not price technology risk alone; they price the risk of a slow, discretionary or opaque process too, and they respond by walking away or by adding a premium. Digital procurement platforms remove that premium by changing the informational structure of tendering: standardised documents, published timelines and clarification logs, secure submissions, and auditable award decisions. Every bidder gets the same information at the same moment, and the room for discretion or renegotiation shrinks.

The World Bank and IFC's Scaling Solar programme produced the effect with standardised, bankable contracts and a one-stop package of finance, guarantees and insurance; Zambia's first auction delivered a then-record USD 0.06/kWh, and the

programme's own review identified scale, transparent competition, a bankable contractual framework, and repetition as the decisive factors. Morocco's MASEN runs a dedicated e-tendering platform to the same end, and Uganda's GET FiT programme did the same for smaller projects: using standardised, pre-approved PPAs and payment guarantees to push a 122 MW portfolio of small hydro and solar to financial close and create roughly 11,700 jobs, showing that the approach scales down to the distributed level as well as up.

Transparency, on this evidence, is not a compliance formality. It is the most affordable available instrument for lowering the cost of capital, and therefore the tariff that citizens ultimately pay. It is also the kind of transparent, bankable pipeline the compacts now commit their signatories to build.

This is a cost-of-capital instrument wearing administrative wrapping. Opacity in tendering is not free; it is

priced into the risk premiums African clean-energy projects borrow at, and into the years projects wait for closure.

Transparent, digital procurement compresses that premium for every asset class at once. It is how utility-scale auctions reach affordable tariffs. It is how aggregated mini-grid portfolios become investable products rather than dispersed pilots. And it is how the subsidy programmes behind connections, solar pumps and clean-cooking appliances come to pay for verified results, not promises. It is also the compact Pillar 4 commitment outside investors can verify from their desks, which makes it the cheapest signal of reform credibility a government can send.

6.4.5 Digital public infrastructure and open data: trust and coordination at scale

The last is full-stack digital public infrastructure. Solar markets require utilities, regulators, ministries, land authorities and system operators to share data and act in sync. Where they rely on disconnected systems and opaque interfaces, transaction costs rise, and confidence falls. Digital public infrastructure (DPI) (shared identity, payments and trusted data exchange, all governed by clear rules) provides the common rails on which sector-specific services can be built, much as digital identity and payment systems have already reshaped public services more broadly across the developing world.

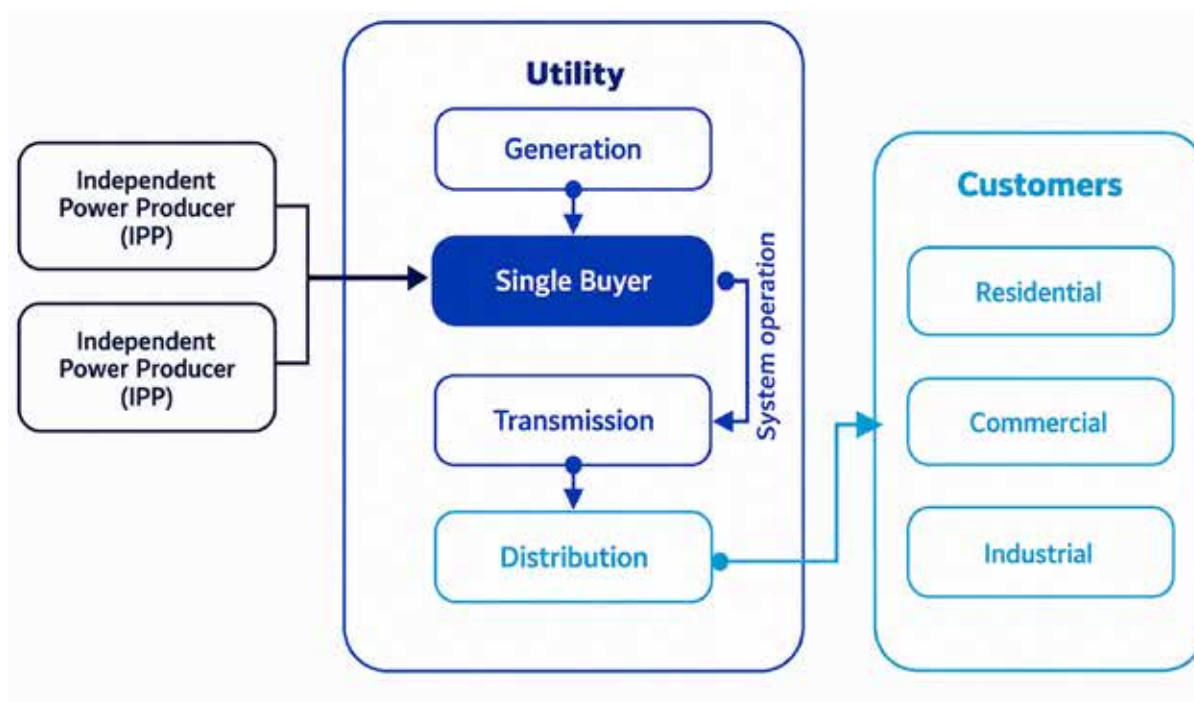


Figure 6.5: The single-buyer PPA model, whose bankability depends on a creditworthy, digitally enabled utility

Source: ISA & RCREEE Analysis

Egypt's PV-Hub brings installers, procedures, costs, certified firms and grid-connection tracking into one place, cutting the information asymmetry that has slowed the small-scale solar market. Eskom's open capacity data turn fragmented datasets into shared planning inputs. The International Solar Alliance is assembling this financing-and-data layer at scale: its Global Solar Facility deploys payment guarantees and blended finance to de-risk exactly the weak-offtaker markets described earlier, with an Africa Solar Facility (about USD 200 million, managed by Africa50) aimed at unlocking some USD 10 billion of investment and clean-energy access for 35–40 million households, while its STAR-C centres build the local capacity to operate these systems. These initiatives are further supported by the Global Mission on AI for Energy and the ongoing digitisation of utilities, which strengthen data-driven planning, system management, and investment decisions. Viewed together, mini-grids and DPI platforms are two expressions of the same underlying idea: digital infrastructure that makes trust and therefore investment possible.

What DPI delivers, ultimately, is trust at transactional scale: the operating condition of any distributed energy economy. Shared payment rails are what let a smallholder pay for irrigation-as-a-service, a rider pay per battery swap, and a household pay off a solar home system or an electric cookstove in daily increments. Open data is what lets thousands of developers, lenders and regulators transact without bilateral due diligence. This is the infrastructure on which the report's demand-side markets (productive use, e-mobility, clean cooking) actually clear, and on which the CPR's twice-yearly monitoring can draw live data instead of retrospective estimates. Where DPI exists, every other chapter's business

model runs cheaper; where it does not, each must build its own rails, and most never do.

One digital investment, four markets. Each lever above earns its return outside this chapter as well as within it. Revenue assurance is what turns a utility into the creditworthy offtaker that utility-scale power purchase agreements depend on. Geospatial least-cost planning is the same national dataset that sites mini-grids and rooftop portfolios, designates productive-use zones for solar irrigation and cold chains, and identifies where charging infrastructure will find demand. Grid visibility and forecasting determine how much solar the system can absorb and whether electric-vehicle charging can be depended upon. Transparent digital procurement lowers the cost of capital for every asset class simultaneously. And digital public infrastructure (payment rails, identity, open data) is what allows a smallholder to pay for irrigation as a service, a rider to pay per battery swap and a household to pay off a solar home system in daily increments.

Solar-powered electric mobility illustrates the dependency most clearly: swap networks, depot charging and public hubs all rely on metering and digital payment platforms to bill customers, on telematics and charging-management systems to manage assets remotely, and on customer data to underwrite financing for operators without formal credit histories. Managed charging (shifting demand towards the midday solar peak using the same digital control systems) is also the cheapest way to prevent clustered charging from stressing weak distribution networks, turning a potential load problem into system value.

The framing matters for sequencing and for measurement alike. Digitalisation deployed on its own produces dashboards over a failing system: metering without tariff reform digitises under-recovery, and SCADA without governance digitises dysfunction. Deployed together with tariff reform, utility governance and investment mobilisation (as the compacts do by design, pairing Pillar 5 metering commitments with tariff and governance reform in the same signed document), it is the multiplier that turns each reform into revenue, and revenue into deployed solar.

6.5 Way forward

The enablers work best in sequence, not in isolation. Digital capability can be structured in four connected layers: data foundations (smart metering, feeder monitoring, SCADA, geospatial datasets); integration (interoperable platforms, cloud infrastructure, APIs); analytics (forecasting, optimisation, hosting-capacity analysis); and market interfaces (e-procurement, digital payments, open-data portals). Each layer enables the next and building the foundations before the advanced functions avoids the fragmented, pilot-by-pilot

investments that rarely produce lasting system-wide impact.

The reform pathway is therefore phased, not merely technical. It runs from data foundations to core systems and integration, to advanced planning and market-facing platforms, and finally to scaled, transparent digital markets. Each stage creates the conditions for the next, and the returns compound. The

countries moving first are converting the same solar resource into lower tariffs, faster access and larger flows of private capital, while those that delay keep paying the hidden cost of losses, leakage and investor caution.

The conclusion is direct. Digitalisation is the precondition that turns Africa's solar potential into bankable, scalable deployment, and initiatives such as the International Solar Alliance and Mission 300 exist to finance and scale it. The resource is settled; the technology is affordable; what remains is the institutional and digital capacity to make it investable.

ACTOR	IMMEDIATE — Establish foundations Priority actions to unlock deployment	MEDIUM TERM — Build systems & scale Deepen coordination across actors	LONG TERM — Sustain & optimise Embed enabling environment at scale
Head of State / Cabinet	Declare digitalisation & cyber resilience as a strategic priority Set tier-specific loss targets	Approve Smart Grid Regulation & smart metering mandate Budget carries loss-reduction & smart-meter metrics	Smart-grid performance as a standing national measurable Utility financial sustainability achieved
Ministry of Energy, ICT & Finance	Commission utility IT / OT digitalisation audit Smart-metering & SCADA plan cyber & data baseline	Gazette Smart Grid Regulation; mobilise first capital Launch AMI rollout & GIS programme	Digitalisation self-financing via loss recovery Data feeds national energy statistics
Energy Regulator / Data Authority	Smart-meter specs, data-privacy & cyber rules Interoperability & open-data standards; loss targets	Tariff recovery + time-of-use & net metering Smart-grid desk, KPI dashboard & IEC standards	Digital consumer address & data-quality assurance Annual review; API third-party access
National Utility / DISCOM	GIS mapping, SCADA feasibility & comms assessment Define 5 tracks (AMI/SCADA/GIS/CIS/analytics); CDO + cyber cell	1M smart meters; SCADA at 3+ substations; GIS 50% Centralised data platform & customer app live	AT&C losses ↓5%, revenue ↑20%, SAIDI ↓30% Full smart grid + regional SCADA integration
Technology Provider / System Integrator	Supply smart meters, SCADA & GIS to standards Build comms backbone; local IT/OT skilling via STAR-C	Deploy AMI by feeder; integrate SCADA / DMS Roll out analytics & solar-forecasting platform	AI / ML predictive maintenance & forecasting Quantum-safe cyber; interoperable open data
Financier / DFI / ISA	Activate sovereign-DFI partnership framework Design performance-based smart-meter facility	First tranche tied to verified loss reduction Smart Grid Green Bond framework live	Repayment self-funded by loss reduction DFI exits as domestic capital takes over

Figure 6.6: Digitalisation pathway for solar deployment

Source: ISA & RCREEE Analysis



Capacity building: strengthening institutions and skills for scalable solar deployment in Africa

7.1 Why capacity building matters for Africa?

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The bottleneck on Africa's solar programme has shifted. It is no longer technology: **pilots across the continent have shown that every segment this report examines works and pays back.** It is no longer, at this point, purely capital either; commitments are being made at unprecedented scale, and private-sector targets are now written in whole countries rather than in individual projects. **What decides whether that capital converts into connections is narrower and less visible.** It is whether institutions can plan, procure, regulate, deliver and sustain energy programmes at national scale.

This chapter argues that institutional and human capacity is that binding constraint and that the stakes go beyond delivery rates. Capacity determines who captures the value of the transition. ISA's Solar PV Skills and Jobs in Africa (2025) puts Africa's potential at 2.5 to 4 million solar jobs by 2050, with small-scale PV

driving most of the employment and technician roles making up the largest share. Whether those jobs are African depends on whether the workforce, the training institutions and the manufacturing and service value chains sit on the continent or are imported from elsewhere. On that reading, capacity building is not a support function to a solar agenda. It is the mechanism by which a solar agenda turns into an industrial and employment strategy, rather than remaining a procurement exercise.

7.1.1 Capacity is what makes replication possible

Every chapter of this report closes with a model worth replicating: Nigeria's DARES, Uganda's cooperative agri-solar, Kenya's e-mobility ecosystem, Zambia's procurement reform. Replication is not automatic. It requires an institution that can adapt a model to its own conditions, procure it credibly, regulate it coherently and monitor it honestly. Where that institution exists, a proven model transfers in months. Where it does not, the same model gets piloted repeatedly and never scales. That is the difference capacity makes: it is what turns a good idea into a national programme.

7.2 Current barriers to institutional and workforce capacity

Consultations for this report identified four structural constraints, all of them common across markets at very different stages of development.

- **Governance fragmentation.** Responsibilities for renewable energy are spread across ministries, regulators, utilities, rural electrification agencies and investment promotion bodies. Without clear mandates and a working coordination mechanism, decisions stall in the space between institutions, accountability blurs, and implementation becomes inconsistent, a pattern visible in the delayed reform actions examined below.
- **Policy frameworks that exist on paper only.** South Africa, Morocco and Egypt run clear solar procurement schemes with the institutional machinery to make them work. In many other markets, ambitious solar targets sit

alongside limited technical staff to implement them, limited procurement capability to tender them, and no regulatory capacity to license them. Private investors read that difference immediately.

- **Regulatory capability that lags the technology.** Regulators set most of the market conditions discussed throughout this report: tariff structures, licensing regimes, interconnection rules, net-metering frameworks, quality standards, consumer protection. Yet regulatory institutions are typically the least-resourced actor in the sector and are asked to rule on mini-grid tariffs, battery-as-a-service arrangements, rooftop aggregation and charging tariffs without dedicated technical staff for any of it.
- **A workforce pipeline far below the requirement.** Technical and vocational systems are not producing the volume or the specialisation the transition needs: in installation and O&M, battery systems, grid integration, data and geospatial analysis, or the trades that keep distributed assets running after commissioning. 13 STAR-C centres are operational against a target of 50.

7.3 Mission 300: capacity as the binding constraint on compact delivery

Mission 300 gives the capacity agenda of this chapter a concrete institutional target. Every National Energy Compact is executed through a national Compact Delivery and Monitoring Unit (CDMU) that reports progress twice a year against dated reform actions.

The pattern of delay is, in effect, a continental capacity map. The differentiator is rarely money alone. It is planning units able to run least-cost models, procurement teams able to execute competitive tenders, regulatory drafters able to convert commitments into gazetted rules, and data systems able to feed the monitoring cycle: exactly the policy, regulatory, financial and data skill areas this chapter prioritises.

The phased roadmap that follows should therefore be aimed deliberately at compact delivery: CDMU staff and reform-action owners should be treated as priority training cohorts, with ISA's STAR-C network and the train-the-trainer strategy as delivery vehicles; the proposed Continental Capacity Building Information System should be interoperable with the Compact Progress Report cycle so that training supply follows demonstrated delivery gaps; and every delayed reform action should be read as a capacity diagnostic: a named institution, a dated obligation, and a specific skill deficit that a targeted intervention can close.



Table 18: Mission 300: Progress, Gaps and Priority Enablers for Scale-Up

National Energy Compact commitments	Where the continent stands	Gap to close	Closing enabler
CDMU delivery architecture and dated reform actions in all 35 compacts	Actions delayed in the Q1-2026 cycle; delays concentrated in planning, procurement and regulatory drafting	Delivery-unit skills: least-cost modelling, competitive tendering, gazetting, monitoring data	'Training Needs Prioritisation' + CDMU/reform-action-owner cohorts (this chapter); ISA Solar PV Skills & Jobs in Africa 2025 as the evidence base
Jobs, gender and youth mainstreamed	ISA estimates 2.5-4 million solar jobs possible by 2050 - the pipeline to fill them barely exists	Training capacity: 13 STAR-C centres today versus 50 targeted; TVET curricula lag technology	'Target Beneficiaries' and 'Training Delivery Methods': STAR-C expansion 13 to 50, train-the-trainer, gender-responsive programmes (AFAWA, ECREEE)
Institution-building with dates (Zimbabwe Energy Planning Unit by Q2 2026)	Consultant dependence persists; knowledge leaves when contracts end	Permanent national delivery structures (NSDUs) and train-the-trainer models	'Institutional Strengthening for Delivery': NSDUs with mandates and decision access; utilities as delivery agencies; AFUR/EREA regulatory partnerships
Institutional reform embedded in every compact pillar	This report's consultations: capacity is the primary bottleneck; consultant dependence hollows out institutions	Ecosystem-level capability, not individual training	'Institutional Strengthening for Delivery': utilities as delivery agencies; national long-term technical-assistance model
Pillar 2 regional integration commitments	Fragmented standards: credentials not recognised across borders	Cross-border certification and mutual recognition	'Institutional Partnerships': ECSES regional certification model; South-South learning missions; AFUR/EREA exchanges

Source: National Energy Compacts submitted by African countries

Two things stand out. First, the constraint is not money. Tanzania and the Democratic Republic of the Congo signed the same instrument, built on the same five pillars, with financing aligned behind both, and one has four delayed actions while the other has completed none. Second, the delays cluster in identifiable functions: least-cost planning, competitive procurement, regulatory drafting and gazetting, and monitoring data. And those are exactly the capabilities a capacity programme can build.

What needs to be done?

Table 19: Summary of actions to be taken for mitigation of Gaps

National Energy Compact commitments	Where the continent stands	Gap to close	Closing enabler
CDMU delivery architecture and dated reform actions in all 35 compacts	Proper planning concentrated in procurement and regulatory drafting	Delivery-unit skills: least-cost modelling, competitive tendering, gazetting, monitoring data	Training-needs prioritisation with CDMU staff and reform-action owners as the first cohort; ISA Skills and Jobs evidence base
Jobs, gender and youth mainstreamed across all 35 compacts	2.5–4 million solar jobs possible by 2050; the training pipeline to fill them barely exists	Training capacity and curricula that track technology	STAR-C expansion; train-the-trainer; gender-responsive programmes
Institution-building with dates	Consultant dependence persists; knowledge leaves when contracts end	Permanent national delivery structures with mandate and decision access	National Solar Delivery Units; utilities as delivery agencies; long-term technical-assistance model
Pillar 2 regional integration commitments	Fragmented standards: credentials not recognised across borders	Cross-border certification and mutual recognition	ECSES regional certification model; AFUR and EREA exchanges; South-South missions
Institutional reform embedded in every compact pillar	Capacity identified in consultations as the primary bottleneck across all chapters	Ecosystem-level capability, not individual training courses	Institutional strengthening across ministry, regulator, utility and delivery unit

Source: National Energy Compacts submitted by African countries

7.4 Priority enablers to accelerate deployment

Capacity building fails when it is delivered as a series of workshops. It works when it is designed as an ecosystem intervention, with a named institutional target, a defined cohort, and a measurable delivery outcome. Five enablers follow, sequenced from most immediately actionable to most structural.

7.4.1 Focus on the delivery institutions first

The fastest return on capacity investment comes from the people already accountable for signed obligations. CDMU and STAR-centre staff, together with the reform-action owners named in each compact, should be treated as the priority training cohort, because their own delay data already identifies which competencies are missing. A country reporting delayed procurement actions needs procurement training. One reporting delayed regulatory drafting needs legal-drafting support. One reporting missing baselines needs data and monitoring capability. This turns the CPR from a compliance exercise into a diagnostic that directs training supply to demonstrated demand, twice a year, in public.

Sequencing beyond the delivery units and STAR-C then follows the value chain: technical experts and engineers who design and supervise projects; project developers and financial analysts who prepare bankable proposals; and then policymakers and regulators, whose decisions set the conditions for everyone else. The regulatory cohort deserves particular emphasis. Regulators are asked to rule on mini-grid tariffs, rooftop net-metering, battery-as-a-service structures and charging tariffs, each of them a novel question, typically without dedicated technical staff to answer it. Building regulatory capability is among the highest-leverage interventions available, because a single well-drafted framework unlocks an entire market segment.

7.4.2 Build the workforce pipeline at the scale the transition requires

Priorities should follow the identified gaps rather than the availability of trainers. Seven skill areas recur across the chapters of this report.

- **Technical and engineering:** System design, installation, commissioning, grid integration, storage and O&M, across both utility-scale and distributed contexts, with hands-on laboratory and field components.
- **Policy, regulatory and governance:** Procurement frameworks, tariff design, off-grid and rooftop regulation, licensing, environmental and social assessment.
- **Financial and investment:** Bankability assessment, blended-finance structuring, risk analysis, access to climate funds, and micro and MSME finance for distributed entrepreneurs.

- **Digital and data:** Energy data analytics, GIS-based resource and least-cost mapping, metering and revenue-assurance systems, SCADA operations: the skills without which the digitalisation chapter's levers cannot be operated.
- **Entrepreneurship and enterprise development:** For the local firms that install, maintain and finance distributed systems, including the delivery-model capabilities that determine whether off-grid businesses survive.
- **Productive-use and sector-specific skills:** Agri-technicians for irrigation, cold chain and processing; EV technicians and battery specialists for the mobility segment; both currently near-absent outside a handful of markets.
- **Leadership, communication and project management:** The soft capabilities that determine whether technically sound programmes are delivered.

Delivery format should follow purpose: seminars, workshops, in-person courses, field placements or online modules. And scope should follow need, with foundational training prioritised in markets with limited capability, and advanced grid-integration and export-oriented programmes for those with mature value chains. Instruction in Arabic, French and Portuguese alongside English is a practical precondition, not a courtesy. Through all of this, the train-the-trainer model is what makes the investment compound: it builds a domestic teaching base rather than a lasting dependency on visiting instructors.

Women should be treated as priority beneficiaries and active agents of the transition, not as end-users. Gender-responsive programmes across the value chain are what unlock that participation: at continental level, IRENA's Women in Energy Network, SEforALL's Gender and Energy Compact and the African Development Bank's AFAWA; regionally, ECREEE's Women in Sustainable Energy programme and GIZ's EnDev. National workforce strategies should embed gender-inclusion targets backed by mentorship, dedicated scholarships and partnerships with universities and vocational centres, and, as Comoros' compact shows, those targets can be written into national energy commitments directly.

7.4.3 Move capability into permanent institutions

Training individuals without strengthening the institutions that employ them produces skilled staff who leave. Three institutional shifts turn individual competence into organisational capability.

- **Utilities as delivery agencies.** Utilities need to develop internal capability under a national, long-term technical-assistance model, built with local universities and TVET centres. In capacity-constrained markets, urgent support

is needed to develop internal solar engineering, metering and project-management functions: the same functions on which the digitalisation chapter's revenue-assurance agenda depends.

- **Regulatory capability and adaptability.** Fragmented mandates and slow rule-making can be addressed through structured regional partnerships: the African Forum for Utility Regulators as a coordination platform, alongside the Energy Regulators Association of East Africa, and drawing on the STAR-C network and the Southern African Power Pool as a working model of regulatory practice.
- **Dedicated delivery structures.** National Solar Delivery Units need three things to function: a clearly defined mandate, institutional stability, and direct access to decision-making authority. Where they exist, they are the link between policy and implementation. Where they are advisory only, they become another coordination layer. Zimbabwe's commitment to establish an Energy Planning Unit is the model to watch, and it should be interlocked with the CDMU rather than run in parallel.

7.4.4 Make regional learning the default, not the exception

Africa is not a single market, and capacity strategies should not assume it is. Access rates range from under 20% to over 90%. Some systems are grid-dominant and others DRE-led. Regulatory traditions, languages and fiscal conditions differ profoundly. The practical consequence is that the most transferable expertise is usually regional rather than international: a regulator in

one African market has typically solved a version of the problem another faces, in comparable legal and fiscal conditions, more recently than any external adviser could have.

Structured peer exchange should therefore be a primary delivery mechanism, matched by market typology rather than geography (grid-dominant against DRE-led, high-access against low-access, anglophone against francophone and lusophone), so that the country being learned from has genuinely faced the conditions of the country learning. Three mechanisms carry the exchange: peer-learning missions to operational projects, regulatory exchanges that move policy and governance frameworks across borders, and developer matchmaking that builds cross-border partnerships. A centralised digital portal should aggregate the tools, data, lessons and programme resources these mechanisms generate, and it should be interoperable with the CPR cycle so that training supply follows demonstrated delivery gaps.

Lessons from comparable transitions outside the continent are equally usable, provided they are read as delivery lessons rather than templates.

India is the closest analogue in scale and starting conditions: it took 132 months to install its first 50 GW of solar and 14 months for the next 50 GW, a nine-fold acceleration achieved with the same technology and the same geography. What changed was institutional. A dedicated central agency aggregated demand and ran competitive reverse auctions, shifting offtake risk away from individual developers and driving tariffs to record lows. Financing was engineered around the end user, with farmers under PM-KUSUM paying a small share of upfront cost through blended subsidy and concessional credit. Skills and domestic manufacturing were built alongside deployment rather than after it. The transferable content is the sequencing: institutional clarity first, aggregation and competitive procurement second, end-user finance and skills in parallel. Moving exactly this kind of applied experience between member countries is the purpose of ISA's Communities of Practice and STAR-C network.

7.4.5 Measure delivery, and retain the people who deliver

Monitoring must go beyond counting participants. Trainees, sessions and geographic coverage are necessary indicators, but the measures that matter are institutional: reform actions completed, procurement rounds run without external support, regulations drafted and gazetted domestically, and monitoring data submitted on time. Pre- and post-training assessment, participant feedback and published site-level results turn a programme into a learning system, and every programme should be designed against SMART criteria: specific, measurable, achievable, relevant and time-bound.

None of this survives brain drain.

Capacity investment must be matched by the economic and educational reforms that retain skilled talent: competitive public-sector terms for

technical staff, career paths inside delivery institutions, and a domestic project pipeline substantial enough to absorb graduates. A trained workforce that leaves for another economy is a direct transfer of Africa's capacity investment to that economy.

7.4.6 Case Study

Case Study 1 : The PESEREE Program (Programme pour l'Enseignement Supérieur en Énergies Renouvelables et Efficacité Énergétique, Sénégal)

a) Problem Statement

Senegal faced a critical gap between academic training and labour market needs in the renewable energy (RE) and energy efficiency (EE) sectors. University curricula were theoretical, producing graduates with limited practical skills. As a result, the employment rate was low, while the country is still relying on external experts to plan, install and maintain renewable energy infrastructure.

b) Implementation

PESEREE, launched in 2015 with a USD 17 million investment, was designed to bridge this gap. Key implementation steps included:

- **Curriculum reform:** Reorienting university programmes toward applied learning, with specialised courses in solar technologies, energy auditing, and grid integration.
- **Certification development:** Establishing a 'Professional License in Renewable Energy and Energy Efficiency' to provide industry-recognised credentials.
- **Hands-on training:** Upgrading laboratories, supporting applied research, and embedding internships into degree programmes.
- **Faculty development:** Training educators through 'Train-the-Trainer' models and fostering international academic partnerships to ensure sustainable knowledge transfer.

c) Key Stakeholders and Roles

- **Senegalese Ministry of Higher Education:** Oversaw programme design and integration into national education policy.
- **German Development Cooperation (GIZ):** Provided technical and financial support, ensuring alignment with international best practices.
- **Universities in Senegal:** Implemented new curricula, upgraded facilities, and partnered with industry for internships.
- **Industry stakeholders:** Collaborated in curriculum design to ensure graduates met practical workforce needs.
- **World Bank (African Centres of Excellence Programme):** Complemented PESEREE with USD 16 million in STEM-focused higher education strengthening.

d) Impact

The implementation of this program had an impact on different levels:

- **Increase job opportunities:** Significant improvement in job readiness, with graduates entering roles in solar installation, energy auditing, and efficiency consulting.
- **Workforce development:** Implementation of university programme and professional licenses recognised by the industry sector.
- **Institutional strengthening:** Enhanced university–industry linkages and sustainable faculty capacity through ToT models.
- **National Energy Transition:** Contributed to Senegal's broader energy transition goals under its national policies and NDC commitments.

Case study 2: ECOWAS Regional Certification System for Sustainable Energy Skills (ECSES)

a) Problem Statement

Fragmented standards and quality gaps: A major barrier to solar deployment in West Africa was the lack of standardised qualifications for technicians and designers. This fragmentation led to inconsistent installation quality, which undermined consumer trust and made it difficult for financial institutions to invest in projects with confidence. Furthermore, local professionals lacked credentials that were recognised across national borders, limiting their mobility and the growth of a regional energy market.

b) Implementation

A Unified Competency Framework: To address these gaps, the region implemented the ECSES, a voluntary and unified certification system recognised across all 15 ECOWAS member states. The implementation focused on:

- **Standardised job task analysis:** Developing rigorous assessments for off-grid PV technicians, designers, and inspectors based on specific industry competencies.
- **Practical and written examinations:** Establishing standardised testing procedures to ensure that certified professionals possess the hands-on skills necessary for safe and high-quality installations.
- **Accredited training networks:** Strengthening a regional network of examination and training institutions to ensure widespread accessibility to certification opportunities.

c) Key stakeholders and action points

- **ECREEE:** The lead regional body overseeing standards development and the exchange of best practices.
- **Regional Technical Committee:** A body that provides expert oversight and ensures uniformity in certification criteria across member states.
- **National focal institutions:** Local entities that provide expertise tailored to specific country conditions and facilitate upskilling.
- **International partners:** Organisations such as UNIDO and the ISA, which supported the structuring of resource centres.

d) Impact

The programme has successfully created a credential that is respected across the ECOWAS region, facilitating the mobility and employability of certified professionals. By ensuring that solar installations are performed by verified experts, the system has enhanced the quality, safety, and reliability of renewable energy projects. Ultimately, this framework bridges the gap between high-level regional energy strategies and practical, local implementation, fostering a more integrated and competitive sustainable energy sector in West Africa.

Capacity-building initiatives across Africa have produced several success stories, demonstrating how targeted investments in training, education, and industrial development can strengthen the renewable energy sector and bridge critical skills gaps. The following table highlights established models and programmes from Nigeria, Senegal, Ethiopia, and Burkina Faso, showcasing practical achievements that range from specialised training institutes to large-scale industrial operations. The following table summarises the key capacity-building success stories and established models.

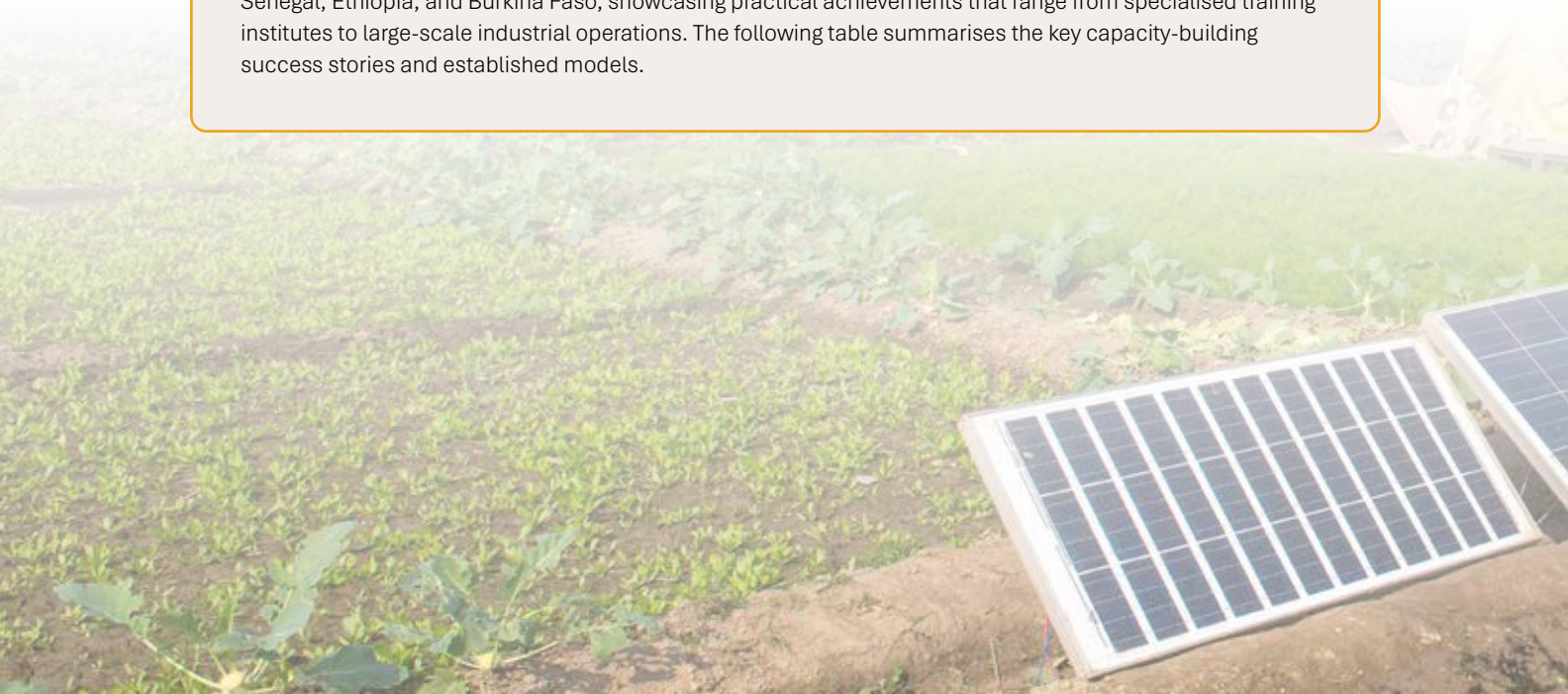


Table 20: Capacity Building: Strengthening Institutions and Skills for Scalable Solar Deployment in Africa

Aspect	Corporate Model	Captive Model
Nigeria	Renewable Energy Technology Training Institute (RETTI)	Provides tailored training across the renewable value chain, specifically focused on solar panel assembly skills.
Senegal	African Centre of Excellence	A World Bank-funded programme with USD 16 million invested to support higher education in science, technology, engineering, and mathematics (STEM).
Ethiopia	Regional Centre of Excellence	A World Bank-funded USD 150 million centre in Addis Ababa is dedicated to technical and professional training to meet regional labour needs in the renewable sector.
Burkina Faso	Faso Energy (Industrial proof of concept)	Successfully established a 30-MW module assembly plant in 2020, demonstrating the country's ability to move from training to active industrial operation.
Morocco	Noor Solar Complex Workforce Programme	Built a domestic solar technician and engineering workforce through IRESEN-linked university programmes, reducing dependence on external solar consultants.
ISA Members States	MTech Fellowship Programme in Renewable Energy Technologies and Management at the Indian Institute of Technology (IIT) Delhi	Provides technical and managerial training for Mid-Level career professional in government institutions across ISA member countries. The program has graduated 6 batches with a minimum of 15 professionals in each batch. Batch 7 and 8 are currently undergoing in-person trainings at IIT Delhi' campus in India.
ISA Members States	Establishment of STAR-C (Solar Technology and Application Resource Centres) in Universities and Public Training Institutions in member countries	The ISA, through the Country Partnership Framework, is currently establishing STAR-C in countries that indicate interest with a minimum target of about 50 countries. The STAR-C is an ISA-UNIDO project that enhances institutional, technical and networking capacity of member countries for accelerated deployment of certified solar energy thereby ensuring energy security.

Source: ISA & RCREEE Analysis

7.5 Way forward

The roadmap focuses on a multi-layered workforce strategy that empowers local institutions, from universities to vocational centres, to become primary delivery partners. It begins in Year 1 with a foundation phase that focuses

on assessment, using capacity identification through data collection and institutional mapping to prioritise training needs and address governance fragmentation across Africa's five regions. By moving from strengthening national educational and professional frameworks in Year 3 to advancing regional integration and South-South learning by Year 5, this plan ensures that Africa evolves into a self-sustaining hub for innovation, skills development, and industrial growth.



	Best Practices to Enhance Capacity Building	Professionals learn from successful regional entities
	Cooperation for Cross-Border Learning	Establishing formal bilateral agreements and facilitating expert exchanges
	Cross-Cutting Themes: Frameworks, Risks, Community, Youth, and Women	Integrate global frameworks into technical training while creating standalone programs for community, youth and women
	Integrated Approach to Capacity Development	Use a multi-layered approach involving local universities and international consulting firms to synchronize individual and institutional skills
	Train-the-Trainer as a Capacity Development Strategy	Prioritise “Train-the-Trainer” models to ensure sustainable knowledge replication and reach more localized jurisdictions
	Capacity Building Information System	Launch a Continental Capacity Building Information System featuring a unified database of providers and a central Learning Management System
	Brain Drain and the Key Issue of Talent Retention	Implement holistic economic and political reforms to combat “brain drain.”

Figure 7.1: Phased roadmap overview
Source: ISA & RCREEE Analysis

Phase 1: Laying the foundations

- These are the **crucial first steps** and prerequisites. Without these in place, subsequent actions remain largely ineffective.
- **Establish regulatory and legal frameworks:** Develop enforceable standards for equipment quality, safety, installation practices, and grid integration.
- **Build administrative infrastructure:** Set up dedicated regulatory agencies and reliable data/statistical systems to monitor market activity and workforce needs.
- **Institutional capacity building:** Strengthen the competencies of government officials, regulators, and financial professionals so they can effectively oversee and finance projects.
- **Formal certification systems:** Implement mandatory systems to validate worker competencies by job type and skill level to enhance credibility and mobility.
- **Formalise the informal sector:** Use dedicated frameworks and incentives to upskill and integrate informal installers into the formal economy.

Phase 2: Building and scaling capacity

- Once foundations are set, these solutions should be implemented in **parallel** to create positive feedback between workforce development and market growth.
- **Public-private partnerships:** Leverage combinations of initiatives from the public sector, private companies, and international organisations to share the training burden.
- **Innovative financing for training:** Mobilise impact investment and blended finance to scale training efforts and encourage businesses to invest in employee upskilling.
- **Cross-sector resource pooling:** Align efforts between ministries (e.g., agriculture and energy) to promote gender diversity and link solar PV with other industrial growth.
- **Market-aligned training content:** Co-design curricula with the private sector to ensure graduates have the ‘job-ready’ technical and non-technical skills (like project management) the market needs.
- **Resilient market development:** Ensure a steady pipeline of projects across all segments (utility and decentralised) to absorb and retain the trained workforce.

Phase 3: Futureproofing

- These are **forward-looking measures** designed to prepare Africa for emerging technologies and long-term sustainability.
- **Align technology roadmaps with workforce planning:** Integrate workforce targets for emerging sectors like battery energy storage (BESS), green hydrogen, and recycling into official national strategies.
- **Digital and e-learning platforms:** Leverage digital tools to overcome geographic constraints and reach remote areas with training.
- **Effective exit strategies:** Ensure that international training programmes prioritise ‘training the trainers’ to build local institutional memory and reduce foreign dependency.
- **Anticipate advanced technologies:** Update curricula to include AI applications, smart grids, and digital monitoring tools.
- **Stimulate value chain creation:** Target all segments, including local manufacturing/assembly, repair, and end-of-life management (dismantling/recycling).
- **Regional and international cooperation:** Establish shared regional training hubs and harmonise certification schemes across borders to improve workforce mobility.





Enabling Financing Ecosystem

8.1 Why financing matters for Africa?

8.1.1 Capital and access scarcity

Africa holds 60% of the world's best solar resources, with energy demand projected to grow eight-fold by 2050. The continent's solar market is scaling rapidly, but total installed capacity remains a small fraction of what its resources and demand growth could support.

Despite record installations in 2025, Africa continues to attract a relatively small share of global clean energy investment, even though electricity demand is growing faster than in most regions.

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The economic upside of large-scale solar power deployment is substantial: a fully renewable-powered Africa would save the continent between USD 3 and USD 5 trillion by 2050 (approximately USD 150 billion per year on average) by substituting fossil fuels with renewables. While this transition would require greater upfront investment in infrastructure, the resulting fuel cost savings would be more than double (2.2x) the additional investment required, halving the continent's fuel bills over the next three decades.

However, this required expansion is met with various barriers, financing

chief among them. Africa's financing challenge is not simply about the lack of capital that flows to the continent; it is about a lack of affordable and accessible capital. The volume gap is stark: Africa attracts only 3% of global energy investment, and meeting the continent's growing energy demand requires more than doubling annual investment by 2030. Three-quarters of this would need to be clean-energy focused.

Additionally, investment inflows have been concentrated in certain countries (the 'Big Four' with the largest investment across sectors: Egypt, Kenya, Nigeria and South Africa), largely bypassing the rest of sub-Saharan Africa. For example, as of 2025, USD 13.84 billion of tracked energy investment was concentrated in a handful of countries, with the top ten, led by South Africa, Egypt, Nigeria and Morocco, accounting for 73% of the total. This largely reflects how projects are driven by strong regulatory signals and established infrastructure.

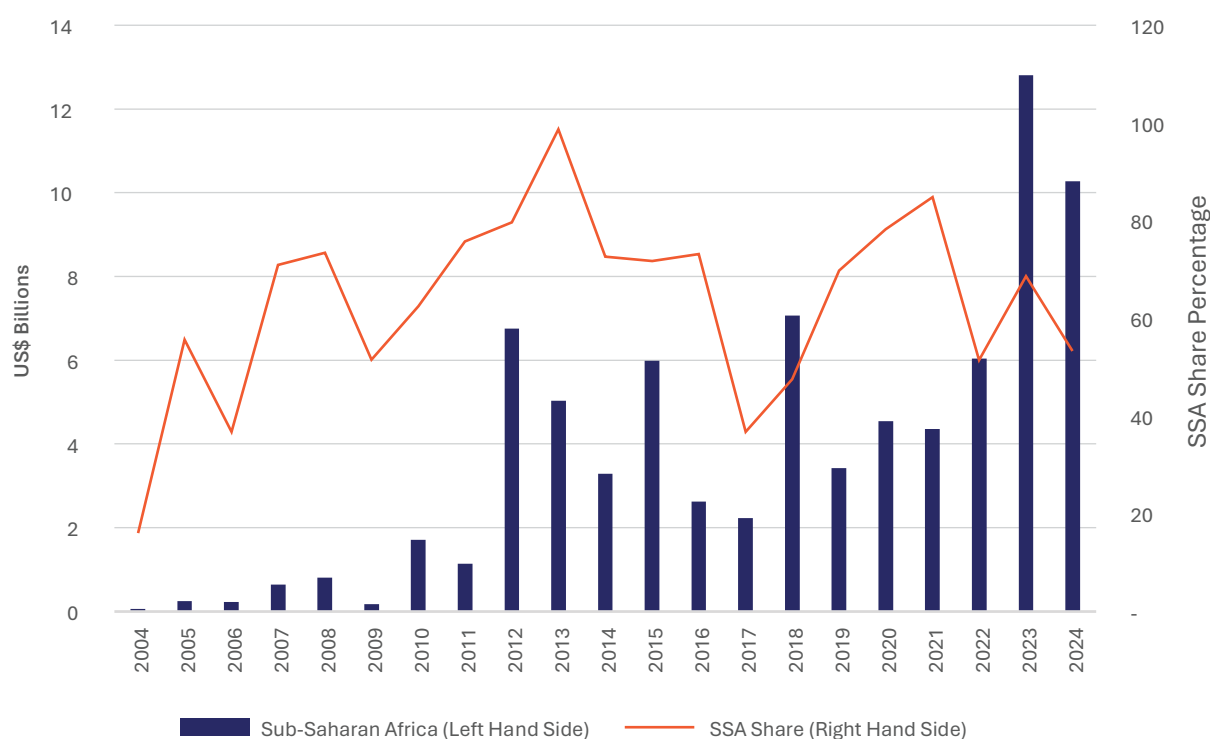


Figure 8.1: Energy transition investment in Africa

Source: BNEF

Of the USD 9.1 billion in cumulative commitments to mini-grid electrification across the continent, only 14 percent (~USD 1.28 billion) has actually been disbursed to date. Understanding the full value chain of finance flows, including how much is committed, from which sources, on what terms, and how much reaches the ground, is therefore central to designing the financing architecture Africa's solar transition needs.

8.1.2 Energy Financing: The Global Picture

Global investment for energy transition technologies was estimated at USD 2.4 trillion in 2024, a 20% increase compared to 2022-23. Investments in RE, grids and storage (USD 1.19 trillion) exceeded fossil fuel investment (USD 1.13 trillion). Energy financing globally combines debt and equity in different ratios depending on the stage of the project cycle. Debt is central to capital-intensive infrastructure, allowing costs to be spread over long tenors, while

equity is essential for smaller, riskier projects and for early-stage development. Solar PV and solar thermal globally have been found to be equity-dominated technologies.

Financing has evolved in Africa, as global markets for solar have become more commercially viable. Between 2012-2024, off-grid solar has attracted over USD 3.6 billion, made up of grants (4%), equity (42%) and debt (55%). However, funding has been limited to certain pockets: East Africa (Kenya, Rwanda, Uganda), followed by Nigeria (West Africa) and Zambia (Southern Africa). Additionally, both sides of this structure are compromised. Equity capital is limited, with many of the equity funds currently active in energy project finance funded by development finance institutions rather than by commercial or institutional investors. Debt is available but expensive: the cost of capital for utility-scale clean energy projects in Africa is at least two to three times higher than in advanced economies and China, and higher still for smaller-scale projects that can only access debt from local commercial banks. In Kenya and Senegal, for example, the weighted average cost of capital for utility-scale solar sits between 8.5% and 9%, compared with 4.7% to 6.4% in North America and Europe. Nonetheless, Kenya and Senegal see lower financing costs than South Africa and other emerging and developing economies including Brazil, India, Indonesia, Mexico, and Vietnam, where the WACC is between 9.5% and 11%. Even these figures understate the private-market rates that domestic businesses face, which often exceed 15%.

Blended finance, where public and concessional capital is combined with private investment to unlock deals that would otherwise not happen, has been widely promoted as a solution to this cost-of-capital problem. Its performance in Africa, however, has fallen well short of expectations. Sub-Saharan Africa's mobilisation ratio sits at around USD 1.80 of private capital for every USD 1 of concessional finance and falls to just USD 0.37 in the continent's low-income countries. By contrast, the IEA's Net Zero Emissions Scenario implies that concessional finance must mobilise between USD 9 and USD 13 of private capital for every dollar committed in order to reach the USD 0.9 to USD 1.1 trillion in annual private investment required across emerging markets by the early 2030s.

Financial sources and instruments

Climate finance in Africa is primarily from public sources (82%), with multilateral DFIs and bilateral flows making up 73% of this share, mostly in the form of market-rate or concessional loans. Within the energy sector specifically, the share of multilateral funding is 21%. Bilateral DFIs focus more heavily on the energy sector, particularly solar PV and, increasingly, grid infrastructure. As of 2024, MDBs committed USD 137 billion in direct climate finance and an additional USD 134 billion mobilised from the private sector.

Private sector participation has increased significantly, especially with global technologies that have become commercially viable, like solar PV. There has been a tripling of private clean energy investment, from USD 17 billion to ~USD 40 billion between 2019 and 2024. However, private finance is also largely concentrated in mature markets (South Africa, Egypt, Nigeria, Kenya, Ethiopia, Morocco, Burkina Faso, Tanzania, Zimbabwe and Ghana). For the larger clean energy sector, 40% has come from venture capital firms to start-ups. This flow, however, has been small toward off-grid solar (only USD 7 billion). The sectoral focus has also not been towards residential access, but towards upcoming areas like EV (USD 70 million in 2023).

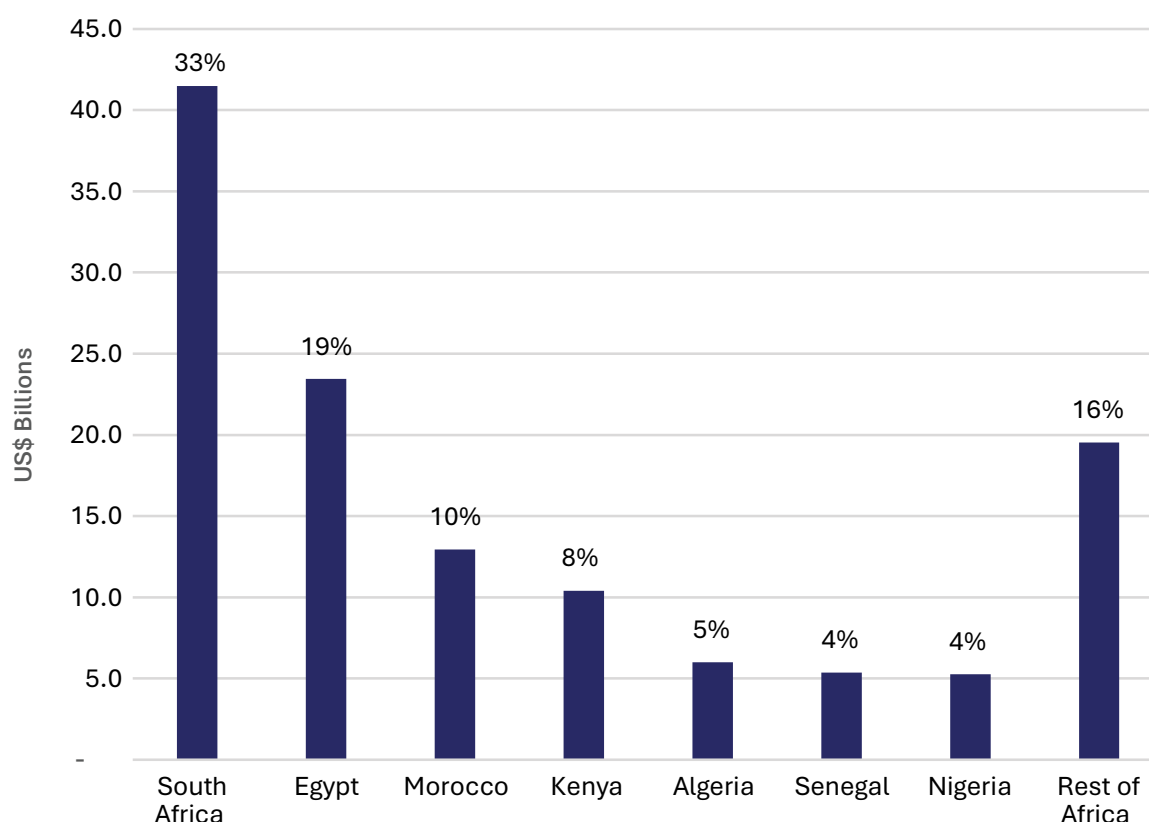


Figure 8.2: Energy transition investment in Africa (2004-2024)

Source: BNEF

8.2 The invisible barriers: macroeconomic, regulatory, market and financial challenges

One of the major challenges observed in Africa is high upfront costs and a high cost of borrowing, at 15-18% compared to developed nations (Europe, US) at 2-5%. This is the case particularly for clean energy investment, while fossil projects (backed by sovereign guarantees) have interest rates of 4-5%.

For every USD 1 invested in fossil fuels, only ~92 cents go to clean energy. It is important to understand the reasons that restrict a larger flow of finance to

clean energy investment in Africa. There is a need to unpack the macroeconomic, regulatory, market and financial challenges. Invisible costs make solar (and RE in general) more expensive on the continent, limiting development. The risks (both actual and perceived) associated with African nations make them less attractive investment markets. Borrowing costs have increased and debt servicing costs are double the costs of clean energy investment. This is compounded by high expenditure on equipment imports, foreign currency risk and currency fluctuations, and investors requiring high returns to offset perceived risks. Credit rating issues and thin capital markets further inflate premiums above actual market conditions, making finance harder to access.

Table 21: Summary of challenges and solutions

Challenge	Issues	Potential Solution	Africa Case Study
Macroeconomic	Public balance sheet/ debt	Debt management	Ghana
	Supply-side imports	Domestic manufacturing	Morocco; Egypt
	Import Tariffs	Regulatory restructuring	Zambia
	Risks - Off-taker risk - FX Risks	- Blended finance - Off-taker guarantees - Sovereign risk insurance - Local currency lending	Kenya
Regulatory	Regulations	Public procurement	Ethiopia
	Electricity tariffs	Time of use tariffs	South Africa
	Fossil subsidies	Subsidy removal	Nigeria
Market and financial	Leveraging finance		ARAF
	Fiduciary framework	Credit guarantees	Nigerian Infrastructure Credit Enhancement Facility
	High-transaction costs	Portfolio aggregation	
	Power sector structure (utilities with large quasi-fiscal deficits)	- Unbundling - Regional trading	

Source: ISA & CETEX Analysis

8.2.1 Macroeconomic

Macro-economic headwinds, in form of weak public accounts, volatile supply chains, energy sector structural barriers and FX mismatch affect solar investments. Investing in solar comes with high upfront cost, expected from the country's public accounts. Public finance for clean

energy investment has fallen by one-third over the last decade. This is driven by high debt distress, with African sovereign debt reaching ~USD 1.13 trillion. IMF found that median debt to GDP ratio for sub-Saharan countries increased by about 30 percentage points (between 2012 and 2022). 23 African countries are in or near debt distress, limiting their ability to invest in renewables. High subsidies for fossil fuels, USD 85 billion in 2024, are also a major contributing factor to debt distress. This debt distress not only affects the lack of public

finances to invest in solar but also puts a risk element for international or private investment due to the risk of default. This adds to the high interest rate offered to projects.

Debt management is, hence, a positive signal that governments can send to investors.

Ghana's recent energy sector debt clearance illustrates this principle in practice. By mid-2025, Ghana's cumulative energy sector liabilities had surpassed USD 3 billion. This was a product of decades of structural imbalances that compounded into one of the country's most pressing fiscal challenges. The 2025 clearance action reversed this trajectory and signalled to investors that the country was prepared to honour its contractual obligations. By the end of the fiscal year, the Government of Ghana had paid approximately USD 1.47 billion in energy sector debts, including arrears owed to Independent Power Producers, and replenished the World Bank Partial Risk Guarantee. The settlement was paired with renegotiated PPAs with major IPPs and a commitment to the disciplined enforcement of a Cash Waterfall Mechanism that ensures revenues collected from electricity consumers

flow systematically to pay for fuel, generation, transmission, and distribution costs in a predetermined sequence. Additionally, the country has launched a USD 4.3 billion renewable energy investment plans, with the aim of targeting private investment. The five-year roadmap specifies the need to expand solar-powered water pumping and 100 charging stations. This debt payoff and clear long-term plans strengthen investor confidence.

Supply-chain risks, driven by import dependency, are a major challenge. Africa's import dependency is due to a lack of manufacturing capacity for solar panels and battery storage technology. This leaves solar expansion largely dependent on other countries, primarily China (see Figure 8.3 below), and hence at risk of supply-side shocks, trade disruptions and export policies. The oil price shocks, especially this year, have resulted in a boom in solar panel imports, exceeding USD 400 million in the first quarter of 2026 (compared to USD 650 million for 2025). Chinese exports have increased by 120% year-on-year. Between 2023 and 2025, solar panel imports from China for sub-Saharan Africa tripled (from 3,734 MW to 11,248 MW). During the Covid crisis, module prices fell from about USD 0.40 per watt in 2019 to USD 0.25-USD 0.32 per watt in 2021. Further, global trade barriers (from the likes of the US and EU) on Chinese solar imports play out favourably for Africa. However, in the longer run, this overdependence could prove risky once prices rebalance. Solar and storage costs are expected to increase by 9%. This is where increasing domestic manufacturing helps: it supports energy security and protects fiscal space. Countries like Egypt (through the Suez Canal Economic Zone), Morocco, South Africa, and Nigeria (to name a few) are increasing their solar and RE manufacturing capabilities to decrease dependence on imported solar panels and provide investor confidence.

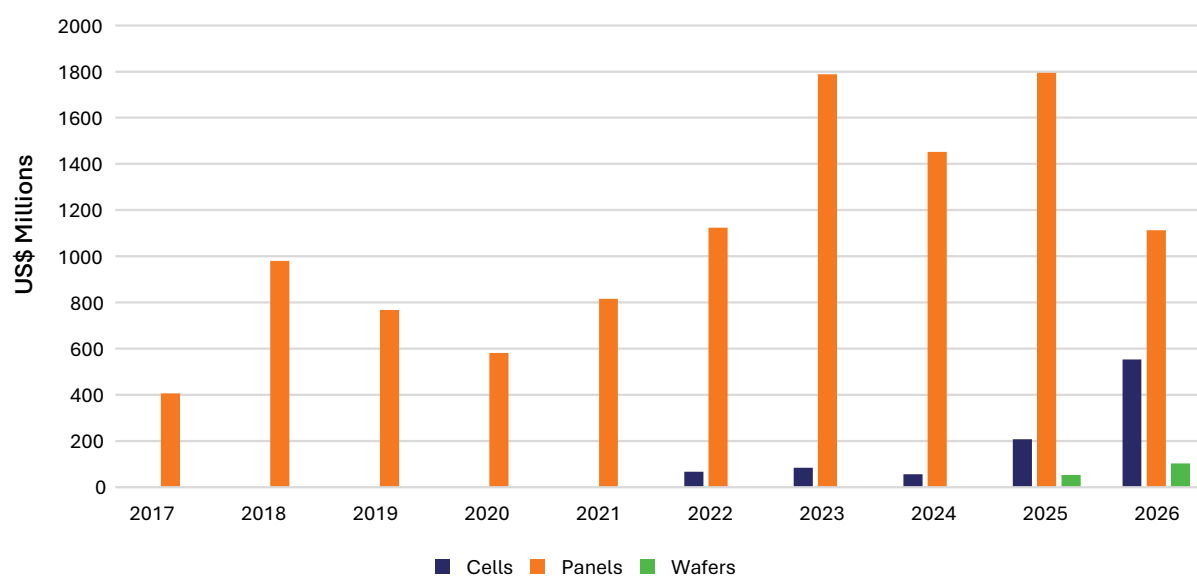


Figure 8.3: Chinese solar exports to Africa

Source: Ember Energy

From a macro-economic lens, regulatory uncertainty also exists in form of import tariffs, and domestic taxes and duties. Countries have complex tariff structures, especially to protect domestic manufacturing. However, balancing regulation is also important: restrictions should not come at the cost of immediate solar capacity expansion. Zambia's structural reform, by removing VAT and import duties on solar panels and fast-tracking agreements with IPPs, supported the surge of solar installation in the country. This was especially necessary given the country's dependence on hydropower, which was affected by the 2023-24 drought. The easing of regulatory barriers resulted in a solar panel boom, growing eightfold year-on-year in 12 months (2025).

The structure of the power sector also plays a role in weakening confidence in investing in African markets. Power sector markets are primarily SOE-dominated, whether unbundled or single-utility models, often carrying high debt with large expenditure on servicing it, and locked into long-term PPAs for fossil energy. Additionally, they need sovereign backing to issue PPAs on RE. Structurally, they have weak grid infrastructure. This impacts uptake of utility-scale solar, where a weak grid with good solar would still be a risky project (with investors fearing it becoming a stranded asset).

International financing into Africa, is primarily dollar-denominated debt from international players and hence the currency mismatch gets highlighted as a larger currency risk. International financing into Africa is primarily dollar-denominated debt from international players, and hence the currency mismatch is highlighted as a larger currency risk. The FX risk for solar arises where revenue generated from projects (which are dollar-denominated)

is received in local currency. Currency devaluation or weak currency stability in these African markets affects the risk portfolio of the project. This is also a cyclical paradigm, where nations vulnerable to external shocks (whether an oil crisis or climate risks) are exposed to higher currency volatility. FX risk plays out not only in finance for implementation but also from importing solar modules and infrastructure (e.g. battery storage). Capital cost requirements factor in this FX mismatch throughout the supply chain, from supplying solar hardware in foreign currency (mostly USD or EUR), to investing in foreign currency, while revenues are generated in local currency. Fluctuating exchange rates further affect the profit margins of investors and hence increase interest rates. Many climate and hedging facilities like The Currency Exchange Fund (TCX) and FX Hedging Facility have been developed to protect investor and developer interests. To address the larger FX issues, there is a need to:

1. Unlock local currency investments, through stronger policies, procurement frameworks and PPAs in local currency.
2. Secure credit risk guarantees through DFIs and domestic institutional investors.

A Kenyan-shilling-denominated securitisation, arranged by Sun King and structured by Citi and Stanbic Bank Kenya in 2025, illustrates the model. Following a PAYGO model, customers pay low amounts (as low as USD 0.19 per day) to get connected to solar systems. Tying these payments to long-term local-currency debt reduces the cost to customers, while also securing investors through predictable revenue streams. This solution not only covers local-currency risk but also mobilises commercial bank capital at scale. An important caveat for PAYGO models is that securitisation depends on companies having a proven repayment record and robust loss monitoring.

8.2.2 Regulatory

Public finance in the form of concessional finance to Sub-Saharan Africa has reached about USD 1.38 billion across 87 transactions. This presents a shallow domestic public finance environment, and hence there is a need for domestic institutional strengthening.

Regulatory uncertainty translates into perceived risk of investing in Africa. Less developed regulatory markets contribute to contractual and project implementation delays, which in turn impact investor confidence. The principal regulatory barrier is institutional fragmentation. Solar deployment cuts across the mandates of the ministries of water, energy, and agriculture, and resolving this institutional fragmentation is a precondition for attracting private sector investment. Several reforms have begun to demonstrate what coordination can look like in practice.

For instance, Ethiopia's Federal Public Procurement Directive 1073/2025 replaces a series of previously disjointed directives with a single unified legal instrument, codifying the end-to-end procurement lifecycle from planning to dispute resolution under one framework, mandating electronic procurement for all public bodies, and embedding sustainability requirements including life-cycle cost analysis.

Beyond institutional coordination, dispute resolution frameworks are a critical dimension of regulatory strengthening. Where contractual disagreements between utilities and independent power producers cannot be resolved through clear domestic mechanisms, disputes can accumulate over years, damaging investor confidence and creating fiscal strain on already-distressed utilities. Zambia's Itezhi Tezhi Power Corporation (ITPC) case is a recent illustration. ITPC is a 120-MW hydropower plant on the Kafue River, structured as a 50/50 joint venture between Tata Africa and ZESCO, the Zambian state utility, with a 25-year off-take agreement between the two parties. Between 2016 and 2022, ZESCO's arrears to ITPC accumulated to approximately USD 784 million, driven by tariff disputes, mathematical and financial modelling errors in the original tariff calculation, and ZESCO's inability to service the growing debt. After a protracted period of dispute, negotiation, and final arbitration, the two parties agreed to restate the account: tariffs were renegotiated and backdated to the 2016 commencement of operations, ITPC wrote off approximately USD 453 million in receivables, and ZESCO made USD 152 million in additional payments, reducing the outstanding debt to approximately USD 179 million. The case underscores the importance of clear contractual guidelines for African power sector agreements, including standardised

tariff calculation methodologies, periodic review mechanisms, and independent verification of performance metrics. Where these are absent, such disputes often recur at significant cost to both parties and to broader investor confidence.

Regulatory risks, in form of inadequate price signals, impact the uptake of renewable energy. The design of the tariff structures distorts the market, failing to incentivise utilities (or consumers) to shift towards cleaner solutions. Electricity tariff structures in Africa are primarily Increasing Block Tariffs (IBTs) or flat-rate tariffs, designed to support the economically vulnerable. IBTs undercut the payback period for solar. Flat tariffs also push for cross-subsidisation, acting as a deterrent to solar adopters (given the large associated upfront costs). More sophisticated tariff designs can create clearer incentives for both utilities and consumers to shift toward solar. Time-of-use (TOU) tariffs charge pre-declared rates that vary by peak, standard, and off-peak periods, while dynamic pricing structures adjust in response to actual grid conditions. South Africa's Eskom has developed a tariff structure that integrates several of the design features referenced above. Its Megaflex and Miniflex tariffs apply to large industrial and commercial customers. They use three time-of-use periods, seasonally differentiated, with a peak-to-off-peak ratio of 6:1. They also include fixed capacity charges, network charges, and explicit cross-subsidy contributions for rural electrification, urban low-voltage supplies, and residential affordability. In 2025, Eskom removed IBT structures from residential tariffs. It also unbundled the domestic Homepower tariff into separate energy, network, and retail charges.

A comparative regulatory assessment of net metering, time-of-use tariffs, and open-access frameworks across six African markets, Ethiopia, Uganda, Rwanda, Kenya, Senegal, and The Gambia - is provided in **Annex VI**.

Subsidies also distort the market, by making fossil energy artificially cost effective. Though the LCOE for solar globally is USD 0.04 to USD 0.044 per kWh, compared with USD 0.069 to USD 0.169 per kWh for coal and USD 0.11 to USD 0.228 per kWh for natural gas, subsidies to fossil fuels cut into the commercial viability of renewables. Subsidies also dig into public coffers, diverting government funds from necessary social spending and, within the energy sector, away from infrastructure upgrades. The strategic move by Nigeria shows the effectiveness of cutting fossil subsidies. Nigeria's 2023 fuel subsidy reform doubled the diesel price, in a country dependent on ~28 GW of distributed diesel. This, complemented by local-currency devaluation, compounded dollar-denominated diesel import costs. Further, the fall in solar costs resulted in rooftop solar installations falling by ~35% between 2022 and 2025. This also resulted in a decrease in the payback period, with savings from diesel imports and subsidies. In most African nations (9 out of the top 10 solar

importers), the import value of refined petroleum is 30 to 107 times that of solar panels. Fiscal management and removal of subsidies is hence another strategic signal that governments can send to investors.

8.2.3 Financial and Market

Creditworthiness is one of the major challenges for investment in Africa. Low credit ratings for off-takers, which are often government-backed utilities, are risky investments for private players. Weak utility off-taker solvency, driven by the existing power market structure, affects investor confidence. This is exacerbated by the country's sovereign rating. As per S&P Global, of the 27 sovereigns rated, only 4 were investment grade. The UNDP estimates that African countries pay a premium of 2.9 percentage points more in borrowing costs as a result. Thirty years of pooled development-bank data (the GEMs Risk Database, 1994–2024) shows private-sector loans in Sub-Saharan Africa defaulting at around 6.05%, the highest of any region, but recovering roughly 78% of value when

they do default, the highest recovery rate of any region and well above the global average recovery rate of 72.9% across all 169 countries in the dataset. Taken together with the UNDP premium figure, this suggests Africa's borrowing costs are priced against default frequency alone, without crediting the strong recovery performance that offsets it. This gap between perceived risk and actual lender losses is the evidence base for the guarantees and blended finance instruments this report proposes. The low credit ratings mark a ceiling for private investors, especially for long-term investments like solar or grid infrastructure. This also feeds into the larger fiscal space, where governments backing investments with higher risk premiums inflate debt costs. Low credit ratings highlight a much bigger systemic issue with how Africa's risk is mispriced.

Local market challenges, given the push for decentralised solar, are not attractive enough for equity funders or institutional investment. Domestic institutional investors, including pension funds, insurance companies, and sovereign wealth funds, represent a substantial but under-deployed pool of capital for African renewable energy. The constraints on this capital are primarily structural and include a lack of appetite for early-stage projects, fiduciary frameworks that favour low-risk assets, and the high perceived transaction cost of every deal. Institutional investors are also constrained in their allocations, committing ~1-2% of their portfolios to infrastructure and minuscule amounts to RE. One way to address these issues without straining public finances is through grants, guarantees and first-loss protections from multilateral climate funds and development banks, which would insulate commercial investors from initial losses. Beyond public balance sheets, estimates



show that Africa holds ~USD 4 trillion of domestic capital: USD 1.1 trillion of institutional capital, USD 2.5 trillion of commercial banking assets and more than USD 470 billion in external reserves. This would lead to an increase in their willingness to commit capital to projects which would otherwise struggle to attract commercial finance. The Acumen Resilient Agriculture Fund (ARAF) demonstrates this model. ARAF is a private equity fund that invests in agricultural businesses across Africa, specifically those helping smallholder farmers cope with climate change. A USD 23 million commitment from the Green Climate Fund (GCF) has protected private investors from downside exposure and mobilised additional commitments from FMO (Netherlands' entrepreneurial development bank) and private foundations. The fund has supported early-stage agribusinesses that have improved resilience for over 3 million smallholder farmers. The model has since been validated by a follow-on fund, ARAF II, which is targeting 20 million additional lives across African smallholder agriculture, demonstrating that catalytic equity structures can be scaled and replicated once their initial deployment has built a credible track record.

The second constraint is the fiduciary framework that governs domestic institutional investors. Pension funds and insurers are bound by conservative capital rules that favour low-risk assets. Credit guarantees are one way to absorb the disproportionate risks that fiduciary frameworks prohibit. The Nigerian Infrastructure Credit Enhancement Facility (InfraCredit) is an example. InfraCredit is a Nigerian institution that guarantees long-term local-currency bonds issued by infrastructure projects, including renewable energy, off-grid power, transport, and telecommunications. It was established in 2017 by the Private Infrastructure

Development Group (PIDG) and the Nigeria Sovereign Investment Authority. InfraCredit has reported consistent year-on-year growth, with net investment and net guarantee income expanding tenfold over the 2017-2022 period. InfraCredit's theory of change rests on three pillars: expanding the market for infrastructure finance, enabling projects to access longer-tenor capital with high impact, and delivering greater access to infrastructure for improved livelihoods. Over 1,000 small and medium-sized enterprises have been supported, and more than one million people have benefited from improved access to infrastructure, with InfraCredit projecting growth to USD 500 million in guarantee capacity by 2026. This demonstrates that locally tailored credit enhancement mechanisms can both de-risk individual transactions and build a durable institutional architecture for mobilising domestic capital at scale.

The third constraint is the high transaction costs that raise the cost of deploying institutional capital into African renewable energy. Individual mini-grids and small commercial projects fall below the deal sizes at which institutional investors can efficiently engage and justify the cost of every due diligence exercise. Two complementary innovations can address this constraint: portfolio aggregation that bundles small projects and local partnerships that enable capital flow. Portfolio aggregation can be undertaken in several ways. For instance, pooled procurement by Nigeria's Demand Aggregation for Renewable Technologies programme allows solar companies to purchase equipment jointly and has led to CAPEX savings of 5-20 percent. Portfolio tendering, used in Zambia, Nigeria, and Madagascar, packages mini-grid sites into investable bundles with longer licence terms. Financial aggregation through securitisation, most notably d.light's multi-currency social impact receivable structures in Kenya and Tanzania totalling USD 490 million, converts future customer payments into tradable securities that can be sold to institutional investors directly.

Taken together, these innovations constitute a coherent strategy for mobilising domestic institutional capital and broadly tackle the market and financial risks.

8.3 Mission 300: matching the financing ecosystem to signed compact targets

8.3.1 What is being done?

The financing ecosystem this chapter describes now has a defined demand side: the National Energy Compacts quantify, country by country, the capital the continent has committed to raise. The asks range from under USD 0.4 billion (Comoros: USD 390 million, Sao Tome and Principe: USD 297 million) to USD 37 billion (DRC), and the private components are explicit –

USD 20 billion for DRC, USD 15.5 billion for Nigeria, USD 9.5 billion for Zambia, roughly USD 9.4 billion for Uganda, USD 8.7 billion for Mozambique, USD 7.6 billion for Guinea and USD 7.4 billion for Burkina Faso.

Reaching the Mission 300 targets will require the World Bank Group to increase IDA financing for the energy sector in Sub-Saharan Africa from USD 3 billion a year to USD 5 billion a year through 2030 to support energy access, sector and utility reforms, as well as generation, transmission and distribution investments. In addition, IFC has committed to increasing its

financing for Africa's energy sector to USD 1 billion per year over the same period.

The first Compact Progress Reports also supply an honest baseline of how far there is to go. By Q1 2026, Zimbabwe led all reporters with USD 687.75 million of cumulative private capital mobilised against a USD 4.42 billion target; Cote d'Ivoire had mobilised roughly USD 1.15 billion against USD 1.94 billion; Burundi USD 137 million against USD 1.54 billion; Tanzania USD 643 million against USD 4.04 billion; Malawi just USD 31.3 million against USD 2.47 billion; and Chad and Niger reported no private capital at all. This gap is not a verdict on the targets: it is a measure of the missing market infrastructure documented in this chapter: high cost of capital, FX mismatch, weak off-taker credit and shallow local financial markets. Closing it is precisely what the instruments proposed here (guarantees as the default architecture, local-currency facilities, results-based subsidy and aggregation vehicles) are for.

Table 22: Current status of financing in select African countries

Country	Private capital target (2030)	Mobilised by Q1 2026	Status till date
Zimbabwe	USD 4.42 billion	USD 687.75m (cumulative 2024-25)	Frontrunner; 50 of 71 actions in progress
Cote d'Ivoire	USD 1.94 billion	~ USD 1.15 bn (cumulative 2024-25)	Well advanced; +3.56 million people connected in 2025
Burundi	USD 1.54 billion	USD 137.1 million	Mobilisation beginning; renewables on track
Tanzania	USD 4.04 billion	USD 643 million (cumulative 2024-25)	Best reform delivery (4 of 53 delayed)
Malawi	USD 2.47 billion	USD 31.3 million	Most actions completed (12), but 28 delayed
Chad/Niger	USD 1.32 billion / ~ USD 527 million	None reported	De-risking instruments not yet in place

Source: Update of National Energy Compacts submitted by African countries

8.3.2 What needs to be done

The compacts have quantified Africa's solar financing challenge with unusual precision. On the demand side, the compacts seek from under USD 0.4 billion (Comoros, Sao Tome) to USD 37 billion (DRC), with explicit private components: USD 20 billion for DRC, USD 15.5 billion for Nigeria, USD 9.5 billion for Zambia, ~USD 9.4 billion for Uganda. On the supply side, Mission

300 aligns up to USD 30 billion of World Bank Group financing, USD 48 billion with the AfDB, USD 6 billion of partner pledges and Zafiri's up-to-USD 1 billion equity vehicle. The first Compact Progress Reports show how far apart the two sides still are:

The mobilisation mathematics do not yet close. The seven largest compact private-capital targets alone exceed USD 77 billion by 2030; the best performer had mobilised USD 687.75 million by Q1 2026, two reporters had mobilised nothing, and blended finance, the designated bridging instrument, leverages USD 1.8 per concessional dollar in SSA (USD 0.37 in low-income countries) against the 9-13x the IEA's net-zero arithmetic requires. Capital that is committed does not flow either: only 14% of USD 9.1 billion in mini-grid commitments has been disbursed.

Table 23: Mission 300: Progress, Gaps and Priority Enablers for Scale-Up

National Energy Compact commitments	Where the continent stands	Gap to close	Closing enabler
Compact private-capital targets: the seven largest alone exceed USD 77 billion by 2030	Q1-2026 mobilisation: Zimbabwe USD 687.75 million (the leader), Cote d'Ivoire ~USD1.15 bn, Malawi USD31.3 m, Chad and Niger zero	An order-of-magnitude shortfall against 2030 targets in most markets	'Structuring an Ecosystem for Finance' (next section): segment-specific instruments for utility-scale, DRE and productive use; CPR delivery evidence priced into country strategies
Blended finance as the compact mobilisation instrument (Pillar 4)	SSA leverage ~ USD 1.8 per concessional dollar - and USD 0.37 in low-income countries	High leverage ratio required	Guarantee-led and blended structures designed toward 9-13x leverage; Global/Africa Solar Facility payment-guarantee architecture; Zafiri equity
Committed programme capital	Mini-grid reality check: only 14% of USD 9.1 billion committed has been disbursed	Pipeline conversion: bankable portfolios, local-currency structures, guarantee cover	Aggregation vehicles, local-currency structures (Sun King KES securitisation precedent) and pipeline conversion to close the disbursement gap
Pillar 4 aims to compress Africa's risk premium	Clean energy borrowing at 15-18% vs 2-5% ; only 4 of 32 rated sovereigns investment grade ; ratings penalty ~2.9 pp	Perceived risk priced above fundamentals	'Risk-mitigation solutions': political-risk insurance, partial risk guarantees, FX hedging (TCX-type facilities)
Domestic resource mobilisation implicit in compact ownership	Majority of climate finance is public ; domestic pension capital sidelined by fiduciary rules and transaction costs	Domestic institutional capital largely untapped	Market/financial enablers (this chapter): fiduciary reform, aggregation, standardised assets, local-currency securitisation (Sun King precedent)

Source: National Energy Compacts submitted by African countries



The financing ecosystem set out below is the closure design for exactly this gap - segmented instruments by asset class, guarantees as the default architecture, local-currency and domestic institutional capital. ISA's role is catalytic on each axis: the Global / Africa Solar

Facility's payment-guarantee architecture converts perceived risk into insurable risk; the Communities of Practice generate the investable national pipelines; and pricing CPR delivery evidence into country strategies, sequencing guarantees toward on-track reformers like Tanzania and Cote d'Ivoire, turns Mission 300's monitoring cycle into the continent's de facto credit-enhancement mechanism for solar.

8.4 Way Forward

The financing needs of solar deployment vary significantly by project type.

For utility-scale clean power, private capital can take the lead, but concessional finance still plays a key de-risking role in less developed markets. Utility-scale projects in Africa are still constrained primarily by off-taker risk, as only about one in three African utilities are able to cover their operational and debt-servicing costs, weakening the case for investing in capital-intensive, long-lived infrastructure.

Distributed renewable energy such as mini-grids, solar home systems, and off-grid solar for rural access face a different challenge.

These projects are smaller than utility-scale developments and the risk associated with the end consumer can be much higher. Only around half of new electricity access connections providing basic energy services are likely to be commercially viable without incentives such as reduced connection charges, lower tariffs, and subsidised appliances. As a result, the traditional channels for energy financing are not well adapted to these smaller, higher-risk projects, and mini-grids rely on a distinct capital stack combining grants and concessional equity at development, commercial debt and results-based finance during operation, and aggregation vehicles to reach institutional scale.

Productive-use applications where energy is used towards an economic purpose, such as solar irrigation, cold

storage, and agro-processing, introduce a third profile and arguably one that makes the other two viable.

Demand can be four times higher per capita than for essential household services, and this higher consumption is precisely the revenue base that mini-grids and utilities need to reach commercial sustainability. This points to a different financing logic than aid dependency: the goal is repayable lending, structured through equipment loans and cooperative or aggregator channels, that customers can pay off from the income the equipment itself generates. Subsidy still has a role, particularly in de-risking early-stage uptake and financing the broader economic development programmes that productive use requires, but it should be structured to taper as the market deepens and repayment track records are established, rather than functioning as a permanent government and donor-funded subsidy.

The implication for financing policy is that a single instrument cannot serve all three categories, because the binding constraints differ. Recognising this segmentation is a precondition for effective financing design.

These large, interconnected issues can also be addressed through regional coordination. Regional integration through interconnected power pools has enabled aggregated demand and the creation of economies of scale in financing, which are critical for attracting investment in energy infrastructure. Five regional power pools have been established across the continent: the Southern African Power Pool (SAPP), the Eastern Africa Power Pool (EAPP), the West African Power Pool (WAPP), the Central African Power Pool (CAPP), and the North African regional grouping (COMELEC/Maghreb). SAPP is currently the most advanced, with a robust institutional framework, high grid interconnection, and a transparent electricity market that has enabled efficient cross-border trading and a diversified generation mix.

Additionally, collating financing approaches at a larger continental scale is also being observed. The African Union and the continent's Regional Economic Communities have taken substantive steps towards establishing the African Single Electricity Market, with the November 2025 AU-ECOWAS meeting advancing regulatory readiness for continental

electricity trading, and the West African Power Pool completing a historic synchronisation test connecting the power grids of all West African countries simultaneously for the first time. Public-private partnership models including Build-Own-Operate, Build-Own-Operate-Transfer, Build-Transfer-Operate, and Engineering, Procurement, Construction and Finance structures are the main models for private sector participation. Examples include the Kigali Power Transmission Project in Rwanda and the Côte d'Ivoire, Liberia, Sierra Leone, and Guinea (CLSG) Interconnector Project. The CLSG project aims to connect these four countries with the regional energy market in West Africa, which would lead to an increase in opportunities for trade and the establishment of a regional power market.

The strongest financing approaches combine public or concessional capital with private investment, while directly addressing specific risks such as FX exposure, revenue uncertainty, political risk, technology adoption, affordability and weak local capital markets. Business models differ based on ownership structure and generation capacity. Different financial models that have been adapted across Africa, under different circumstances and in different regions, provide the following key learnings:

- Different market segments need different financing models.
- Risk mitigation is central to attracting private capital.
- Local-currency finance is increasingly becoming key to attract domestic finance.
- Blended finance helps move projects from high-risk to bankable
- Guarantee structures are especially important for scaling infrastructure finance; utility-scale solar projects, given their larger capital requirements, need sovereign or multilateral guarantee backing.

- Capital markets are increasingly being used for off-grid solar.
- Government policy and institutional alignment are critical.
- Productive-use solar needs end-to-end financing models.
- Demand aggregation can reduce costs and improve affordability.

Drawing on these learnings and various examples, different archetypes can be observed across Africa, based on ownership and financing structure. The archetypes can be developed based on: 1) who holds the asset; 2) who is liable for construction and takes on the operating risk; and 3) how the end-user and off-taker relationship is structured. The ownership-based model can be developed as:

1. Independent Power producer (IPP)- Public Private Partnerships:
 - Build-Own-Operate: a private company (or consortium of private/multilateral players) builds, owns and operates the power asset, with a long-term PPA with government/state-owned utility (mitigating the risk of revenue, political and regulatory uncertainty). Ownership is privately held, with sovereign guarantee in the form of the government acting as off-taker (e.g. Utility-scale solar: Benban Solar Plants)
 - Co-development/joint ventures, where an equity stake is taken by government in addition to the private player (e.g. utility-scale solar: Angola Solar Plant)
2. Portfolio Ownership: ownership type built for scale, across various countries, is supported by guarantee from multilateral body like MIGA (e.g. Utility Scale Solar- AMEA Power).
3. Permanent Capital Vehicle: ensures long term financing, and hence also called evergreen or perpetual funds (e.g. Off-grid- Zafiri platform; Utility Scale Solar- Spearhead Africa Infrastructure Fund (SAIF)).
4. Consumer ownership through Pay-as-you-go or Rent-to-Own models: ownership is privately held (be commercial companies investing in product/ service) but is designed to transfer to end-user overtime (e.g. Off-grid- d.light, Sun King; Productive use of Solar)

Hence, the success of a model can be seen by following a whole-value-chain approach, aligning financial risks with the revenue stream and ensuring long-term sustainability. Upfront cost structures should be predictable, stable and long-term. This would involve managing the invisible barriers (macroeconomic, regulatory, market and financial risks), as well as defining the target market or choosing the right operational structure for revenue and hence long-term stability. The table below provides examples of cases where specific design features have addressed the risk and are aimed at long-term sustainability.

Business model archetypes: examples of design features addressing risk and ensuring long-term sustainability

Table 24: Financial Structures and De-risking Mechanisms Across Solar Market Segments

Type	Example	Financial model/ business model	Risks mitigated	Conditions ensuring long-term sustainability of model
Utility-scale solar	Benban Solar Plants: park includes 34 solar plants	Blended multilateral finance IPP business model, using Build-Own-Operate (BOO) contracts	- Political and currency risk: MIGA guarantee - Revenue certainty: government-backed long-term PPA and FIT programme - Financial security through both debt and equity financing	BOO contracts
	The Angola Solar project: diversifying solar mix	Export-credit financing State-utility PPA	- Diversifying from China-US exports and Swedish solar exports - Long-term financing and PPAs: 18-year tenure, 85% of project - Sovereign guarantee: from the Government of Angola, Ministry of Finance	State-utility PPA
	Tati Solar Project, Botswana (100 MW)	Blended finance Merchant IPP	Off-taker volatility mitigated by structured commercial capital (through RMB) and selling to SAPP (rather than a single domestic off-taker)	To be tested for investor appetite: revenue dependent on selling into the competitive pool (SAPP)
	Kenya: Spearhead Africa Infrastructure Fund (SAIF)	Fund structure with debt financing Local-currency financing	- Reducing FX risk: using local currency (Kenyan shilling) - Attractive to local investors through public listing: the first infrastructure fund listed on the Nairobi Stock Exchange (NSE)	
	AMEA Power (multiple countries)	Guarantee IPP using Build-Own-Operate-Transfer (BOOT) model	- Geographical diversification across multiple countries streamlines risk insurance - Streamlined underwriting reduces execution timelines: in Egypt, the project was completed in 6 months - Enables scaling by attracting private capital - Long tenor allowing regulatory/political risk coverage - MIGA guarantee mitigates sovereign risk - Long-term revenue security through BOOT model	BOOT model
Off-grid	Off-grid solar company, d.light Sun King pay-as-you-go solar model	Securitisation Asset aggregation Local currency	- Attracting institutional investors - Using capital markets to recycle customer receivables into new investment capital - Tying payments to long-term local-currency debt reduces the cost to customers, while also securing investors through revenue streams; this solution covers local-currency risk and mobilises commercial bank capital at scale - Local-currency loans allow FX risk mitigation	- Asset ownership plans - Centralised management
	InfraCredit Nigeria (Nigeria Infrastructure Credit Enhancement Facility) Dhamana Guarantee Company	Guarantee facilities (local currency)	- Targets institutional investors through a guarantee structure that mitigates credit risk for infrastructure projects - FX risk mitigated by allowing only local-currency-denominated debt instruments - Large capital inflow (from the likes of PIDG) allowed InfraCredit to build its capital base and underwrite long-term local-currency guarantees - Increased average tenor of bond issuances: 11 years, compared with 3.2 years in markets without InfraCredit support - Credit wrap lowers perceived risks and reduces the cost of long-term local-currency debt	Unlocking patient capital necessary for the long term

Type	Example	Financial model/ business model	Risks mitigated	Conditions ensuring long-term sustainability of model
	Demand Aggregation for Renewable Technologies (DART) Programme, Nigeria	Demand aggregation	- Economies of scale through demand aggregation - FX risk reduced by allowing a mixture of dollar and local-currency funding	Needs policy integration and alignment with ongoing larger programmes (such as World Bank DARES in this case)
Productive use of solar: agriculture	SunCulture	Pay-as-you-grow and carbon finance (PES)	- PAYG financing allows smallholder farmers to avoid large upfront costs - Uses carbon finance innovatively to reduce the price of solar irrigation through subsidies	Subsidy phase-out needs to be planned and complemented by innovative financing (such as carbon credits)
	Productive Use Financing Facility	Multi-stakeholder financing at pilot stage Results-based financing	De-risks early investment for consumers through concessional debt and guarantees	Needs to support market development to allow phase-out of RBF
	Malawi: end-to-end solutions for women farmers (rent-to-own scheme)	Contract farming		Revenue guarantee through rent-to-own scheme
	Uganda: Solar for Sustainable Income in Dairy (Cooling)	PPP Productive use of energy	Diverse capital streams (blended finance) de-risk investment for commercial participation	Cooperative ownership allows centralised investment (and repayment plans)
Productive use of solar: EV	South African EV firm Zero Carbon Charge (CHARGE): a developer and operator of off-grid EV charging stations	Commercial (EV off-grid)	- First funding from ABSA (over 2 years) allowed bankability and investment readiness to be seen - Long-term project viability through long-term funding	- Uptake by consumers dependent on pricing model (time-based, energy-based, fixed-rate or hybrid) - Following global models by building charging stations in key freight and passenger corridors
	Battery swapping: example of Spiro	Commercial Battery-as-a-Service (BaaS)	- Patient, blended capital, aiming more for debt over equity, with swap revenue expected to repay it - Reduced asset risk (negligible) due to battery ownership - Battery swapping allows protection from volatile fuel prices	- Substitute to time-consuming charging where charging infrastructure is weak or grid power is not reliable - Market structure can become monopoly-dominated, dictating pricing; policy intervention can help ensure interoperability and standardisation of battery infrastructure

Source: ISA & CETEX Analysis



Local manufacturing and the African solar value chain

9.1 Why local manufacturing matters for Africa

Every preceding chapter of this report describes energy demand as a **key enabler** - for last-mile systems, for irrigation and cold chains, for charging infrastructure, for utility-scale plants. This chapter asks a slightly different question: Where does the equipment that meets this demand get manufactured and what does it mean for **Africa when it is made elsewhere?**

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The answer has changed sharply in the past two years. Africa's imports of solar panels from China reached 15.0 GW in the 12 months to June 2025, up 60% year-on-year, while imports totalled 18.8 GW across calendar year 2025, a 48% increase from 2024, highlighting the rapid acceleration of solar deployment across the continent. Excluding South Africa, imports of Chinese solar panels to African countries nearly tripled over the past two years, increasing from 3,734 MW to 11,248 MW. In the 12 months to June 2025, 20 countries set record import levels, and the number of countries importing solar panels of capacity at least 100 MWp rose from 15 to 25. Three consequences follow, and each maps to a constraint identified elsewhere in this report.

- **Cost.** The Africa CAPEX premium in the distributed renewables chapter, mini-grids at roughly **USD 6,824/kWp against a global benchmark near USD 3,000/kWp**, is largely a logistics, duty and small-order-size premium, not a technology premium. Every **USD 1,000/kWp saved unlocks around USD 4.2 billion in avoided cost, enough to connect some 10 million more people.**
- **Foreign exchange risk and supply security.** Equipment is priced in dollars while revenue is collected in local currency: the same mismatch that constrains off-grid and mini-grid companies throughout this report. Dependence on a single supplier geography adds strategic exposure that could reverse as quickly as it arrived.
- **Value capture and jobs.** According to ISA's Solar PV Skills and Jobs in Africa (2025) analysis, Africa's solar workforce could grow from approximately 226,000 jobs today to 2.5-4.2 million jobs by 2050. Achieving the upper end of this range will depend in part on expanding local value addition through module assembly, balance-of-system manufacturing, and solar appliance production.

The trade argument reinforces all three. For 9 of Africa's 10 largest solar importing countries, refined petroleum imports exceed solar panel imports by a

factor of between 30 and 107, and a panel in Nigeria repays its cost in avoided diesel within roughly six months. Solar already substitutes for far larger fuel imports; manufacturing retains a growing share of the equipment spend as well.

9.2 Types of equipment procured by different solar power thematic areas

The solar manufacturing opportunity is not characterised by a single market. Each solar thematic chapters covered in this report generates its own bill of materials, and the most useful insight into industrial policy is that the highest-volume, most localisable items are

usually not solar panels. These are mounting structures, poles and cabling, meters, pumps, cold rooms, battery packs and appliances: goods with high weight-to-value ratios, moderate technical barriers, small production runs and heavy after-sales content. To be read as a procurement list rather than a technology list, the report's own opportunity pipeline showcases where African industry can compete now.

Table 25: Local and Regional Manufacturing Opportunities in Solar

Solar thematic (report chapter)	Principal manufactured inputs	Where it should be made
Utility-scale and interconnection	Modules, central inverters, mounting and tracking structures, foundations, cabling, transformers, switchgear	▪ Country: structures, foundations, civil works ▪ Region: modules, inverters, transformers
Mini-grids	Poles, distribution cabling, connection boxes, meters, controllers, power houses, batteries	▪ Country: balance of system, the dominant cost driver ▪ Region: controllers, batteries
Off-grid solar / SHS	Kits, PAYGo control units, lights, fans, televisions, efficient refrigerators	▪ Country: kit assembly, appliances, repair networks ▪ Region: electronics, cells
Rooftop solar	Roof mounting systems, string inverters, isolators, enclosures, bidirectional meters	▪ Country: mounting to local roof and wind codes, enclosures ▪ Region: inverters, meters
Agriculture/ productive use	Pumps, drip systems, cold rooms, dryers, mills, agrivoltaic elevated structures	▪ Country: specification-sensitive and service-intensive
Solar e-mobility	Battery packs, swap-station hardware, chargers, two- and three-wheeler assembly, second-life packs	▪ Country: packs, swap hardware, vehicle assembly ▪ Region: cells, power electronics
Digitalisation and storage	AMI meters, communications modules, SCADA hardware, BESS containers and packs	▪ Country: meter assembly, the largest volume item in this report ▪ Region: electronics, cells

Source: ISA Analysis

9.3 Current barriers limiting manufacturing potential

Africa's manufacturing base has begun to move, but from a low level. Morocco recently doubled module capacity to around 1 GW a year and South Africa operates at comparable scale, with smaller lines in Egypt, Nigeria and Kenya. The significant recent additions are cell-level: Ethiopia's Hawassa industrial park now hosts multi-gigawatt cell production. Five barriers explain the gap.

- **Scale and cost competitiveness:** A sub-gigawatt African line importing cells, glass and frames cannot match integrated Chinese producers on price alone. Without aggregated demand, new lines run below capacity and fail.
- **Fragmented demand:** Africa's 2.4 GW of annual installation is spread
- across more than fifty markets with separate procurement rules and standards. Outside South Africa, Egypt and increasingly Nigeria, no national market can underwrite a competitive factory, which makes regional integration a manufacturing question, not only a trade question.
- **Input tariffs that invert the incentive:** Many countries levy higher duties on cells, glass, junction boxes and inverter parts than on finished modules, taxing local assembly and subsidising the imported finished product.
- **Power, logistics and finance:** Factories need reliable, competitively priced electricity, working ports and predictable customs. At 15–18% borrowing costs against 2–5% in advanced economies, the payback math rarely closes without concessional support or an anchor offtake.
- **Skills and quality infrastructure:** Assembly needs production engineers, quality controllers and accredited testing laboratories; without recognised certification a factory cannot export into neighbouring markets at all.

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9.4 Mission 300 and the manufacturing agenda

9.4.1 What is being done?

Mission 300's national energy compacts create the demand certainty on which manufacturing investment depends. Across the Compacts, governments have committed to connecting a large share of 300 million people by 2030, roughly half through mini-grids and standalone solar, with quantified equipment implications: Zambia's 3,000 MW solar programme, Uganda's ~2,712 planned mini-grids, Gabon's 300 MW of solar-plus-storage, Madagascar's 893 MW of new renewable capacity. Aggregated, this is a multi-gigawatt, multi-year and now visible

order book: the first time African equipment demand can be articulated in a way manufacturers can plan against.

A parallel industrial architecture is emerging around critical minerals. Sub-Saharan Africa holds approximately 30% of the world's proven critical mineral reserves, while the DRC accounts for more than 70% of global cobalt production. In 2022, the DRC and Zambia signed a cooperation agreement to develop a regional battery value chain, followed by a UNECA-Afreximbank framework to establish battery and electric-vehicle special economic zones, including planned battery-precursor production facilities in the two countries.

9.4.2 What needs to be done?

The gap is one of translation: demand exists, and minerals exist, but neither is being converted into manufacturing capacity in the continent.

Table 26: Mission 300: Progress, Gaps and Priority Enablers for Scale-Up

National Energy Compact commitments	Where the continent stands	Gap to close	Closing enabler
Compacts commit to multi-gigawatt deployment by 2030	~18.8 GW of solar panels were imported from China in 2025; domestic capacity is a small fraction of that	Demand not aggregated or signalled to manufacturers in procurable form	Regional aggregation and multi-year framework procurement
~30% of global critical mineral reserves; >70% of cobalt from the DRC	Minerals exported largely unprocessed; precursor and cathode value captured offshore	Refining, precursor and cathode capacity and the power to run it	DRC–Zambia SEZ framework; ECA–Afreximbank corridor; clean power
Pillar 4 private-capital mobilisation across all compacts	Industrial finance at 15–18% cannot support capital-intensive factories	Long-tenor, competitively priced finance with anchor offtake	Blended industrial finance; guarantees applied to offtake
Jobs and skills mainstreamed in every compact	Jobs per GW of capacity that Africa currently forgoes	Production engineering, quality control and testing skills	STAR-C and TVET manufacturing tracks; regional testing
Regional integration under Pillar 2 and the AfCFTA	50+ fragmented markets; input duties often exceed finished-goods duties	A single regional market with harmonised standards	AfCFTA tariff alignment; mutual recognition of certification

Source : ISA Analysis, IRENA and National Energy Compacts submitted by African countries

9.5 Country-level and regional manufacturing: matching segment to scale

The question is not whether to localise but at what scale each segment of the solar power value chain should be localised. A country that attempts cell manufacturing for a 200-MW domestic solar energy market builds a plant that never reaches viable utilisation; a region that imports mounting structures and solar pumps forgoes the jobs most readily available for it. The distinction is economic, not political: each segment of the value chain has a minimum efficient scale, and the right jurisdiction is the smallest one that can supply it.

Solar value chain segments that are weight-intensive, service-intensive or sensitive to local specification belong close to the customer: shipping a steel mounting structure across an ocean makes no sense, shipping a wafer does. Four categories of manufacturing qualify for localisation almost everywhere:

- Balance of system (mounting and racking, cabling, junction boxes, enclosures, poles)

- Productive-use equipment assembly (pumps, cold rooms, dryers, mills), where small runs and after-sales presence are advantages rather than costs.
- Installation, O&M and refurbishment services, the largest single source of domestic employment in the chain.
- Final assembly and kitting to national programme specifications.

Module assembly and battery pack integration become viable nationally once demand reaches several hundred megawatts a year or an anchor public programme exists: a threshold that countries like Morocco and South Africa have passed at roughly 1 GW each.

The upstream segments cannot be justified by a single national market outside the largest three or four economies. Cells and wafers, inverter electronics, glass and encapsulant, battery cells, and precursor and cathode processing each require gigawatt-scale throughput, very low-cost firm power, or proximity to processed minerals. Pooled under the African Continental Free Trade Area, Africa's 2.4 GW of annual solar power capacity installation supports competitive plants. Regional integration is a manufacturing precondition, not an adjunct, and comparative advantage is already visible in regions/ countries where investment has arrived.

Table 27: Potential Regional Hubs for Solar and Battery Manufacturing in Africa

Region / corridor	Anchor markets	Comparative advantage	Realistic manufacturing focus
North Africa	Morocco, Egypt	Industrial base, deep ports, proximity to Europe; Morocco ~1 GW module capacity, Egypt hosting gigawatt-scale cell projects	Modules and cells at export scale; inverters and electronics
West Africa (ECOWAS)	Nigeria, Ghana, Côte d'Ivoire, Senegal	Largest demand pool in Sub-Saharan Africa (Nigeria alone ~1.7 GW in a year) plus ECREEE and ECSES standards architecture	Module assembly and battery packs for the ECOWAS market; productive-use equipment; balance of system
East Africa (EAC / Horn)	Ethiopia, Kenya, Tanzania	Ethiopia: lowest-cost clean firm power and working industrial parks, already producing cells at Hawassa. Kenya: 200 MW module plant, mature off-grid and e-mobility markets	Cells in Ethiopia; modules, appliances, e-mobility components and battery packs in Kenya and Tanzania
Southern Africa (SADC / SAPP)	South Africa, Zambia, Namibia, Botswana	Deepest industrial and engineering base, an integrated power pool, adjacency to the mineral belt; largest single import market (~3.8 GW)	Modules, inverters, storage integration, mounting systems; industrial supply into the mineral corridor
Central mineral corridor	DR Congo, Zambia	Over 70% of world cobalt and ~10% of copper; clean hydro power; ECA–Afreximbank battery and EV special economic zones	Mineral refining, precursor and cathode materials, battery cells, the highest-value opportunity on the continent

Source: ISA Analysis

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The principal risk of local manufacturing is not under-ambition but duplication—ten governments each announcing a national module factory produces ten sub-scale plants, each protected by tariffs against the others, none of them are competitive. Three instruments prevent this: **(i) Solar-specific rules of origin under AfCFTA**, phased upward as capability deepens, are the single most important technical instrument in this chapter; set too low, repackaged imports qualify; set too high, the preference is worthless. **(ii) Regional specialisation agreements**, hosted by the power pools and RECs that already coordinate electricity trade, let states take complementary segments rather than compete for the same factory. **(iii) And harmonised standards with mutual recognition**—the ECSES model from the capacity chapter, applied to equipment—open neighbouring markets to compliant producers while excluding

sub-standard imports. Sequenced this way, every country builds the labour-intensive segments of the solar value chain at home while regions build the capital-intensive segments/ equipment and trade them.

9.6 Priority enablers to accelerate deployment

Manufacturing policy fails when it begins with factories. It succeeds when it begins with demand and then removes the frictions that stop a competitive plant from serving it.

9.6.1 Aggregate demand before building supply

The most powerful instrument African governments hold is their own procurement. Compact targets, rural electrification programmes, public-building rooftop portfolios and pump schemes together represent a predictable multi-gigawatt pipeline. Converting it into multi-year framework contracts, rather than annual project-by-project tenders, gives a manufacturer the volume certainty needed to finance a line and the Utility Aggregator Model from the distributed renewables chapter does the same on the rooftop side. Aggregation works best regionally: under the AfCFTA a manufacturer faces a

demand base an order of magnitude larger than any national market outside South Africa and Egypt.

9.6.2 Fix the tariff inversion and sequence the value chain realistically

The immediate reform is to ensure duties on inputs never exceed duties on finished goods. Zambia's removal of VAT and import duties on solar components, which preceded an eightfold rise in imports, shows how fast fiscal signals move this market. Sequencing matters as much as tariffs, and most markets should begin well upstream of cells: balance of system is low-capital intensive and viable immediately almost everywhere; appliance and productive-use assembly follows closely behind; module assembly and battery pack integration are medium-term, needing several hundred megawatts of aggregated annual demand; cells, wafers and precursor materials are long-term and belong only where very low-cost firm power or processed minerals are close at hand; and polysilicon and ingots sit beyond the current horizon.

9.6.3 Broaden the definition beyond PV modules

Framing local manufacturing as a question about panels understates the opportunity. Three adjacent segments are commercially closer and more employment-intensive: **productive-use appliances**, assembled from widely available components in runs small enough for African firms and sold

where after-sales presence decides the sale; **electric-mobility components**, where two- and three-wheeler assembly, battery packs and swap-station hardware are already within reach and where battery weight favours production close to the market; and **repair, refurbishment and end-of-life**, which turns the maintenance constraint identified in the distributed renewables chapter into spare-parts production, recycling and second-life packs feeding mini-grid and rooftop storage.

9.6.4 Solve the industrial finance and power problem together

A factory needs two things African markets supply poorly: long-tenor capital at reasonable cost, and reliable competitively priced electricity. The guarantee architecture built for generation - payment guarantees, FX cover, local-currency facilities and ISA's Global and Africa Solar Facility - can be extended to **industrial offtake**, since a manufacturer holding a guaranteed multi-year order from a national electrification programme is far more bankable than one selling into a spot market. On power, captive and corporate-PPA solar is the fastest route to competitive industrial electricity and makes the factory a demonstration of its own product. Special economic zones can bundle both provided they are tied to a real offtake pipeline rather than offered as a general incentive.

9.6.5 Build the quality infrastructure that makes regional trade possible

A manufacturer confined to one national market will struggle to reach competitive scale, while regional trade depends on recognised testing, certification and mutual-recognition frameworks. Regional testing laboratories and accredited certification systems are therefore industrial infrastructure, not merely consumer-protection mechanisms. The leading markets show how the pieces combine: Morocco anchored manufacturing within a broader industrial-development strategy; Egypt demonstrates how market scale can attract further investment; Ethiopia shows that cell-level manufacturing can locate in a lower-income economy with competitive power costs and functioning industrial infrastructure; and the DRC-Zambia corridor points to the highest-value opportunity of all, processing minerals closer to where they are mined, with regional integration as the enabling framework rather than an afterthought.

Conclusion

This report examines four solar thematic chapters and four cross-cutting enabler chapters that are critical for accelerating solar energy deployment across Africa. **The technical chapters focus on distributed renewable energy for last-mile access, solar-powered agriculture, solar-powered e-mobility, and utility-scale solar and regional interconnections.** These are complemented by four cross-cutting enablers (digitalisation of utilities, institutional capacity building, financing ecosystems, and local manufacturing pathways) that are essential for moving from scattered pilot successes to scalable, replicable, and continent-wide deployment models.

Across all four solar thematic areas, the report finds that solar is no longer constrained primarily by technology or cost (costs have fallen sharply and Africa's resource base is exceptional), but by a recurring set of non-technical barriers: underdeveloped policy and regulatory frameworks, high financing costs driven by currency mismatch and weak power utility creditworthiness, and limited institutional capacity, which in turn constrains technical and managerial delivery. Lessons drawn from successful cases, such as Nigeria's DARES, Uganda's agri-solar pilots, Egypt's Benban and Morocco's Noor complexes, and Rwanda's and Nigeria's digital planning platforms, share a common pattern: a clear policy mandate, an innovative financing structure that blends concessional and commercial capital, and de-risking mechanisms that make solar investment bankable.

The consistency of this pattern across different sub-sectors (off-grid access, agriculture, electric mobility, utility-scale generation, digital infrastructure) indicates that Africa's solar transition is best understood as a single interconnected system rather than separate markets. Weak utility digitalisation undermines the bankability of utility-scale projects; currency risk and high WACC constrain DRE, agriculture, and utility-scale financing alike; and capacity gaps cut across every sector. This means that gains made in one area (e.g., digital revenue-assurance tools) directly improve outcomes in another (e.g., utility-scale project bankability), and conversely, that an isolated intervention in only one sector is unlikely to achieve transformational scale.

From a policy and regulatory perspective, clear solar policy mandates covering licensing, tariff design, land allocation and water governance (for

agri-solar), and procurement transparency are key prerequisites. Regional bodies also need to support harmonisation to enable regional interconnection and cross-border replicability.

On finance, the blended-finance architecture, including concessional capital, local-currency instruments, risk guarantees, and carbon finance, should be built as shared financing infrastructure, rather than treated separately for each sector. Early-stage concessional support needs to also be directed toward missing middle companies, those with a track record but not yet able to access commercial capital, and utility-scale projects constrained by the sovereign ceiling, paired with explicit subsidy exit strategies to ensure long-term market sustainability.

Innovative digital tools (geospatial planning, digital procurement, PAYGO platforms, digital public infrastructure) are cross-cutting market-making infrastructure that needs to be sequenced early, since they directly determine the bankability and transparency on which financing decisions in every other chapter depend.

Effective capacity-building intervention in parallel with financing and policy reform efforts, using sector-specific training plans coordinated through a phased roadmap, is crucial, since institutional and human capacity is the bedrock of the success of solar energy deployment.

Local manufacturing represents a strategic opportunity for Africa to move beyond being a consumer of solar technologies and become an active participant in the global clean energy value chain. By aligning industrial policies with growing solar demand, regional integration, and investment, the continent can strengthen energy security, create jobs, and capture greater economic value.

Overall, the report's findings support a single overarching recommendation: Africa's solar transition will scale rapidly not through additional standalone pilots, but through effective policy reform, blended finance, digital infrastructure, and capacity building as one coordinated package, applied across DRE, agriculture, utility-scale, and digitalisation, with international and regional institutions playing a central role in harmonising standards, mitigating risk, and enabling replication, especially across the African countries that have so far seen the least solar investment.

Finally, none of these recommendations need be built from a blank page. Mission 300 and its 35 National Energy Compacts already provide the political mandate, the five-pillar reform architecture, the financing envelope, and the twice-yearly monitoring rhythm that this report's agenda requires. The report's thematic chapters align closely with the Compact

pillars: distributed renewable energy and solar-powered agriculture support last-mile access (Pillar 3); utility-scale solar and One Grid Africa contribute to competitive generation and regional power integration (Pillars 1 and 2); the financing ecosystem advances private-sector participation (Pillar 4); while utility digitalisation, institutional capacity building, and local manufacturing strengthen financially viable utilities, domestic industrial capabilities, and the institutional foundations underpinning all five pillars, particularly Pillar 5. African governments have already signed the commitments, and more than 50 million people have already been connected. What this report adds is the ‘how’: a sequenced, stakeholder-assigned playbook translating national commitments into scalable solar deployment, strengthened local industries, and continent-wide clean energy transformation.

Way Forward

Based on the current pace of policy and financing reform across the continent, Africa is estimated to be capable of reaching approximately 1,000 GW of installed solar PV capacity by 2050, up from roughly 22 GW today, with solar’s share of total generation rising from about 3–4% to roughly 40%. Achieving this requires three sequenced phases, backed by the actions proposed in the roadmaps for each thematic area:

2025–2030: Lay the foundation.

Installing 100–200 GW of solar by

2030 means building three things at once: stable policy and regulatory frameworks (clear licensing, fair tariffs, transparent tenders); blended finance to lower Africa’s high cost of capital; and stronger utility digitalisation (in metering, billing, revenue collection). Distributed solar and agri-solar should scale alongside utility-scale projects in this phase, since they reach people and remote areas that utility-scale alone cannot.

2030–2040: Scale systemically. Growing from 200 GW to 500 GW means turning early financing innovations (e.g., aggregation, securitisation) into standard practice and connecting power grids regionally so countries can pool risk and demand rather than relying solely on their own limited capital markets. This phase should bring in the many underserved countries that currently receive only a small share of solar investment.

2040–2050: Consolidate solar as the backbone. Reaching 1,000 GW shifts the challenge from building generation capacity to managing it: storage, grid flexibility, and skilled institutions become as important as the generation projects.

Throughout all phases, policy, finance, innovation and digitalisation must move together. International and regional bodies should lead this coordination: aligning policies, pooling financial risk, and replicating proven models across the continent so Africa’s solar transition functions as one connected system rather than scattered national efforts.

The first horizon of this trajectory is deliberately co-terminous with Mission 300: the 2025-2030 foundation phase is the compact delivery window, and its 100-200 GW ambition should be pursued through the compact machinery rather than alongside it. The twice-yearly Compact Progress Report cycle offers the continent a ready-made accountability rhythm for this phase; ISA’s Communities of Practice and the proposed Africa Solar Facility should plug into that machinery, so that every blueprint in this report lands on a signed national commitment with a delivery unit, a reporting date and a financing line already attached. The milestone of more than 50 million people connected by mid-2026 demonstrates that the required pace is achievable: the task for the decade is to hold it.

Table 28: Africa’s’ phased solar energy target

Year	2025	2030	2040	2050
Total generation capacity (GW)	242	500	1,200	2,000
Total RE capacity (GW)	62	200-300	750	1,400
Solar PV capacity (GW)	22	100-200	~500	~1000
RE share of generation (%)	26%	40-50%	62.5%	>70%
Solar share of generation (%)	~3-4%	10-12%	15-16%	~40%

Source: RCREEE Analysis

Annexure

Annex I: Economic Assessment of Solar Water Pumping Systems: Comparative Case Studies from Ethiopia and Uganda

This annex presents the detailed economic assessment underpinning the analysis of solar-powered irrigation systems discussed in the report. Using representative case studies from Ethiopia and Uganda, it compares conventional diesel-based irrigation systems with solar-powered alternatives across key technical, financial, and environmental parameters. The assessment evaluates capital and operating expenditures, life-cycle costs, levelised cost of electricity (LCOE), greenhouse gas emissions, fuel savings, and investment payback periods under country-specific operating conditions. The results demonstrate the long-term economic viability and environmental benefits of solar water pumping technologies and provide quantitative evidence to support policy formulation, investment planning, and large-scale deployment of solar irrigation systems across Africa. The annex also presents an illustrative scenario assessing the potential impacts of replacing one million diesel irrigation pumps with solar-powered systems.

In **Ethiopia**, the project implements an innovative lease-to-own business model where private solar vendors cover 100% of the initial capital investment, and the community repays them through monthly instalments over three to five years. A typical system, such as the one at the Chiri Sirba pilot site, features a 27.3-kWp solar array powering alternating current (AC) pumps, with an expected system life of over 25 years. Financially, the model requires a 10% down payment from the community. To de-risk private sector investment, the project provides results-based grants to developers, which have ranged from USD 2.00/m⁴ to USD 0.70/m⁴ based on hydraulic duty. The economic analysis utilises a real discount rate of 4% and accounts for a significant 12% differential fuel inflation rate, making solar highly competitive with a payback period of less than two years.

In **Uganda**, the case study focuses on a Solar-Powered Water Pumping (SPWP) system optimised for rural needs, utilising a 3.6-kW photovoltaic (PV) array (comprised of twelve 300W panels) coupled with a 10-kWh battery storage system. This system is designed to meet a daily demand of 5,000 litres at a 25-meter total pumping head, achieving an overall efficiency of approximately 68%. While the initial capital cost is higher at USD 12,000 compared to USD 7,500 for diesel, the annual operating cost is drastically lower at just USD 150, resulting in a 52% reduction in long-term expenditure over a 20-year service life. The model demonstrates a payback period of approximately five years. To support scaling, the study recommends government-led subsidies, grants, and tax incentives to lower the barrier for rural adoption.

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Table A1: Comparative economic assessment of diesel and solar water pumping systems in Ethiopia and Uganda

Parameter	Unit	Ethiopia		Uganda	
		Diesel	Solar	Diesel	Solar + BESS
System Description					
Solar Irradiance	kWh/m ² /day		5.5 ^a		5.2 ^f
Power	kW	27.3	27.3 ^b	3.6	3.6
System efficiency	%	68% ^a			
Days per year	days/year	365 ^a			
CAPEX	USD	53,000 ^b	68,000 ^b	7,500	12,000
Replacement 1*	USD	11,177		2,892	
Replacement 2**	USD	8,329			
OPEX maintenance	USD/year	907 ^b	429 ^b	2,400	150
Diesel consumption	L/year	18,217 ^b		1,455	
Diesel price	USD/L	1.139 ^c		1.649	
OPEX fuel cost	USD/year	20,749		2,400	

Parameter	Unit	Ethiopia		Uganda	
		Diesel	Solar	Diesel	Solar + BESS
Life Cycle Cost (LCC)					
Nominal Discount rate	%	22% ^b			
Actual discount rate	%	4% ^b		10% ^g	
Depreciation rate	%	0.5% ^b		0.5% ^g	
Fuel escalation rate	%/year	12% ^b		1.5% ^g	
NP_OPEX	USD	210,454	6,536	22,856	1,583
LCC	USD	282,960	74,536	33,247	13,583
% reduction	USD		74%		59%
Levelised Cost of Electricity (LCOE)					
Annual energy	kWh/y	37,267		4,646	
Net present energy	kWh	543,741		42,755	
LCOE	USD/kWh	0.520	0.137	0.778	0.318
Emission Savings					
Emission	kg CO2/L		2.66 ^d		2.66
Emission saved	kg CO2/year		48,485		3,874
Emission/kWh	kgCO2/kWh		1.3		0.83
Tax and subsidies savings					
OPEX savings	USD/year		478		2250
Fuel Subsidies	%		60% ^e		
Tax Excise Duty	%				17% ^h
Subsidies savings	USD/year		31,124		
Diesel tax	USD				408
Total savings	USD/year		31,602		2,658
Incremental cost	USD		15,000		4,500
Payback					
SPB for new w/ subsidies	years		0.3		1.7
SPB for new w/out subsidies	years		0.7		2.0
SPB for rep w/ subsidies	years		1.3		4.5
SPB for rep w/subsidies	years		3.2		5.3
a case study in Ethiopia1					
b Case study in Ethiopia 2					
c Global petrol prices					
d DEFRA 2025					
e Ethiopian Subsidies					
f Uganda Case Study 1					
g Discount rate					
h Tax rate in Uganda					

** Note: For Ethiopia, the diesel generator service life is 7.5 years; thus, two replacements have been considered for the LCC analysis through 20 years. While for Uganda, the diesel system service life is 10 years, only one replacement is considered.

Source: ISA & RCREEE Analysis

Benchmarks

Switching from diesel to solar systems results in significant total cost reduction of 59% to 74% over the project lifetime. LCOE is significantly lower, ranging from 0.137 to 0.318 USD/kWh. The payback period for solar integration remains highly attractive, falling between 1 year and about 5.5 years. The emissions intensity of the baseline diesel generation ranges from 0.83 to 1.3 kg CO₂/kWh.

Table A2: Economic and environmental comparison of replacing 1 million diesel pumps with solar pumps

Replacing million diesel pumps with solar pumps			
Parameter	Unit	Diesel	Solar
CAPEX	billion USD	7.5	12
OPEX	billion USD/year	2.4	0.15
LCC	billion USD	33	14
LCOE	USD/kWh	0.778	0.318
Emission saved	kton CO ₂ /year	3,874	
SPB	Years	5.3	
Productivity	#	Irrigated land is 3.2 times more productive than rainfed land	
Water saved	%	20% to 47% for Agrivoltaics	
Job creation	#	80,861	

Source: ISA & RCREEE Analysis

Annex II. Strategic Roadmap for Scaling Agrivoltaics in Africa

Agrivoltaics, the co-location of solar photovoltaic systems with agricultural activities, offers a transformative opportunity to simultaneously address Africa's energy, food, water, and climate challenges. However, scaling agrivoltaic systems requires more than technological readiness; it depends on coordinated policy reforms, institutional capacity, enabling regulations, innovative financing, technical standards, and active participation from public and private stakeholders. This annex presents a phased implementation roadmap that outlines the key actions required across immediate, medium-term, and long-term time horizons. It identifies the roles and responsibilities of major stakeholders, including governments, regulators, farmers, private developers, financial institutions, and development partners, to support the systematic deployment of agrivoltaic systems across the continent. The roadmap is intended to serve as a practical reference for policymakers and practitioners seeking to establish an enabling ecosystem for large-scale agrivoltaic adoption in Africa.

ACTOR	IMMEDIATE — Assess Potential & Establish Foundations	MEDIUM TERM — Build systems & scale	LONG TERM — Sustain & optimise
Head of State / Cabinet	Conduct a national Agri-PV potential assessments. Undertake policy, regulatory and institutional gap assessment. Develop a national Agri-PV roadmap/strategy.	Introduce Agri-PV policy incentives. Establish national Agri-PV monitoring and evaluation framework. Set national deployment targets.	Periodically review and update Agri-PV policies based on implementation experience. Position Agri-PV as a core climate-smart agriculture strategy.
Ministry of Agri - Water	Assess crop, livestock and agro-climatic suitability. Identify suitable agro-climatic zones using GIS. Assess irrigation infrastructure and water availability. Conduct farmer consultations and needs assessment.	Develop crop-specific Agri-PV cultivation guidelines. Train agricultural extension officers. Establish crop yield, water-use and soil health monitoring protocols.	Develop national Agri-PV best practice manuals. Embed Agri-PV within national agricultural programmes. Institutionalise long-term productivity and environmental monitoring.
Ministry of Energy & Regulator	Assess grid proximity and hosting capacity. Assess grid, off-grid and hybrid deployment options. Clarify land-use and electricity regulations. Develop preliminary interconnection guidelines.	Develop grid integration standards for Agri-PV. Strengthen distribution infrastructure where required. Develop model PPAs and regulatory guidelines.	Periodically update technical standards and grid codes. Establish certification and quality assurance mechanisms. Facilitate regional cooperation on Agri-PV standards, capacity building and knowledge sharing.
Farmers Cooperative & Smallholders	Participate in pilot projects, awareness programmes and stakeholder consultations. Identify operational constraints and willingness to adopt Agri-PV. Form producer groups and cooperatives.	Develop farmer-led demonstration sites. Strengthen technical skills for system operation and maintenance.	Develop farmer-led Agri-PV enterprises. Integrate Agri-PV into local value chains. Participate in Agri-PV knowledge-sharing networks.
Developers & Private Sector	Conduct site screening and feasibility assessments. Generate cost benchmarks for different business models. Evaluate suitable Agri-PV configurations (height, spacing, tracking, GCR). Partner with farmers and research institutions.	Collect operational and performance data from pilot projects. Develop standardized engineering designs. Expand EPC and service networks.	Develop local technology innovation and digital monitoring solutions. Invest in local manufacturing. Strengthen after-sales service ecosystem.
Ministry of Finance / Financier / DFI / ISA	Support feasibility and resource assessment studies. Leverage the Africa Solar Facility (ASF) to support pilot financing and project preparation. Provide grants for pilot preparation and technical assistance.	Introduce viability gap funding where required. Develop risk-sharing instruments for early-stage projects. Mobilise private investment.	Create dedicated Agri-PV investment facilities. Develop green bonds and climate finance mechanisms. Promote results-based financing and carbon finance opportunities.

Figure A1: Strategic roadmap for scaling agrivoltaics in Africa

Source: ISA Analysis

Annex III: Selected national electric mobility policies and incentives in Africa

Country	Policy or incentive description	Type of policy	Date
Ethiopia	Ban on imported ICE vehicles (fully built units from January 2024; expanded to SKD/CKD kits May 2025); broad tax exemptions for EVs including duty-free assembly kits	Import restriction and tax incentives	January 2024 (expanded May 2025)
Rwanda	0% import duty on EVs and charging equipment; VAT waivers for locally assembled EVs; ban on new petrol motorcycle registrations in Kigali from 2025	Fiscal incentives and regulatory restriction	Active by 2025 and ongoing
Ghana	National Electric Vehicle Policy launched at COP28; phased targets aiming for 35% EV penetration by 2035 and an end to new petrol and diesel vehicle sales by 2045	National EV policy	2 December 2023
Kenya	National Electric Mobility Policy to accelerate EV adoption and infrastructure deployment; zero-rated VAT on electric buses, motorcycles and lithium-ion batteries	National EV policy and fiscal incentives	4 February 2026
Nigeria	National Automotive Industry Development Plan 2023 includes EV provisions targeting 30% local EV production by 2033; Electric Vehicle Transition and Green Mobility Bill passed second Senate reading October 2025 but is not yet law	Automotive development plan with EV provisions; pending legislation	2023 (plan); 2025 (bill, not yet enacted)
Egypt	Vision 2030 strategy targets phase-out of petrol and diesel vehicles by 2040; customs duty exemptions on EV components under Ministerial Resolution 255/2018; subsidies of up to EGP 50,000 for locally produced EVs	National strategy and fiscal incentives	Ongoing from 2018; Vision 2030 target
Morocco	VAT exemptions and reduced customs duties; plans for 5,000 charging stations by 2028; USD 15 billion in EV and battery manufacturing investment including BYD facility in Kenitra	Manufacturing incentives and industrial policy	Ongoing from 2023
South Africa	150% tax deduction on qualifying EV manufacturing investment (Section 12V of the Income Tax Act); USD 54 million committed to support local EV and battery production	Manufacturing tax incentive	Effective 1 March 2026
Mauritius	Duty-free imports and excise duty rebate of up to Rs 200,000 for EV purchases introduced in 2022; incentives partially reversed from June 2025 with reintroduction of excise duty on EVs	Fiscal incentives (partially reversed)	From 2023; partial reversal 2025
Zambia	0% customs duty on EVs and related equipment; excise duty reductions for hybrid vehicles	Fiscal incentives	From 2024
Zimbabwe	Import duty on EVs reduced from 40% to 25%; ICE vehicles remain subject to 40% import duty	Fiscal incentives	From 2024
Cameroon	Finance Law 2025: 50% reduction in taxable value for EVs, motorcycles, batteries and charging stations for 24 months; exemption from excise duty and road tax	Fiscal incentives	Effective 1 January 2025
Côte d'Ivoire	Decree No. 326/2024 promoting electric mobility establishes conditions for EV import, assembly and production, and development of charging infrastructure; target of 10% EV fleet share by 2030	National EV decree	Adopted May 2024

Annex IV: Kenya Battery Swapping with RE: behind the meter, swap station model/ pathway

Kenya's EV market is growing rapidly with annual registrations increased from 796 in 2022 to 24,754 in 2025. There are cumulatively 35,000+ EVs in 2025 dominated by electric two-wheelers (e-2W) with ~33,000+ units representing nearly 94% market. To meet this growing demand of e-2Ws, Kenya's battery-swapping network has expanded across urban and rural areas and has ~630+ public battery-swapping stations/cabinets across key market players including Spiro, Ampersand, ARC Ride, Roam, Ecobodaa, Kiri EV, STIMA Mobility, eWAKA, FIKA Mobility and Powerhive. Kenya's battery-swapping network is expected to expand significantly to at least 3,000+ stations by 2030.

Case Study 1: Battery Swapping Station with Solar

- A typical urban battery-swap station serving around 150 riders/swaps per day is configured with 30 battery-charging slots resulting in an estimated daily energy demand of around 486 kWh/day (each battery capacity is 3.24 kWh)
- Typical solar installation is around 30% of the station's total demand (in this case 30 kWp rooftop solar system generating 150 kWh/day)
- Under grid-connected operation, the electricity tariff to Charge Point Operator (CPO) is KES 16/kWh during peak hours and KES 8/kWh during off-peak hours. With solar integration, the tariff can be up to KES 10/kWh, thereby improving economic viability mainly by reducing dependence on peak-hour grid electricity.
- As a scalable solar-powered charging solution, a CPO with multiple battery-swap stations can aggregate EV charging demand and explore RE power sourcing through open access. Kenya's open access eligibility requires a minimum load of 1 MVA on the distribution system subject to regulatory approval, wheeling charges, network-use charges and the final commercial structure.
- In addition to grid-connected urban battery-swap stations, rural and county-level battery swap stations are also emerging as an important growth opportunity in Kenya's e-mobility market, especially in areas where boda-boda (2W) is popular for commercial transport but grid access is weak or unreliable. These rural stations are primarily powered by mini-grid or off-grid solar systems and several players have successfully deployed these solutions and are expanding.



Credit: Roam Electric Battery Swap Station

Annex V: Kenya e-Bus charging with RE: grid connected solar charging model/ pathway

Kenya has over 100 electric buses operating on public transport and school routes, primarily in and around Nairobi. The leading local manufacturer, BasiGo, leads this sector and has a fleet of 152 buses across two countries Kenya and Rwanda, operates one of the region's largest DC fast-charging networks with 11 charging stations in Kenya and is targeting 1,000 e-buses by 2027. In addition, Roam is also adding to Kenya's e-bus market with a plan to deploy 200 e-buses across Kenya by end-2026.

BasiGo supports public transport operators such as Royal Express and KBS through its Pay-As-You-Drive model, offering two business options: (i) Full Electric Bus Lease and (ii) Battery Lease. Under the Full Electric Bus Lease, operators lease the entire e-bus with a KSH 1 million security deposit and pay KSH 70/km. Under the Battery Lease model, operators purchase the e-bus without the battery at around KSH 7.5 million and lease the battery from BasiGo at KSH 44/km. Both models include services such as charging at BasiGo depots, night inspection and cleaning, free maintenance/service at every 15,000 km intervals, roadside assistance, comprehensive insurance, bus monitoring and analytics through PAYD and a 90% monthly uptime guarantee.

Case Study 2: e-Bus Charging Station with Solar

- A typical e-bus charging hub has 6 DC fast chargers with charger capacity up to 160 kW, resulting in an estimated daily charging demand of around 4,600 kWh/day including 10% charging losses for a hub serving 20 buses/day (each e-bus have a battery capacity of around 176–210 kWh)
- A typical solar-integrated e-bus charging hub can install 300 kWp rooftop/canopy solar generating around 1,500 kWh/day (based on 1 kWp = 5 kWh/day) and can meet ~30% of daily charging demand. This can be paired with BESS to shift daytime solar energy, reduce peak-grid draw, improve charging reliability and support buses returning outside solar-generation hours.
- Under grid-only operation, these charging hubs use Kenya's e-mobility tariff of KES 16/kWh during peak hours and KES 8/kWh during off-peak hours. With partial solar integration, the blended tariff can be reduced around KES 13–14/kWh. Solar integration is most financially attractive when it offsets daytime or peak-period charging and night charging can still use off-peak grid tariff, creating a hybrid operating model where it uses solar during the day and low-cost grid electricity at night.
- A larger charging hub with 10 chargers × 160 kW can have a connected charging load of 1.6 MW, which may allow renewable power sourcing through open access as Kenya's open access eligibility requires a minimum load of 1 MVA (~0.9 MW) on the distribution system, subject to approvals, wheeling charges and commercial structure.
- Solar-integrated charging can improve operational and financial viability by reducing peak-grid dependence, lowering energy cost per bus-km, supporting larger fleet deployment and strengthening the climate-finance case for scaling electric public transport in Kenya.



Credit: BasiGo e-Bus Charging Station

Annex VI: Comparative Electricity-Sector Regulatory Analysis

Background

Electricity markets across Africa are evolving as governments seek to expand renewable-energy deployment, improve grid efficiency and enable greater consumer participation. Against this background, this **Annex** compares the operative regulatory and tariff frameworks in Ethiopia, Uganda, Rwanda, Kenya, Senegal and The Gambia, focusing on net metering, time-of-use tariffs, green open access or equivalent arrangements, and high-tension/low-tension classification thresholds. It identifies established mechanisms and remaining regulatory gaps based on legal instruments, tariff decisions and other publicly available information current to August 2026.

Method and Important Qualifications

- “Operative” means that a specific law, regulation, tariff decision or implementation instrument has commenced. A general power to regulate, a renewable-energy target or a proposal does not qualify.
- “Net metering” means an arrangement in which exported electricity generates bill credits. A feed-in tariff or cash purchase of surplus electricity is reported separately.
- USD conversions are indicative and rounded. They do not alter the legally applicable local-currency tariffs.

FX rates used for USD conversions

Country	FX rate used
Ethiopia	ETB 159.9833/USD — National Bank of Ethiopia, 7 Aug 2026
Uganda	UGX 3,777.81/USD — Bank of Uganda reference dated 29 May 2026, reproduced in ERA's Q3-2026 determination
Rwanda	RWF 1,468.93/USD — midpoint of NBR's 6 Aug 2026 buy/sell quotes, NBR exchange-rate portal
Kenya	KES 129.39/USD — Central Bank of Kenya, 7 Aug 2026
Senegal	XOF 568.25/USD — midpoint of BCEAO's 7 Aug 2026 buy/sell quotes, BCEAO
The Gambia	GMD 73.01/USD — Central Bank of The Gambia , current quote at the cutoff

Comparison across the six countries

Headline comparison across the six countries

Country	Net metering	ToU retail tariff	Direct renewable procurement / open access	Practical HT/LT split
Ethiopia	None identified	No operative ToU schedule identified; smart-meter/ToU work remains developmental	No end-consumer open-access framework	LV 230/400 V; industrial categories historically LV, 15/33 kV MV, and above 66 kV HV
Uganda	Operative, below 500 kW	Operative for commercial and industrial customers	Operative bulk direct-supply regime; ≥1,500 kVA and up to 30% direct procurement	LV 415 V through 500 kVA; HV 11/33 kV above 500 kVA
Rwanda	None identified	Operative industrial ToU maximum-demand tariff	Enabling law exists, but no operational customer-switching/wheeling framework	LV 230/400 V; MV principally 15/30 kV; no universal load threshold

Country	Net metering	ToU retail tariff	Direct renewable procurement / open access	Practical HT/LT split
Kenya	Operative, below 1 MW	Operative commercial/ industrial and e-mobility ToU	Operative 2026 open-access regulations; ≥1 MVA distribution or ≥10 MVA transmission	240/415 V LV; tariffed MV/HT starts at 11 kV
Senegal	No credit-based net metering; regulated surplus sale exists	Operative BT/MT/HT two-period tariff	Operative third-party transmission access; current eligibility threshold 50 MW	Tariff classes BT/MT/HT; no universal connected-load threshold published
The Gambia	Under development	None identified	None identified; IPP/FIT sales to NAWEC are not consumer open access	LV 230/400 V, MV 11/30/33 kV; retail tariff not voltage-differentiated

Overall Conclusions

- **Strongest operative combination:** Kenya has both net metering and a newly operative open-access regime. Uganda also has both, although its direct-supply regime is limited to very large consumers and 30% procurement.
- **ToU maturity:** Uganda, Rwanda, Kenya and Senegal have operative differentiated tariffs. Rwanda uses time-differentiated maximum-demand charges; Kenya and Senegal have no shoulder period; Uganda's current public tariff table omits reliable clock definitions.
- **Surplus sale is not net metering:** Senegal permits licensed cash sale of limited surplus but does not provide bill-credit net metering. The Gambia's FIT likewise concerns sales to the utility.
- **No verified net metering:** Ethiopia, Rwanda, Senegal in the strict credit-based sense, and The Gambia.
- **No operational consumer open access:** Ethiopia, Rwanda and The Gambia.
- **HT/LT classifications are mostly voltage-based:** Uganda provides the clearest load-linked transition at 500 kVA. Kenya starts MV/HT tariff service at 11 kV. Ethiopia, Rwanda, Senegal and The Gambia do not publish a single universal connected-load boundary applicable to all consumers.

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1. Ethiopia

1.1 Net Metering

No operative regulation identified as of August 2026.

The [Energy Proclamation No. 810/2013](#)—Federal Government, published 27 January 2014 and effective on publication—and the [Council of Ministers Energy Regulation No. 447/2019](#) provide the general licensing, tariff and network-service framework. Neither establishes retail net metering, export-credit accounting or a right for a customer-generator to offset imports.

1.2 Time-of-Use (ToU) ariffs

No operative regulation identified as of August 2026.

The [Ethiopian Energy Outlook 2025](#), describes ToU pilots and prospective implementation for large commercial and industrial consumers. EEU's 500,000-smart-meter programme¹ [announcement](#), dated 26 March 2026, provides implementation infrastructure but does not itself establish a ToU tariff.

¹ EEU Implementing 48.8 million USD worth project to install 500 thousand Modern Energy Meters

1.3 Green Open Access or Equivalent

No operative regulation identified as of August 2026.

The 2013 Proclamation and 2019 Regulation allow licensed private generation, PPAs, network-service agreements and sales into the national system. In practice, IPPs contract with Ethiopian Electric Power. That framework does not give an end consumer a right to select an off-site renewable generator, wheel electricity through the public network or form a group-captive arrangement.

1.4 HT versus LT Threshold

Ethiopia's classifications are primarily **voltage-based**, rather than defined by one universal connected-load threshold:

Classification	Technical definition	Older EEU industrial tariff category
LV	Up to 400 V	LV industry, generally supplied at 220/380 V
MV	Above 400 V up to 33 kV	Industry supplied at 15 kV or 33 kV
HV	Above 33 kV	Tariff category described as supply "above 66 kV"

Ethiopia's statutory electricity classifications are voltage-based: low voltage is up to 400 V, medium voltage is above 400 V and up to 33 kV, and high voltage is above 33 kV. Separately, the older published EEU industrial tariff schedule classified industrial consumers as low-voltage industry, medium-voltage industry supplied at 15 kV or 33 kV, and high-voltage industry supplied above 66 kV. These tariff categories should not be treated as the statutory boundaries between LV, MV and HV. No single nationally prescribed connected-load threshold separating these voltage classes was identified.

2. Uganda

2.1 Net Metering

Uganda has a legally operative net-metering framework under the **Electricity (Net Metering) Regulations, 2024² (S.I. No. 14 of 2024)**, made by the Electricity Regulatory Authority on 9 January 2024 and published in the *Uganda Gazette* on 2 April 2024.

Under Uganda's Electricity (Net Metering) Regulations, 2024, all customers supplied by a distribution licensee—including residential, commercial and industrial consumers—may participate using eligible renewable-energy technologies. Installed capacity must be below 500 kilowatts (kW), must not exceed the customer's maximum demand recorded during the preceding 12 months (or the allowed demand where maximum demand is not recorded), and remains subject to network constraints and an aggregate cap of 5% of system peak demand.

A bidirectional meter verified by the Uganda National Bureau of Standards (UNBS) and capable of time-of-use (ToU) metering is required. The prosumer bears the metering and interconnection costs. Exports receive an 80% kilowatt-hour (kWh) credit against energy charges only, with no cash compensation. Credits roll over monthly but lapse at financial year-end, upon ownership change or termination.

2.2 Time-of-Use Tariffs

Uganda has operative ToU retail tariffs for commercial and interval-metered industrial customers. ERA's [Q3-2026 tariff approval](#) was issued 7 July 2026 and applies to meter readings or prepaid purchases from July through September 2026. UEDCL publishes the [detailed approved schedule](#). Rates are energy-only rates in UGX/kWh;

² The Electricity (Net Metering) Regulations, 2024

Uganda Q3-2026 ToU retail tariff (UGX/kWh, USD equivalent)

Category	Peak	Shoulder	Off-peak
Commercial, three-phase LV ≤100 A	UGX 666.5 (\$0.1764)	562.1 (\$0.1488)	429.7 (\$0.1137)
Medium manufacturing, 415 V, ≤500 kVA	436.7 (\$0.1156)	363.8 (\$0.0963)	284.3 (\$0.0753)
Medium service, 415 V, ≤500 kVA	508.6 (\$0.1346)	423.9 (\$0.1122)	331.5 (\$0.0877)
Large manufacturing, block 1	378.2 (\$0.1001)	308.1 (\$0.0816)	239.3 (\$0.0633)
Large manufacturing, declining block 2	356.7 (\$0.0944)	290.6 (\$0.0769)	225.8 (\$0.0598)
Large service	428.8 (\$0.1135)	357.0 (\$0.0945)	286.5 (\$0.0758)
Extra-large manufacturing	233.2 (\$0.0617)	207.7 (\$0.0550)	188.7 (\$0.0499)
Extra-large service, ≥10,000 kVA	310.3 (\$0.0821)	207.7 (\$0.0550)	188.7 (\$0.0499)

The latest retail schedule does **not** reproduce the clock-time definitions. Older primary and utility documents use differing descriptions, and a generation-PPA block definition cannot safely be substituted for retail billing periods. Consequently, reliable August 2026 retail peak/shoulder/off-peak clock times were not identified.

2.3 Green Open Access or Equivalent

Uganda's equivalent is the [Electricity \(Supply of Electricity in Bulk to Specified Consumers\) Regulations, 2022](#), Statutory Instrument 136 of 2022, made 27 December and gazetted 30 December 2022.

Eligibility

- Seller may be a generation licensee, bulk supplier or generator with uncontracted capacity.
- Capacity already committed under an existing PPA is unavailable unless that PPA expires or is amended.
- A consumer may also use an off-site owned generator.
- ERA's latest [eligible-consumer notice register](#) retains an average-demand threshold of **at least 1,500 kVA**.
- An eligible national-grid customer may directly procure up to **30%** of its demand.

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2.4 HT versus LT Threshold

The current UEDCL tariff schedule provides the clearest operative boundary:

- **Domestic LV:** single-phase, 240 V.
- **Commercial LV:** three-phase, not exceeding 100 A.
- **Medium LV:** 415 V, maximum demand up to **500 kVA**.
- **Large HV:** 11 kV or 33 kV, demand **above 500 kVA and up to 1,500 kVA**.
- **Extra-large HV:** 11/33 kV, average demand at least 1,500 kVA for manufacturing; the service subclass begins at 10,000 kVA.

Thus the practical tariff threshold is **above 500 kVA**, when service moves from 415-V LV to 11/33-kV HV. HV customers require demand/interval metering, dedicated transformation and switchgear, protection coordination and grid-code-compliant connection facilities.

3. Rwanda

3.1 Net Metering

No operative regulation identified as of August 2026.

The [RURA electricity regulatory instrument register](#) lists the Electricity Law, licensing rules, Grid Code and quality-of-service instruments but no net-metering regulation, credit formula or standard net-metering agreement.

A 2024 Rwanda C&I solar regulatory guide similarly notes the absence of specific solar-PV/net-metering regulation. It is corroborative, not the source of law.

3.2 Time-of-Use Tariffs

Rwanda's current tariffs were adopted in RURA Decision No. 01/BD/ER-ENERGY/RURA/2025, dated 14 September 2025 and effective 1 October 2025. REG/EUCL publishes the same rates on its current tariff page.

ToU operates through time-differentiated maximum-demand charges for smart-metered post-paid industrial customers; the energy rate itself is constant across periods.

Rwanda industrial ToU maximum-demand tariff (effective 1 October 2025)

Industrial class	Energy rate	Peak MD	Shoulder MD	Off-peak
Small, 5,000–100,000 kWh/year	RWF 175/kWh (\$0.1191)	RWF 11,017/kVA/month (\$7.50)	4,008 (\$2.73)	0
Medium, >100,000–<1 million kWh/year	133 (\$0.0905)	10,514 (\$7.16)	3,588 (\$2.44)	0
Large, ≥1 million kWh/year	110 (\$0.0749)	7,184 (\$4.89)	2,004 (\$1.36)	0
Steel, mining and cement, ≥1 million kWh/year	97 (\$0.0660)	7,184 (\$4.89)	2,004 (\$1.36)	0

Time periods: **Peak:** 18:00–22:59, **Off-peak:** 23:00–07:59 and **Shoulder:** 08:00–17:59.

3.3 Green Open Access or Equivalent

No operative regulation identified as of August 2026.

The Electricity Law No. 21/2011, published in 2011 and effective on Gazette publication, permits licensing for production, supply and sale and contains high-level concepts under which large customers might eventually procure directly.

However, RURA's current market description states that EUCL retains transmission, distribution and sale functions for national-grid customers.

3.4 HT versus LT Threshold³

Rwanda does not publish one universal connected-load threshold separating LT from HT consumers.

Current technical classifications are:

- **LV:** nominal 230/400 V.
- **MV:** principally 15 kV and 30 kV.
- Higher transmission voltages apply to bulk-network connections.

³ REG's Distribution Reticulation Standards, Version VII, issued in 2025, and RURA's Electricity Quality of Service Regulations

4. Kenya

4.1 Net Metering

Kenya's framework is the Energy (Net-Metering) Regulations, 2024, Legal Notice 104 of 2024. It commenced on 18 July 2024 and was published in the Kenya Gazette on 26 July 2024.

Eligibility and limits

- Renewable-energy systems **below 1 MW**.
- Domestic single-phase: maximum **4 kW**.
- Domestic three-phase: maximum **10 kW**.
- Commercial and industrial: maximum **1 MW**, but not above the customer's maximum demand in the preceding 12 months or contracted demand.
- Multiple meters at one facility are aggregated.
- National programme cap: **100 MW for the first five years**, subject to regulatory review.

4.2 Time-of-Use Tariffs

The operative basis remains Gazette Notice No. 3899, Schedule of Tariffs 2023, issued by EPRA on 24 March 2023, effective 1 April 2023. Its Part II rates took effect on 1 July 2025. No replacement schedule had taken effect by 7 August 2026.

Applicable base and off-peak energy rates are:

Kenya ToU energy and demand charges by category

Category / voltage	Standard rate	Off-peak rate	Demand charge
SC3, 100–15,000 kWh/month	KES 19.00/kWh (\$0.1468)	9.50 (\$0.0734)	None
E-mobility	16.00 (\$0.1237)	8.00 (\$0.0618)	As applicable to connection
CI1, 415 V, >15,000 kWh/month	13.44 (\$0.1039)	6.72 (\$0.0519)	KES 1,100/kVA/month (\$8.50)
CI2, 11 kV	12.16 (\$0.0940)	6.08 (\$0.0470)	700 (\$5.41)
CI3, 33 kV	11.68 (\$0.0903)	5.84 (\$0.0451)	370 (\$2.86)
CI4, 66 kV	11.42 (\$0.0883)	5.71 (\$0.0441)	300 (\$2.32)
CI5, 132 kV	11.16 (\$0.0863)	5.58 (\$0.0431)	300 (\$2.32)
CI6, 220 kV	10.00 (\$0.0773)	7.42 (\$0.0573)	200 (\$1.55)
CI7, special economic zones	10.00 (\$0.0773)	7.42 (\$0.0573)	200 (\$1.55)

Periods:

- Weekdays: **22:00–06:00**.
- Saturdays and public holidays: **14:00–08:00 the following day**.
- Sundays: all day.
- No shoulder period.

For SC3 and most CI customers, the off-peak discount applies only to consumption exceeding the prescribed baseline—normally the prior six-month average plus 6%; special initial rules apply to new consumers. CI6 and CI7 are not on a 50% discount, despite general descriptions of Kenya's ToU programme as "half price."

- **Participation:** automatic for an eligible ToU-metered customer when qualifying off-peak consumption occurs; not a separately contracted green tariff.
- **Authority/utility:** EPRA approves; Kenya Power meters and bills.

Kenya Power's 2026 e-mobility transition notice confirms continuing implementation.

4.3 Green Open Access or Equivalent

Kenya enacted the Energy (Electricity Market, Bulk Supply and Open Access) Regulations, 2026, Legal Notice 79 of 2026, commenced and published 8 May 2026. EPRA also hosts the official PDF.

The regulations are technology-neutral but permit renewable corporate procurement.

Eligibility

- Distribution-connected consumer: contracted capacity of at least **1 MVA**.
- Transmission-connected consumer: at least **10 MVA**.
- Consumer may contract with a licensed generator for bulk supply.

Implementation: the legal right is operative, but the market was only three months old at the cutoff. No authoritative register of completed corporate renewable PPAs was located.

4.4 HT versus LT Threshold

Kenya's current tariff and connection classes are voltage-based:

- **Domestic/small commercial:** 240 or 415 V.
- **CI1:** 415 V, generally above 15,000 kWh/month.
- **CI2:** 11 kV.
- **CI3:** 33 kV.
- **CI4:** 66 kV.
- **CI5:** 132 kV.
- **CI6:** 220 kV.

There is no universal statutory connected-load threshold that converts every customer from LT to HT. In tariff practice, supply above 415 V begins at **11 kV** and is treated as MV/HT service.

5. Senegal

5.1 Net Metering and Surplus Sale

No operative regulation identified as of August 2026 for credit-based net metering.

Senegal instead has an operative **surplus-sale/net-billing** framework under:

- Law No. 2021-31 of 9 July 2021 establishing the Electricity Code, Government of Senegal, effective on publication; and
- Decree No. 2023-286 concerning electricity self-generation, issued in 2023 and effective on publication.

Eligibility and capacity

Self-generation is subject to declaration below:

- 500 kW for thermal, hydro or wind;
- 1 MW for solar thermal/PV;
- 2 MW for biomass/waste; and
- 2 MW for other technologies.

Above those levels a self-generation licence is required. **Any sale of surplus requires a surplus-sale licence**, irrespective of the self-generation declaration threshold.

For a surplus-selling installation:

- domestic installed capacity may not exceed **120% of peak demand**;
- professional/industrial capacity may not exceed **110% of equipment nominal demand**; and
- annual exports may not exceed **10% of annual consumption**.

5.2 Time-of-Use Tariffs

CRSE's Senelec tariff schedule dated 26 December 2025 took effect 1 January 2026.

Periods:

- **Off-peak:** 23:00–24:00 and 00:00–19:00.
- **Peak:** 19:00–23:00.
- No shoulder period.

Senegal Senelec ToU tariff (effective 1 January 2026)

Category	Off-peak	Peak	Fixed/demand component
BT domestic, high-power option	XOF 118.37/kWh (\$0.2083)	170.53 (\$0.3001)	XOF 956.13/kW/month (\$1.68)
BT professional, high-power option	140.74 (\$0.2477)	232.23 (\$0.4087)	2,868.39 (\$5.05)
MT short-use/TCU	155.50 (\$0.2736)	248.28 (\$0.4369)	961.76 (\$1.69)
MT general	111.91 (\$0.1969)	184.65 (\$0.3249)	4,093.60 (\$7.20)
MT long-use	91.93 (\$0.1618)	151.72 (\$0.2670)	9,880.54 (\$17.39)
HT general	71.43 (\$0.1257)	108.52 (\$0.1910)	10,028.90 (\$17.65)
HT backup	95.12 (\$0.1674)	144.49 (\$0.2543)	4,458.61 (\$7.85)

- **Participation:** mandatory within the selected/subscribed high-power, MT or HT tariff option. It is not a casual opt-in discount.
- **Authority/utility:** CRSE sets the tariff; Senelec implements it.

5.3 Green Open Access or Equivalent

Senegal now has an operative transmission third-party-access framework.

The Electricity Code, particularly its eligible-customer and network-access provisions, allows an eligible consumer to buy from an independent producer at a bilaterally negotiated energy price. The contract is submitted to CRSE; the network-access tariff remains regulated.

Eligibility and inconsistency between official instruments

An older Order No. 006242 of 29 March 2024 used a 75-MW starting threshold and a staged reduction. It was superseded by Order No. 027819 of 5 November 2024, which reduced the current threshold to 50 MW.

The later order is referenced in CRSE's official 2024 opinion and subsequent decisions, including CRSE Opinion No. 35/2024 and Decision No. 2026-06. The continued availability of the 75-MW instrument on a ministry webpage is therefore misleading; the later 50-MW order is legally controlling.

The customer must be connected to the transmission system and receive eligible-customer status.

5.4 HT versus LT Threshold

The operative Senelec tariff uses three supply groups:

- **BT — basse tension:** low-voltage retail service.
- **MT — moyenne tension:** medium-voltage service.
- **HT — haute tension:** high-voltage service.

The current tariff schedule does not prescribe a universal connected-load number separating them. Senegal's network operates standard LV around 230/400 V, distribution MV including 6.6/30 kV configurations, and transmission principally at 90 and 225 kV. The precise connection voltage is determined through Senelec's connection study and the network configuration.

6. The Gambia

6.1 Net Metering

No operative regulation identified as of August 2026.

The Renewable Energy Act 2013, enacted in 2013, supplies general powers for renewable generation, grid connection and tariff support but does not establish a complete net-metering mechanism.

PURA held a distributed-generation and net-metering stakeholder process on 24–25 March 2026. This confirms that the substantive framework was still being developed.

The draft PURA Unified Fees Regulations 2026 define “net-metering operator” and propose a registration fee of GMD 5,000 (\$68.48). However, the instrument states that it commences only on a date appointed by ministerial Gazette notice; no such commencement notice was identified; and a fee regulation alone would not establish capacity, metering, credit or settlement rules.

6.2 Time-of-Use Tariffs

No operative regulation identified as of August 2026.

PURA's current electricity tariff page shows flat or consumption-block tariffs, without peak, shoulder or off-peak periods and without ToU demand charges.

6.3 Green Open Access or Equivalent

No operative regulation identified as of August 2026.

The Electricity Act and Renewable Energy Act permit licensed generation and sales to the national utility. The government's National Energy Policy discusses market development and possible open access, but no implementing regulations were located that give an end consumer a legally enforceable right to buy renewable electricity from a third-party generator through NAWEC's network.

6.4 HT versus LT Threshold

No current statutory connected-load threshold separating LT and HT retail consumers was identified.

The system's principal voltage classes are approximately:

- **LV:** 230/400 V.
- **MV:** 11 kV, 30 kV and 33 kV depending on network area.
- **Regional/bulk transmission:** 225 kV on the OMVG interconnection.

The current PURA retail tariff is based on consumer use—domestic, commercial, hotel/industry, agriculture and government—rather than connection voltage. It does not prescribe separate LT and HT energy or demand tariffs.

The government's Electricity Sector Strategic Roadmap describes these network levels, but it does not create a statutory kW/kVA boundary for consumer classification.

Bibliography

- [1]. Global Solar Council. Africa Market Outlook 2026–2029: Africa Market Outlook for Solar PV. Brussels: Global Solar Council, 2026. [Online]. Available: <https://www.globalsolarcouncil.org/>
- [2]. International Renewable Energy Agency (IRENA), Renewable Energy for Remote Communities: A Guidebook for Off-Grid Projects. 2023. [Online]. Available: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Nov/IRENA_Remote_Communities_2023.pdf
- [3]. IEA, “IEA, Access to electricity,” <https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity>. Accessed: May 20, 2026. [Online]. Available: <https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity>
- [4]. “Access to electricity (% of population) - Sub-Saharan Africa | Data.” Accessed: Jun. 24, 2026. [Online]. Available: <https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=ZG>
- [5]. RES4Africa, “From ambition to action: what’s missing between Africa’s energy potential and the deployment of RES solutions - RES4Africa.” Accessed: May 20, 2026. [Online]. Available: <https://res4africa.org/news/2022/from-ambition-to-action-whats-missing-between-africas-energy-potential-and-the-deployment-of-res-solutions/>
- [6]. S. Szabó et al., “Mapping of affordability levels for photovoltaic-based electricity generation in the solar belt of sub-Saharan Africa, East Asia and South Asia,” *Scientific Reports* 2021 11:1, vol. 11, no. 1, pp. 3226–, Feb. 2021, doi: 10.1038/s41598-021-82638-x.
- [7]. A. T. Carabajal et al., “Social and economic impact analysis of solar mini-grids in rural Africa: a cohort study from Kenya and Nigeria,” *Environmental Research: Infrastructure and Sustainability*, vol. 4, no. 2, Jun. 2024, doi: 10.1088/2634-4505/AD4FFB.
- [8]. T. Laku, “Case Study: Empowering Financial Inclusion Through Technology in Africa: M-Kopa’s Model.” Accessed: May 20, 2026. [Online]. Available: <https://www.timothylaku.com/post/case-study-empowering-financial-inclusion-through-technology-in-africa-m-kopa-s-pay-as-you-go-sol>
- [9]. J. Lee, “Solar Energy in Rural Kenya: A Pathway Out of Poverty - The Borgen Project.” Accessed: May 20, 2026. [Online]. Available: <https://borgenproject.org/solar-energy-in-rural-kenya/>
- [10]. O. Adigun, “REA deploys over 200 mini-grids in 2025, targets 1,350 power projects - Nairametrics.” Accessed: May 20, 2026. [Online]. Available: <https://nairametrics.com/2025/12/25/rea-deploys-over-200-mini-grids-in-2025-targets-1350-power-projects/>
- [11]. RMI, “Sharing the Power: Community-Led Minigrids - RMI.” Accessed: May 20, 2026. [Online]. Available: <https://rmi.org/rmi-insights/sharing-the-power/>
- [12]. RMI, “Productive Use - RMI.” Accessed: May 20, 2026. [Online]. Available: <https://rmi.org/productive-use/>
- [13]. A. SHRESTHA and C. OBI, “Nigeria DARES Project.” Accessed: May 20, 2026. [Online]. Available: <https://share.google/KxXrfxsQRf258r574>
- [14]. Rural Electrification Agency (REA). Project Implementation Manual for the Distributed Access Through Renewable Energy Scale-Up (DARES) Project. Abuja, Nigeria: Rural Electrification Agency, June 2025. [Online]. Available: https://nep.rea.gov.ng/assets/documents/resource-hub/DARES_PIM_Final.pdf
- [15]. Rural Electrification Agency (REA), “Nigeria Electrification Programme (NEP)- Distributed Access through Renewable Energy Scale-up (DARES).” Accessed: May 20, 2026. [Online]. Available: <https://nep.rea.gov.ng/dares.html>
- [16]. CrossBoundary, “Appliance Financing 3.0 Mini-Grid Innovation Insight – CrossBoundary Innovation Lab,” Jan. 10, 2023. [Online]. Available: <https://crossboundary.com/mini-grid-innovation-insight-appliance-financing-3-0-crossboundary-innovation-lab/>
- [17]. Z. Y. I. Abba, N. Balta-Ozkan, and G. Drew, “Catalysing decentralised renewable energy investment in Nigeria: Investor-focused risk evaluation and de-risking strategies,” *Renewable and Sustainable Energy Transition*, vol. 7, p. 100112, Jun. 2025, doi: 10.1016/J.RSET.2025.100112.
- [18]. International Energy Agency, “Financing Electricity Access in Africa -- Analysis - IEA.” Accessed: May 20, 2026. [Online]. Available: <https://www.iea.org/reports/financing-electricity-access-in-africa>
- [19]. “Unlocking diaspora remittances: A strategic blueprint for shifting consumption-based remittances into investment - The Business & Financial Times.” Accessed: Jun. 24, 2026. [Online]. Available: <https://thebftonline.com/2026/05/19/unlocking-diaspora-remittances-a-strategic-blueprint-for-shifting-consumption-based-remittances-into-investment/>
- [20]. “How Remittances Are Transforming African Communities.” Accessed: Jun. 24, 2026. [Online]. Available: <https://www.sendvalu.com/en/blog/article/how-remittances-are-transforming-african-communities>
- [21]. “Designing Responsible End-User Subsidies.” Accessed: Jun. 24, 2026. [Online]. Available: <https://documents1.worldbank.org/curated/en/099071524185022858/pdf/P174361181b66e0011a3921a4f2f50753cb.pdf>
- [22]. Global Platform for Action (GPA) Coordination Unit. Blended Finance Solutions for Clean Energy in Humanitarian and Displacement Settings: Lessons Learnt -- An Initial Overview. January 2022. [Online]. Available: <https://www.nrc.no/globalassets/pdf/reports/blended-finance-solutions-for-clean-energy/blended-finance-solutions-for-clean-energy-in-humanitarian-and-displacement-settings.pdf>
- [23]. Falchetta, G., Semeria, F., Tuninetti, M., Giordano, V., Pachauri, S., & Byers, E. “Solar irrigation in sub-Saharan Africa: Economic feasibility and development potential.” *Environmental Research Letters*, 18(9), Article 094044, September 2023. <https://doi.org/10.1088/1748-9326/acefe5>
- [24]. IRENA Coalition for Action (2026), Solar-powered agri-food systems: Seven success stories, International Renewable Energy Agency, Abu Dhabi. [Online]. Available: https://coalition.irena.org/-/media/Files/IRENA/Coalition-for-Action/Publication/IRENA_PAR_Coalition_Solar-powered_agri-food_2026.pdf
- [25]. S. Schneider, M. Raabe, K. Fahsold, and M. Yetano Roche, Productive Use of Solar Energy: About the Sustainable Energy Solutions Catalogue. SESA, Factsheet 2, 2024. [Online]. Available: https://sesa-euafrika.eu/wp-content/uploads/2024/02/SESA-factsheet-2-Productive-Use-Solutions_Approved.pdf
- [26]. International Renewable Energy Agency (IRENA) and Food and Agriculture Organization of the United Nations (FAO). Renewable Energy and Agri-food Systems: Advancing Energy and Food Security towards Sustainable Development Goals. Abu Dhabi and Rome: IRENA and FAO, 2021. <https://doi.org/10.4060/cb7433en>
- [27]. Powering Renewable Energy Opportunities (PREO). Cultivating Opportunities in Africa: Powering Agricultural Productivity Through Renewable Energy Integration. No-

- ember 2024. [Online]. Available: <https://www.preo.org/reports/cultivating-opportunities-in-africa-report/>
- [28]. Regional Center for Renewable Energy and Energy Efficiency (RCREEE). Diesel to Solar Transformation: Accelerating Achievement of SDG 7 on Sustainable Energy -- Assessing Untapped Solar Potential in Existing Off-grid Systems in the Arab Region. Cairo, Egypt: RCREEE, 2016. [Online]. Available: https://rise.esmap.org/sites/default/files/library/yemen%2C-rep./Renewable%20Energy/Yemen_Diesel%20to%20Solar%20Transformation_2016.pdf
- [29]. International Renewable Energy Agency (IRENA). Solar Pumping for Irrigation: Improving Livelihoods and Sustainability. 2016. [Online]. Available: <https://www.irena.org/Publications/2016/Jun/Solar-Pumping-for-Irrigation-Improving-livelihoods-and-sustainability>
- [30]. International Renewable Energy Agency (IRENA) and African Development Bank (AfDB). Renewable Energy Market Analysis: Africa and Its Regions. Abu Dhabi: International Renewable Energy Agency, 2022. [Online]. Available: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Market_Africa_2022.pdf
- [31]. M. Smith, G. Muñoz, and J. Sanz Alvarez, Irrigation Techniques for Small-scale Farmers: Key Practices for DRR Implementers. FAO, 2014. [Online]. Available: <https://openknowledge.fao.org/handle/20.500.14283/i3765e>
- [32]. Regional Center for Renewable Energy and Energy Efficiency (RCREEE), Inass Abou-Khodier, and Maged Mahmoud. Market Assessment Study of Socio-Economic Impacts of Solar Pumping Systems in Terms of Local Job and Value Creation in Egypt. Cairo: RCREEE, 2017. [Online]. Available: <https://www.rcreee.org/>
- [33]. R. J. Randle-Boggis et al., "Harvesting the sun twice: Energy, food and water benefits from agrivoltaics in East Africa," *Renewable and Sustainable Energy Reviews*, vol. 208, Feb. 2025, doi: 10.1016/j.rser.2024.115066.
- [34]. Global Green Growth Institute (GGGI). Landscape Analysis Report to Scale Up the Installation of Solar Irrigation Businesses in Senegal. November 2020. [Online]. Available: <https://gggi.org/report/landscape-analysis-report-to-scale-up-the-installation-of-solar-irrigation-businesses-in-senegal/>
- [35]. Shortlist, FSD Africa, and Boston Consulting Group (BCG). Forecasting Green Jobs in Africa. July 2024. [Online]. Available: <https://www.fsdafrica.org/publication/forecasting-green-jobs-in-africa/>
- [36]. M. Cameron, "Intra-Africa and Global Trade," Cold Facts, Global Cold Chain Alliance, May–June 2025. [Online]. Available: <https://www.gcca.org/wp-content/uploads/2023/05/GCCA-Cold-Facts-Magazine-May-June-2025-1.pdf>
- [37]. "Universal Access to Clean Cooking in Africa -- Analysis - IEA." Accessed: Jun. 23, 2026. [Online]. Available: <https://www.iea.org/reports/universal-access-to-clean-cooking-in-africa>
- [38]. N. Durga et al., "Barriers to the uptake of solar-powered irrigation by smallholder farmers in sub-saharan Africa: A review," *Energy Strategy Reviews*, vol. 51, Jan. 2024, doi: 10.1016/j.esr.2024.101294.
- [39]. A. E. Cheo, N. Adelhardt, T. Krieger, et al., "Agrivoltaics across the Water-Energy-Food-Nexus in Africa: Opportunities and Challenges for Rural Communities in Mali," Discussion Paper Series, No. 2022-03, University of Freiburg, 2022. [Online]. Available: <https://hdl.handle.net/10419/253418>
- [40]. S. Agrawal and A. Jain, "Solar Pumps for Sustainable Irrigation: A Budget Neutral Opportunity," CEEW Policy Brief, Council on Energy, Environment and Water, New Delhi, 2015. [Online]. Available: <https://www.ceew.in/publications/solar-pumps-sustainable-irrigation>
- [41]. Rahman, Anas, Shalu Agrawal, and Abhishek Jain. 2021. Powering Agriculture in India: Strategies to Boost Components A & C Under PM-KUSUM Scheme. New Delhi: Council on Energy, Environment and Water. [Online]. Available: <https://www.ceew.in/publications/powering-irrigation-system-with-solar-powered-plants-and-grid-pumps-in-india>
- [42]. Global Green Growth Institute (GGGI). Solar Powered Irrigation Systems (SPIS): Potential and Perspectives in Sub-Saharan Africa. GGGI Technical Report No. 39, October 2024. [Online]. Available: <https://gggi.org/report/solar-powered-irrigation-systems-spis-potential-and-perspectives-in-sub-saharan-africa/>
- [43]. "TAAT to leverage lessons learned from AGRA." Accessed: Jun. 23, 2026. [Online]. Available: <https://www.iita.org/news-item/taat-to-leverage-lessons-learned-from-agra/>
- [44]. "Project Cluster Evaluation of the AfDB's Technology for African Agriculture Transformation (TAAT) Program-Phase I Summary Report," 2023.
- [45]. Global Panel on Agriculture and Food Systems for Nutrition. Building Resilience and Enhancing Nutrition in Africa's Food Systems. 2025. [Online]. Available: <https://www.glopan.org/building-resilience-and-enhancing-nutrition-in-africas-food-systems/>
- [46]. M. Otoo, N. Lefore, P. Schmitter, J. Barron, and G. Gebregziabher, "Business Model Scenarios and Suitability: Smallholder Solar Pump-based Irrigation in Ethiopia," IWMI Research Report 172, International Water Management Institute, 2018, doi: 10.5337/2018.207.
- [47]. D. Eck, Accelerating Solar System Adoption in South Africa: The Role of Business Models in Rural Electrification. Master's thesis, KTH Royal Institute of Technology, 2025. [Online]. Available: <https://kth.diva-portal.org/smash/record.jsf?pid=diva2:1952230>
- [48]. S. Agrawal and A. Jain, "Sustainable deployment of solar irrigation pumps: Key determinants and strategies," Mar. 01, 2019, John Wiley and Sons Ltd. doi: 10.1002/wene.325.
- [49]. "Employment in agriculture in Africa | TheGlobalEconomy.com." Accessed: Jun. 23, 2026. [Online]. Available: https://www.theglobaleconomy.com/rankings/employment_in_agriculture/Africa/
- [50]. Ministry of Energy and Mineral Development (MEMD). National Road Map on Scaling Up Productive Use of Solar Energy: Leveraging Solar Energy for Economic Empowerment and Food Security. 2023. [Online]. Available: <https://nrep.ug/wp-content/uploads/2023/08/National-Road-Map-on-Scaling-Up-Productive-Use-of-Solar-Energy-1.pdf>
- [51]. GOGLA. Uganda Productive Use of Renewable Energy Market Assessment. July 2023. [Online]. Available: <https://gogla.org/reports/productive-uses-of-renewable-energy-pure-uganda-roadmap-and-market-assessment/>
- [52]. A. Eberhard, J. Kolker, and J. Leigland, South Africa's Renewable Energy IPP Procurement Program: Success Factors and Lessons. Washington, DC: Public-Private Infrastructure Advisory Facility (PPIAF), World Bank Group, May 2014. [Online]. Available: <https://ppp.worldbank.org/library/south-africa-s-renewable-energy-ipp-procurement-program-success-factors-and-lessons>
- [53]. K. Rangelova, How Cheap Is Battery Storage? Ember, December 2025. [Online]. Available: <https://ember-energy.org/latest-insights/how-cheap-is-battery-storage/>
- [54]. International Renewable Energy Agency (IRENA), 24/7 Renewables: The Economics of Firm Solar and Wind. Abu Dhabi: IRENA, 2026. [Online]. Available: <https://www.irena.org/Publications/2026/May/24-7-renewables-The-economics-of-firm-solar-and-wind>
- [55]. M. Were, "Public debt challenges in sub-Saharan Africa," The Domestic Savings Shortfall in Sub-Saharan Africa: What Can Be Done About It?, pp. 117–142, Jan. 2025, doi: 10.1093/OSO/9780198932482.003.0006.
- [56]. "A world of debt: Regional stories | UN Trade and Devel-

- opment (UNCTAD)." Accessed: Apr. 20, 2026. [Online]. Available: <https://unctad.org/publication/world-of-debt/regional-stories>
- [57]. "Currency Conundrums: Volatile African Exchange Rates and What Can Be Done | MIT Sloan." Accessed: Apr. 20, 2026. [Online]. Available: <https://mitsloan.mit.edu/centers-initiatives/ksc/currency-conundrums-volatile-african-exchange-rates-and-what-can-be-done>
- [58]. "Scaling Up Local Currency Lending: A Strategic Imperative for Africa | Office of the Special Adviser on Africa." Accessed: Apr. 20, 2026. [Online]. Available: <https://www.un.org/osaah/news/scaling-local-currency-lending-strategic-imperative-africa>
- [59]. Dagal, "Decoding Africa's energy divide: A systematic review of SDG 7 progress, structural determinants, and pathways to inclusive electrification," *Unconventional Resources*, vol. 10, p. 100330, Mar. 2026, doi: 10.1016/J.UNCRES.2026.100330.
- [60]. N. Ifeanyi-Nwaoha, "Energising Africa: Enabling Private Sector Development in Renewable Energy," 2025, doi: 10.59184/pb025.03.
- [61]. "Corruption Perceptions Index 2025: Public sector... - Transparency.org." Accessed: Apr. 20, 2026. [Online]. Available: <https://www.transparency.org/en/press/corruption-perceptions-index-2025-public-sector-corruption-sub-saharan-africa-face-highest-corruption-levels-globally>
- [62]. C. Maslen, "Corruption Risks in Mozambique's Energy Sector," U4 Helpdesk Answer 2024:31, U4 Anti-Corruption Resource Centre, Chr. Michelsen Institute, 2024. [Online]. Available: <https://www.u4.no/publications/corruption-risks-in-mozambiques-energy-sector>
- [63]. R. Yin and J. Liu, "How does corruption hinder energy transition? A perspective from Sub-Saharan Africa," *Energy Policy*, vol. 206, p. 114778, Nov. 2025, doi: 10.1016/J.ENPOL.2025.114778.
- [64]. "Three frontlines in Africa's resource conflicts | DIIS." Accessed: Apr. 20, 2026. [Online]. Available: <https://www.diis.dk/en/research/three-frontlines-in-africas-resource-conflicts>
- [65]. "A Just Transition: Business and Human Rights in East Africa - International Alert." Accessed: Apr. 20, 2026. [Online]. Available: <https://www.international-alert.org/blogs/a-just-transition-business-and-human-rights-in-east-africa/>
- [66]. M. M. Akrofi, B. C. McLellan, and M. Okitasari, "Characterizing 'injustices' in clean energy transitions in Africa," *Energy for Sustainable Development*, vol. 83, p. 101546, Dec. 2024, doi: 10.1016/J.ESD.2024.101546.
- [67]. M. R. Ali, M. Shafiq, and M. Andejany, "Determinants of consumers' intentions towards the purchase of energy efficient appliances in pakistan: An extended model of the theory of planned behavior," *Sustainability (Switzerland)*, vol. 13, no. 2, pp. 1–17, Jan. 2021, doi: 10.3390/SU13020565.
- [68]. African Development Bank Group (AfDB). Electricity Regulatory Index for Africa 2024. [Online]. Available: <https://www.afdb.org/en/documents/electricity-regulatory-index-africa-2024>
- [69]. African Energy Chamber (AEC), in partnership with S&P Global Commodity Insights. The State of African Energy 2026 Outlook Report. September 2025. [Online]. Available: <https://energychamber.org/report/the-state-of-the-african-energy-2026-outlook-report/>
- [70]. International Energy Agency (IEA), Financing Clean Energy in Africa. World Energy Outlook Special Report, Paris: IEA, 2023. doi: 10.1787/0d5a2eee-en. [Online]. Available: <https://www.iea.org/reports/financing-clean-energy-in-africa>
- [71]. CPCS, Policy Guidelines for the Development of Pro-Poor Electricity Tariffs and Charges, Enhancement of a Sustainable Regional Energy Market – Eastern Africa, Southern Africa, and Indian Ocean (ESREM: EA-SA-IO), CPCS Ref. 19479, 2022. [Online]. Available: <https://www.comesa.int/wp-content/uploads/2023/02/Lifeline-Tariff-Policy-Guidelines-Final.pdf>
- [72]. Niranjana Sarangi and Daniel Griswold, "Debt Swap for Climate and SDGs Finance in the Arab Region," 2020. Accessed: Apr. 21, 2026. [Online]. Available: https://www.unescwa.org/sites/default/files/event/materials/ESCWA_Paper_Debt_Swap_for_Climate_and_SDGs_Finance.pdf
- [73]. Udo Udoma & Belo-Osagie (UUBO). Green Finance in Nigeria: 2025 in Review and Outlook for 2026. 2026. [Online]. Available: <https://uubo.org/wp-content/uploads/2026/01/Green-Finance-in-Nigeria-2025-in-Review-and-Outlook-for-2026.pdf>
- [74]. "Political risk insurance and guarantees | RMID." Accessed: Apr. 21, 2026. [Online]. Available: <https://rmid-oecd.asean.org/political-risk-insurance-and-guarantees/>
- [75]. K. Sharma et al., "Bibliometric Review of Blended Finance and Partial Risk Guarantee: Establishing Needs and Advantages," *International Journal of Financial Studies* 2023, Vol. 11, Page 103, vol. 11, no. 3, p. 103, Aug. 2023, doi: 10.3390/IJFS11030103.
- [76]. "Letter of Credit (LoC) in Renewable Energy Project Finance." Accessed: Apr. 21, 2026. [Online]. Available: <https://courses.renewablesvaluationinstitute.com/pages/academy/letter-of-credit-loc-in-renewable-energy-project-finance>
- [77]. T. Alex-Oke et al., "Renewable energy market in Africa: Opportunities, progress, challenges, and future prospects," *Energy Strategy Reviews*, vol. 59, p. 101700, May 2025, doi: 10.1016/J.ESR.2025.101700.
- [78]. W. Wang and Z. Lu, "Cyber security in the Smart Grid: Survey and challenges," *Computer Networks*, vol. 57, no. 5, pp. 1344–1371, Apr. 2013, doi: 10.1016/J.COM-NET.2012.12.017.
- [79]. A. A. Adenle, "Assessment of solar energy technologies in Africa—opportunities and challenges in meeting the 2030 agenda and sustainable development goals," *Energy Policy*, vol. 137, Art. no. 111180, 2020, doi: 10.1016/j.enpol.2019.111180. [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S0301421519307669>.
- [80]. S. S. S. R. Depuru, L. Wang, and V. Devabhaktuni, "Electricity theft: Overview, issues, prevention and a smart meter-based approach to control theft," *Energy Policy*, vol. 39, no. 2, pp. 1007–1015, Feb. 2011, doi: 10.1016/J.ENPOL.2010.11.037.
- [81]. S. Adams, F. Atsu, E. M. Klobodu, and L. Richmond, "Electricity transmission, distribution losses and economic growth in South Africa," *Heliyon*, vol. 6, no. 11, Nov. 2020, doi: 10.1016/j.heliyon.2020.e05564.
- [82]. P. A. Trotter, M. C. McManus, and R. Maconachie, "Electricity planning and implementation in sub-Saharan Africa: A systematic review," *Renewable and Sustainable Energy Reviews*, vol. 74, pp. 1189–1209, Jul. 2017, doi: 10.1016/J.RSER.2017.03.001.
- [83]. L. Hirth, "The market value of variable renewables: The effect of solar wind power variability on their relative price," *Energy Econ.*, vol. 38, pp. 218–236, Jul. 2013, doi: 10.1016/J.ENERCO.2013.02.004.
- [84]. A. Eberhard, K. Gratwick, E. Morella, and P. Antmann, "Independent Power Projects in Sub-Saharan Africa: Investment trends and policy lessons," *Energy Policy*, vol. 108, pp. 390–424, Sep. 2017, doi: 10.1016/J.ENPOL.2017.05.023.
- [85]. "Pay-as-you-go contracts for electricity access: Bridging the 'last mile' gap? A case study in Benin - Science-Direct." Accessed: Jun. 29, 2026. [Online]. Available:

- <https://www.sciencedirect.com/science/article/abs/pii/S0140988320301833?via%3Dihub>
- [86]. "M. I. Imam, T. Jamasb, and M. Llorca, "Sector reforms and institutional corruption: Evidence from electricity industry in Sub-Saharan Africa," *Energy Policy*, vol. 129, pp. 532–545, Jun. 2019, doi: 10.1016/J.ENPOL.2019.02.043.
 - [87]. O. A. Aluko, E. E. O. Opoku, M. Ibrahim, and N. K. Kufuor, "Put on the light! Foreign direct investment, governance and access to electricity," *Energy Econ.*, vol. 119, p. 106563, Mar. 2023, doi: 10.1016/J.ENERG.2023.106563.
 - [88]. G. Schwerhoff and M. Sy, "Financing renewable energy in Africa -- Key challenge of the sustainable development goals," *Renewable and Sustainable Energy Reviews*, vol. 75, pp. 393–401, Aug. 2017, doi: 10.1016/J.RSER.2016.11.004.
 - [89]. International Energy Agency (IEA), *Electricity Grids and Secure Energy Transitions: Enhancing the Foundations of Resilient, Sustainable and Affordable Power Systems*. Paris: IEA, 2023. [Online]. Available: <https://www.iea.org/reports/electricity-grids-and-secure-energy-transitions>
 - [90]. International Energy Agency (IEA), *Financing Clean Energy Transitions in Emerging and Developing Economies*. World Energy Investment 2021 Special Report, Paris: IEA, 2021. [Online]. Available: <https://www.iea.org/reports/financing-clean-energy-transitions-in-emerging-and-developing-economies>
 - [91]. S. Isihak, U. Akpan, and S. Bhattacharyya, "Evolution of GIS-based rural electrification planning models and an application of OnSSET in Nigeria," *Renewable and Sustainable Energy Transition*, vol. 2, p. 100019, Aug. 2022, doi: 10.1016/J.RSET.2022.100019.
 - [92]. G. Godínez-Zamora et al., "Decarbonising the transport and energy sectors: Technical feasibility and socioeconomic impacts in Costa Rica," *Energy Strategy Reviews*, vol. 32, Nov. 2020, doi: 10.1016/j.esr.2020.100573.
 - [93]. International Energy Agency (IEA), *Digitalisation and Energy*. Paris: IEA, 2017. [Online]. Available: <https://iea.blob.core.windows.net/assets/b1e6600c-4e40-4d9c-809d-1d1724c763d5/DigitalizationandEnergy3.pdf>.
 - [94]. "Five government approaches to promote solar hybrid mini grids in Africa: Which works when---and why?" Accessed: May 23, 2026. [Online]. Available: <https://documents1.worldbank.org/curated/en/099039002132514792/pdf/IDU-52542576-023c-409c-bad5-76fd525343f.pdf>
 - [95]. Ani Balabanyan, Yadviga Semikolenova, Arun Singh, And Min A Lee., "Utility Performance and Behavior in Africa Today," Jun. 2021. Accessed: May 23, 2026. [Online]. Available: <https://documents1.worldbank.org/curated/en/440591628869078878/pdf/Summary-Report.pdf>
 - [96]. M. Moner-Girona et al., "A multidimensional high-resolution assessment approach to boost decentralised energy investments in Sub-Saharan Africa," *Renewable and Sustainable Energy Reviews*, vol. 148, Sep. 2021, doi: 10.1016/J.RSER.2021.111282.
 - [97]. "Umeme FY 2022 Results Presentation, Energy sector in Uganda." 2022, pp. 0–23. Accessed: May 23, 2026. [Online]. Available: https://www.umeme.co.ug/umeme_api/wp-content/uploads/2023/03/Umeme_FY-2022-Results-Presentation-.pdf
 - [98]. "Implementation Completion and Results Report," Republic of Ghana, Jan. 2025. Accessed: May 23, 2026. [Online]. Available: <https://documents1.worldbank.org/curated/en/099021625182512351/pdf/BOSIB-7cd4cb3a-13e6-41b8-8724-7889610a637c.pdf>
 - [99]. The Kenya Power and Lighting Company PLC, *The Abridged Report and Financial Statements for the Year Ended 30 June 2025*. 2025. [Online]. Available: <https://kplc.co.ke/storage/01K9BVVYAZ6V5YFCJKBW5C33W.pdf>.
 - [100]. "Implementation Completion Report (Ida-24890) On A Credit in The Amount of Us\$200 million Equivalent to the United Republic of Tanzania for Tanzania Power VI Project," World Bank. Accessed: May 23, 2026. [Online]. Available: <https://documents1.worldbank.org/curated/en/264191468760799364/pdf/267450icr.pdf>
 - [101]. M. Khalid, "Smart grids and renewable energy systems: Perspectives and grid integration challenges," *Energy Strategy Reviews*, vol. 51, Jan. 2024, doi: 10.1016/J.ESR.2024.101299.
 - [102]. "Transmission Development Plan 2023-2032," South Africa, 2023. Accessed: May 23, 2026. [Online]. Available: https://www.eskom.co.za/wp-content/uploads/2023/11/Transmission_Development_Plan_2023%E2%80%932032_Rev2.pdf
 - [103]. International Energy Agency (IEA), *Integrating Variable Renewable Energy in Kenya: Key Challenges and Strategic Priorities*. Paris: IEA, 2026. [Online]. Available: <https://www.iea.org/reports/integrating-variable-renewable-energy-in-kenya>.
 - [104]. "Sub-Saharan Africa: Policies and Finance for Renewable Energy Deployment," 2024. Accessed: May 23, 2026. [Online]. Available: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Jul/IRENA_SS_Africa_policies_finance_RE_2024.pdf
 - [105]. World Bank. *The Critical Link: Empowering Utilities for the Energy Transition*. Washington, DC: World Bank, May 2024. doi: <https://doi.org/10.1596/41618>
 - [106]. "Take a data-led approach to scale clean energy access with ARE Member VIDA - The Alliance for Renewable Electrification." Accessed: May 23, 2026. [Online]. Available: <https://renewelec.org/take-a-data-led-approach-to-scale-clean-energy-access-with-are-member-vida/>
 - [107]. "Morocco Infrastructure Review," World Bank. Accessed: May 23, 2026. [Online]. Available: <https://documents1.worldbank.org/curated/en/194961592448114381/pdf/Morocco-Infrastructure-Review.pdf>
 - [108]. C. Warburg, T. Kivevele, and T. Pogrebnya, "Solar Technology Penetration in Sub-Saharan Africa: Status, Drivers, Barriers, and Future Prospects," *Journal of Sustainable Development of Energy, Water and Environment Systems*, vol. 14, no. 1, pp. 1–29, Mar. 2026, doi: 10.13044/J.SDEWES.D13.0648.
 - [109]. Directorate-General for Energy, European Commission, *Scaling-up Energy Investments in Africa for Inclusive and Sustainable Growth: Report of the Africa–Europe High-Level Platform for Sustainable Energy Investments in Africa*, 2019. [Online]. Available: https://international-partnerships.ec.europa.eu/document/download/5d300b44-de22-49c1-ac5b-a2e4226c72c1_en?filename=sei-platformreport-executive-summary_en.pdf.
 - [110]. E. Akcura, A. O. Adewole, and E. Mutambatsere, "Repurposing Power Markets: The Path to Sustainable and Affordable Energy for All," International Finance Corporation, Washington, DC, 2024. [Online]. Available: <https://www.ifc.org/content/dam/ifc/doc/2024/repurposing-power-markets.pdf>
 - [111]. World Bank Group, *The Role of Blended Finance in an Evolving Global Context*. Technical Note for the International Financial Architecture Working Group of the G20, 2025. [Online]. Available: <https://www.ifc.org/content/dam/ifc/doc/2025/role-of-blended-finance-in-an-evolving-global-context.pdf>.
 - [112]. D. Carr and M. Thomson, "Non-Technical Electricity Losses," *Energies*, vol. 15, no. 6, p. 2218, Mar. 2022, doi: 10.3390/EN15062218.
 - [113]. B. K. Jack and G. Smith, "Charging Ahead: Prepaid Electricity Metering in South Africa," 2016, Accessed: Jun. 29, 2026. [Online]. Available: <http://www.nber.org/data-appendix/w22895>

- [114]. International Energy Agency (IEA), "Enhancing Cyber Resilience in Electricity Systems," part of Electricity Security 2021, Paris: IEA, 2021. [Online]. Available: <https://www.iea.org/reports/enhancing-cyber-resilience-in-electricity-systems>.
- [115]. United Nations Development Programme (UNDP), Accelerating the SDGs through Digital Public Infrastructure: A Compendium of the Potential of Digital Public Infrastructure. 2023. [Online]. Available: <https://www.undp.org/publications/accelerating-sdgs-through-digital-public-infrastructure-compedium-potential-digital-public-infrastructure>.
- [116]. "Digital Public Infrastructure and Development: A World Bank Group Approach," World Bank Group. Accessed: May 23, 2026. [Online]. Available: <https://documents1.worldbank.org/curated/en/099031025172027713/pdf/P505739-84c5073b-9d40-4b83-a211-98b2263e87dd.pdf>
- [117]. "Scaling Infrastructure." Accessed: Jun. 29, 2026. [Online]. Available: <https://documents1.worldbank.org/curated/en/478221582537751050/pdf/Scaling-SolarThe-Complete-Package.pdf>
- [118]. "Africa GIS Catalogue for Energy Planning -- Data Tools - IEA." Accessed: May 23, 2026. [Online]. Available: <https://www.iea.org/data-and-statistics/data-tools/africa-gis-catalogue-for-energy-planning>
- [119]. GET.transform, Power Futures Lab, and Sustainable Renewables Risk Mitigation Initiative (SRMI), Driving Growth: Effective Renewable Energy Tendering in Africa: Success Factors for Private Power Investment and Procurement. 2024. [Online]. Available: <https://www.get-transform.eu/driving-growth-effective-renewable-energy-tendering-in-africa/>.
- [120]. R. Marais et al., "Generation Connection Capacity Assessment 2025: Connection Capacity for IPP Generators," Eskom Transmission Division, Oct. 2023. [Online]. Available: https://www.eskom.co.za/wp-content/uploads/2023/10/Generation_Connection_Capacity_AssessmentGC-CA-2025finalfinal_rev0003.pdf
- [121]. "International Development Association Project Appraisal Document," World Bank. Accessed: May 24, 2026. [Online]. Available: <https://documents1.worldbank.org/curated/en/819241600653622828/pdf/Rwanda-Energy-Access-and-Quality-Improvement-Project.pdf>
- [122]. "Nigeria Integrated Energy Planning Tool." Accessed: May 24, 2026. [Online]. Available: <https://nigeria-iep.sdg7energyplanning.org/>
- [123]. "Improving Utility Governance and Management in West Africa," World Bank. Accessed: May 24, 2026. [Online]. Available: <https://openknowledge.worldbank.org/server/api/core/bitstreams/0795f8b4-6d70-4fdb-a47d-767e41c0e8ec/content>
- [124]. "International Solar Alliance | Scaling Solar Mini Grids." Accessed: Jun. 29, 2026. [Online]. Available: <https://isa.int/scaling-solar-mini-grids>
- [125]. International Energy Agency (IEA). Renewables 2025. Paris: International Energy Agency, 2025. [Online]. Available: <https://www.iea.org/reports/renewables-2025>
- [126]. RES4Africa, "Annual Report 2021." Accessed: Jun. 25, 2026. [Online]. Available: <https://res4africa.org/wp-content/uploads/2023/04/AnnualReport2021DEF.pdf>
- [127]. African Energy Commission (AFREC), Comprehensive Capacity Building Programme for the African Energy Sector, Edition 2024. [Online]. Available: https://au-afrec.org/sites/default/files/2025-09/Capacity_Building_Programme_for_the_African_Energy_Sector.pdf.
- [128]. "Renewable Energy: A Gender Perspective." Accessed: Jun. 24, 2026. [Online]. Available: <https://www.irena.org/publications/2019/Jan/Renewable-Energy-A-Gender-Perspective>
- [129]. C. Remerscheid and S. Kotecha, "Empowering Women in Clean Energy: Advancing and Retaining an Equitable Workforce," Shortlist, 2024. [Online]. Available: https://energyalliance.org/wp-content/uploads/2024/02/Empowering-Women-in-Clean-Energy_ShortlistFeb-2024.pdf
- [130]. "Gender and Youth | Sustainable Energy for All." Accessed: Jun. 25, 2026. [Online]. Available: <https://www.seforall.org/programmes/Gender-and-Youth>
- [131]. The Future of Energy (TFE), Cracking the Code: Lessons learned from 12 years of mini-grid results-based financing in Africa. Beyond the Grid Fund for Africa (BGFA), Nov. 2025. [Online]. Available: https://beyondthegrid.africa/wp-content/uploads/TFE-study_BGFA_Lessons-learned-from-mini-grid-results-based-financing-in-Africa_Nov-2025-Print.pdf
- [132]. CrossBoundary Innovation Lab, "New study reveals mesh-grids as a cost-effective, scalable approach for rural electrification – Mini-Grid Innovation Insight," Jun. 10, 2025. [Online]. Available: <https://crossboundary.com/mesh-grids-cost-effective-scalable-for-rural-electrification/>.
- [133]. Africa Minigrid Developers Association (AMDA), Benchmarking Africa's Minigrids Report 2024, 2025. [Online]. Available: <https://www.africamda.org/wp-content/uploads/2025/04/Benchmarking-Africas-Minigrids-Report-2024-Online-version.pdf>.
- [134]. Energy Sector Management Assistance Program (ESMAP), Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers, World Bank, Washington, DC, 2019. [Online]. Available: https://www.esmap.org/sites/default/files/esmap-files/Mini%20Grids%20for%20Half%20a%20Billion%20People%20-%20OKR%20Download%20Version_compressed_MKA.pdf.
- [135]. CrossBoundary, "Multi-load metering for reduced costs, accurate billing & tailored tariffs," Apr. 23, 2025. [Online]. Available: <https://crossboundary.com/innovation-lab-multi-load-metering/>.
- [136]. OECD et al. (2025), Africa's Urbanisation Dynamics 2025: Planning for Urban Expansion, West African Studies, OECD Publishing, Paris, <https://doi.org/10.1787/2a47845c-en>
- [137]. BloombergNEF (BNEF), "Lithium-Ion Battery Pack Prices Fall to \$108 Per Kilowatt-Hour, Despite Rising Metal Prices: BloombergNEF," Dec. 9, 2025. [Online]. Available: <https://about.bnef.com/insights/clean-transport/lithium-ion-battery-pack-prices-fall-to-108-per-kilowatt-hour-despite-rising-metal-prices-bloombergnef/>.
- [138]. International Renewable Energy Agency (IRENA), Renewable Power Generation Costs in 2024, Abu Dhabi: IRENA, 2025. [Online]. Available: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2025/Jul/IRENA_TEC_RPGC_in_2024_2025.pdf.
- [139]. Energy Transitions Commission (ETC), The Road Ahead: Electrification, Design and Mobility Choices for Efficient Transport, Dec. 2025. [Online]. Available: <https://www.energy-transitions.org/publications/the-road-ahead/>.
- [140]. International Energy Agency (IEA), Global EV Outlook 2025, IEA, Paris, 2025. [Online]. Available: <https://www.iea.org/reports/global-ev-outlook-2025>
- [141]. World Bank, "Fuel imports (% of merchandise imports)," World Development Indicators, indicator code TM.VAL.FUEL.ZS.UN, 2025. [Online]. Available: <https://data.worldbank.org/indicator/TM.VAL.FUEL.ZS.UN>
- [142]. R. Behrens, D. McCormick, and D. Mfinanga, eds., Paratransit in African Cities: Operations, Regulation and Reform. London: Routledge, 2015. [Online]. Available: https://books.google.com/books/about/Paratransit_in_African_Cities.html?id=J0WDCgAAQBAJ.
- [143]. J. Dumoulin, A. Pena-Bello, N. Jeannin, C. Ballif, and N. Wyrsh, "Energy, environment, and economy implications of electrifying minibuses in African cities," Scientific Re-

- ports, vol. 16, Art. no. 10661, 2026, doi: 10.1038/s41598-026-45790-w. [Online]. Available: <https://doi.org/10.1038/s41598-026-45790-w>.
- [144]. L. Diaz Olvera, D. Plat, and P. Pochet, "Looking for the obvious: Motorcycle taxi services in Sub-Saharan African cities," *Journal of Transport Geography*, vol. 88, Art. no. 102476, Oct. 2020, doi: 10.1016/j.jtrangeo.2019.102476.
- [145]. F. G. Boateng, "Africa's Used Vehicle Dependency: A Complicated Double-Edged Phenomenon," *Australian Institute of International Affairs*, May 2, 2025. [Online]. Available: <https://www.internationalaffairs.org.au/australianoutlook/africas-used-vehicle-dependency-a-complicated-double-edged-phenomenon/>.
- [146]. B. Noll, D. Graff, T. S. Schmidt, A. Patt, C. Bauer, C. Agutu, P. K. Asiimwe, O. E. Diemuodeke, S. Krygsman, I. Nienkerke, T. Tröndle, and C. Moretti, "Battery-electric passenger vehicles will be cost-effective across Africa well before 2040," *Nature Energy*, vol. 11, pp. 284–298, 2026, doi: 10.1038/s41560-025-01955-x. [Online]. Available: <https://doi.org/10.1038/s41560-025-01955-x>
- [147]. International Renewable Energy Agency (IRENA), *Innovation Landscape Brief: Renewable Mini-Grids*, Abu Dhabi: IRENA, 2019. [Online]. Available: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Renewable_mini-grids_2019.pdf
- [148]. Sustainable Energy for All (SEforALL), *Beyond Gensets: Advancing the Energy Transition in Lagos State*, Oct. 2024. [Online]. Available: <https://www.seforall.org/system/files/2024-10/SEforall%20Beyond%20Gensets%20LASG%20Extended-final.pdf>.
- [149]. C. Zhang and M. Hong, "Solar-Powered Battery Swap Stations Could Speed Rwanda's Shift to Electric 'Motos'," *World Resources Institute (WRI)*, Mar. 25, 2024. [Online]. Available: <https://www.wri.org/insights/solar-powered-battery-swap-stations-rwanda-shift-electric-motos>.
- [150]. R. J. Kuhudzai, "Ampersand Energy Opens Its Battery Swap Network to Global Electric Motorcycle Manufacturers," *CleanTechnica*, Dec. 15, 2025. [Online]. Available: <https://cleantechnica.com/2025/12/15/ampersand-energy-opens-its-battery-swap-network-to-global-electric-motorcycle-manufacturers/>.
- [151]. CrossBoundary Energy, "Ampersand Energy's electric two-wheelers get a renewable boost from CrossBoundary Energy EVx in Nairobi," Oct. 29, 2025. [Online]. Available: <https://crossboundaryenergy.com/ampersand-energys-electric-two-wheelers-get-a-renewable-boost-from-crossboundary-energy-evx-in-nairobi/>.
- [152]. J. H. Giliomee, B. G. Pretorius, L. Füll, B. Thomas, and M. J. Booyen, "Using Solar PV and Stationary Storage to Buffer the Impact of Electric Minibus Charging in Grid-Constrained Sub-Saharan Africa," *Energies*, vol. 17, no. 2, p. 457, Jan. 2024, doi: 10.3390/en17020457. [Online]. Available: <https://doi.org/10.3390/en17020457>.
- [153]. E. Odhiambo, D. Kipkoeh, A. Hegazy, M. Hegazy, M. Manuel, H. Schalekamp, and J. M. Klopp, *The Potential for Minibus Electrification in Three African Cities: Cairo, Nairobi, and Cape Town*, Volvo Research and Educational Foundation (VREF), Aug. 2021. [Online]. Available: <https://transportforcairo.com/wp-content/uploads/2021/09/PotentialforMinibusElectrificationinAfricanCitiesStudyReport.pdf>.
- [154]. R. Mutiso, H. Tariq, and D. Johansson, "Who in Africa Is Ready for EVs?," *Energy for Growth Hub*, Oct. 23, 2024. [Online]. Available: <https://energyforgrowth.org/article/who-in-africa-is-ready-for-evs/>.
- [155]. BasiGo, "BasiGo Secures \$42M in Funding to Scale Public Transport Electrification in Sub-Saharan Africa," Oct. 23, 2024. [Online]. Available: <https://www.basi-go.com/in-the-news/basigo-secures-42m-in-funding-to-scale-public-transport-electrification-in-sub-saharan-africa>.
- [156]. MobilityX Africa, "Rwanda's E-Mobility Analysis," 2025. [Online]. Available: <https://mobilityx.africa/ecosystem-mapping-database/country-analysis/country-analysis/rwanda>.
- [157]. R. J. Kuhudzai, "Kenya Power Says Consumption From EV Charging Was Up 188% In Kenya In 2025," *CleanTechnica*, Feb. 12, 2026. [Online]. Available: <https://cleantechnica.com/2026/02/12/kenya-power-says-consumption-from-ev-charging-was-up-188-in-kenya-in-2025/>.
- [158]. U.S. International Development Finance Corporation (DFC), "U.S., Kenya Advance Shared Priorities – Surpassing \$1 Billion in DFC Exposure, Intent to Open Nairobi Office," May 23, 2024. [Online]. Available: <https://www.dfc.gov/media/press-releases/us-kenya-advance-shared-priorities-surpassing-1-billion-dfc-exposure-intent>.
- [159]. BudgetIT, *Economic Sensitivity of Petrol Subsidy Removal*, 2023. [Online]. Available: <https://budgetit.org/wp-content/uploads/2023/05/Economic-Subsidy.pdf>.
- [160]. IRENA Coalition for Action, *Scaling up renewable energy investments in West Africa*, International Renewable Energy Agency, Abu Dhabi, 2023. [Online]. Available: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Oct/IRENA_Coalition_Scaling_up_investment_West_Africa_2023.pdf.
- [161]. Public-Private Infrastructure Advisory Facility (PPIAF), *Democratic Republic of Congo: Mobilizing the Private Sector for Renewable-Based Electrification of DRC's Unserved and Underserved Cities*, World Bank Group, 2019. [Online]. Available: <https://www.ppiaf.org/activity/democratic-republic-congo-mobilizing-private-sector-renewable-based-electrification-drc%E2%80%99s>
- [162]. Business Wire, "Autel Energy Powers South Africa's Largest Public EV Bus Charging Project in Cape Town, Supporting 120-Bus Fleet Transition by 2025," Sep. 19, 2025. [Online]. Available: <https://www.businesswire.com/news/home/20250917279619/en/Autel-Energy-Powers-South-Africas-Largest-Public-EV-Bus-Charging-Project-in-Cape-Town-Supporting-120-Bus-Fleet-Transition-by-2025>
- [163]. BasiGo, "Charging & Service," [Online]. Available: <https://www.basi-go.com/charging-and-service>.
- [164]. African Union, *Agreement Establishing the African Continental Free Trade Area*, 2018. [Online]. Available: <https://au.int/en/treaty/agreement-establishing-african-continental-free-trade-area>
- [165]. Umeme Limited, *2023 Annual Report*, 2024. [Online]. Available: https://umeme.co.ug/umeme_api/wp-content/uploads/2024/05/Umeme-2023-Annual-Report-1.pdf
- [166]. J. Mutua, "Share of electricity lost to theft and transmission dips to 7-year low," *Business Daily Africa*, Nov. 6, 2025. [Online]. Available: <https://www.businessdailyafrica.com/bd/corporate/industry/electricity-lost-to-theft-and-transmission-dips-to-7-year-low-5255874>
- [167]. Energy Transition Africa, "Africa Has Energy Finance but It Is Not Reaching Where It Matters," Apr. 24, 2026. [Online]. Available: <https://www.energytransitionafrica.com/insights/article/africa-energy-finance-access-gap>
- [168]. International Energy Agency (IEA), "How a high cost of capital is holding back energy development in Kenya and Senegal," IEA, Paris, 2025. [Online]. Available: <https://www.iea.org/commentaries/how-a-high-cost-of-capital-is-holding-back-energy-development-in-kenya-and-senegal>
- [169]. S. Attridge and L. Engen, "Blended Finance in the Poorest Countries: The Need for a Better Approach," *Overseas Development Institute (ODI)*, Apr. 2019. [Online]. Available: <https://media.odi.org/documents/12666.pdf>
- [170]. International Energy Agency (IEA) and International Finance Corporation (IFC), *Scaling Up Private Finance for*

- Clean Energy in Emerging and Developing Economies. Paris: IEA, 2023. [Online]. Available: <https://www.ifc.org/content/dam/ifc/doc/2023-delta/scaling-up-private-finance-for-clean-energy-in-edmes-summary-en.pdf>.
- [171]. African Development Bank Group (AfDB), “Multilateral Development Banks Hit Record \$137 Billion in Climate Finance, Driving Sustainable Development Worldwide,” Sep. 9, 2025. [Online]. Available: <https://www.afdb.org/en/news-and-events/press-releases/multilateral-development-banks-hit-record-137-billion-climate-finance-driving-sustainable-development-worldwide-86747>
- [172]. Energy Transition Africa (ETA), “The Price of Being African: How Creditworthiness Became a Geopolitical Tool,” 2026. [Online]. Available: <https://www.energytransitionafrica.com/insights/article/africa-climate-finance-cost-of-capital-creditworthiness-trap>.
- [173]. Energy Transition Africa (ETA), “Locked In: The Debt, Subsidy and Oil Economy Holding Africa Back from a Just Energy Transition,” 2025. [Online]. Available: <https://www.energytransitionafrica.com/insights/article/debt-subsidies-fossil-lock-in-africa>.
- [174]. Energy Transition Africa (ETA), “Africa Has 20% of the World’s Population but Receives Just 3% of Its Energy Investment,” Jun. 1, 2026. [Online]. Available: <https://www.energytransitionafrica.com/insights/article/africa-energy-investment-gap-iea-world-energy-investment-2026>.
- [175]. T. Muchiya, “IPP takes half a billion dollars knock after ZESCO debt write-off,” *Zambian Business Times*, Feb. 22, 2024. [Online]. Available: <https://zambianbusinesstimes.com/ipp-takes-half-a-billion-dollars-knock-after-zesco-debt-write-off/>
- [176]. E. M. Sampson and O. M. Longe, “Review of the Role of Energy Pricing Policies in Electricity Retail Market,” in 2021 IEEE PES/IAS PowerAfrica, Nairobi, Kenya, Aug. 2021. doi: 10.1109/PowerAfrica52236.2021.9543429.
- [177]. African Energy Leadership Report: The Case for 100% Renewable Energy. Power Shift Africa, 2025. [Online]. Available: <https://www.powershiftafrica.org/publications/african-energy-leadership-report>.
- [178]. International Energy Agency (IEA), *Clean Energy Investment for Development in Africa: Status and Opportunities*. Paris: IEA, 2024. [Online]. Available: <https://www.iea.org/reports/clean-energy-investment-for-development-in-africa>.
- [179]. M. Kamau, “Africa Draws \$13.84 Billion in Clean Energy Investment in 2025, But a Widening Gap Between Ambition and Delivery Defines the Market,” *Serrari Group*, Feb. 23, 2026. [Online]. Available: <https://serrarigroup.com/africa-draws-13-84-billion-in-clean-energy-investment-in-2025-but-a-widening-gap-between-ambition-and-delivery-defines-the-market/>
- [180]. International Renewable Energy Agency (IRENA) and Climate Policy Initiative (CPI), *Global Landscape of Energy Transition Finance 2025*. Abu Dhabi: IRENA, 2025. [Online]. Available: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2025/Nov/IRENA_CPI_FIN_Global_Landscape_Energy_Transition_Finance_2025.pdf.
- [181]. Chavi Meattle, Anna Balm, Jose E. Diaz, Gaoyi Miao, Sean Stout, Ishrita Gupta, Sasha Abraham, Alfred Sloley, and Dharshan Wignarajah, *Landscape of Climate Finance in Africa 2024*. Climate Policy Initiative (CPI), 2024. [Online]. Available: <https://www.climatepolicyinitiative.org/wp-content/uploads/2024/10/Landscape-of-Climate-Finance-in-Africa-2024.pdf>.
- [182]. International Energy Agency (IEA), *World Energy Investment 2025, “Africa,”* Paris: IEA, 2025. [Online]. Available: <https://www.iea.org/reports/world-energy-investment-2025/africa>.
- [183]. The Renewable Energy Investment Case for Africa. Enzi Ijaye Africa Initiative, Nov. 7, 2025. [Online]. Available: <https://www.enzijiaye.org/reports/therenewableenergyinvestmentcaseforafrica-7x9ej>.
- [184]. S&P Global Ratings, “Sovereign Debt 2026: African Sovereigns to Borrow \$155 Billion,” Mar. 17, 2026. [Online]. Available: <https://www.spglobal.com/ratings/en/regulatory/article/sovereign-debt-2026-african-sovereigns-to-borrow-155-billion-s101672058>.
- [185]. E. O. Asamoah, “A Journey Through Ghana’s Energy-Sector Debt: Part 1,” *ModernGhana*, May 14, 2026. [Online]. Available: <https://www.modernghana.com/news/1493255/a-journey-through-ghanas-energy-sector-debt-part.html>.
- [186]. Wood Mackenzie, “Solar and storage costs are set to increase 9% in Q4 2025 as Chinese policy shifts end an era of low equipment prices,” Oct. 2, 2025. [Online]. Available: <https://www.woodmac.com/press-releases/solar-and-storage-costs-are-set-to-increase-9-in-q4-2025-as-chinese-policy-shifts-end-an-era-of-low-equipment-prices/>
- [187]. Ember, “The first evidence of a take-off in solar in Africa,” Aug. 26, 2025. [Online]. Available: <https://ember-energy.org/latest-updates/africas-solar-imports-surge-60-giving-the-first-evidence-of-a-take-off-in-solar-in-africa>.
- [188]. M. Amoah and M. Bazilian, “Africa’s Solar Inflection Point,” *Payne Institute for Public Policy*, May 29, 2026. [Online]. Available: <https://payneinstitute.mines.edu/africas-solar-inflection-point/>.
- [189]. W. Kruger and D. Cassimon, “The Currency Risk Challenge in African Power Finance: Structures, Politics, and Emerging Responses,” *IOB Working Papers 2025.12*, Institute of Development Policy (IOB), Universiteit Antwerpen, Aug. 2025. [Online]. Available: <https://ideas.repec.org/p/iob/wpaper/2025.12.html>.
- [190]. MIT Kuo Sharper Center for Prosperity and Entrepreneurship, “Hedging Currency Risk: From Strategies to Implementation,” *MIT Sloan School of Management*, Aug. 11, 2025. [Online]. Available: <https://mitsloan.mit.edu/centers-initiatives/ksc/hedging-currency-risk-strategies-to-implementation>.
- [191]. A. Apampa, “How are Sub-Saharan Africa’s public institutions building their blended finance capacity?” *Convergence*, Oct. 8, 2025. [Online]. Available: <https://www.convergence.finance/news/3ERFGoHVK7SU6rlqZ0kRca/view>.
- [192]. Haymanot & Advocates, “Federal Public Procurement Directive No. 1073/2025,” 2025. [Online]. Available: <https://www.haymanotbelay.com/federal-public-procurement-directive-no-1073-2025/>.
- [193]. Africa Finance Corporation (AFC), *State of Africa’s Infrastructure Report 2025: Mobilising Domestic Capital*, 2025. [Online]. Available: <https://www.africafc.org/our-impact/our-publications/state-of-africa-infrastructure-report-2025>.
- [194]. FMO, “Project detail – Acumen Resilient Agriculture Fund II, LP,” May 23, 2025. [Online]. Available: <https://www.fmo.nl/project-detail/64863>.
- [195]. OECD, “InfraCredit: Making Infrastructure Projects in Nigeria More Bankable through Credit Enhancement,” Sept. 1, 2025. [Online]. Available: https://www.oecd.org/en/publications/blended-finance-case-studies_2fb-90b9a-en/infacredit-making-infrastructure-projects-in-nigeria-more-bankable-through-credit-enhancement_bd-b679c6-en.html.
- [196]. African Energy Chamber, “African Power Pools: How Regional Integration Can Strengthen Energy Security,” Jan. 9, 2026. [Online]. Available: <https://energychamber.org/african-power-pools-how-regional-integration-can-strengthen-energy-security/>.
- [197]. S. Prempeh, “The Year of Modest Regulatory Clarity,

- but Every Little Helps,” Africa Policy Research Institute (APRI), Mar. 11, 2026. [Online]. Available: <https://afripoli.org/the-year-of-modest-regulatory-clarity-but-every-little-helps>.
- [198]. Global Infrastructure Hub, Showcase Project: Côte d’Ivoire-Liberia-Sierra Leone-Guinea (CLSG) Interconnector Project, May 2019. [Online]. Available: <https://cdn.gihub.org/umbraco/media/2519/gih-showcase-projects-2019-cslg-interconnector-project-art-web.pdf>.
- [199]. International Monetary Fund (IMF), “Debt Dilemmas in Sub-Saharan Africa: Some Principles and Trade-Offs in Debt Restructuring,” Analytical Note in Regional Economic Outlook: Sub-Saharan Africa - A Light on the Horizon?, Washington, DC, October 2023. [Online]. Available: <https://www.imf.org/-/media/files/publications/reo/afr/2023/october/english/debt-note2.pdf>
- [200]. Energy Transition Africa (ETA), “The Price of Clean Energy: Why Africa Still Pays More for Sunlight Than Oil,” Nov. 10, 2025. [Online]. Available: <https://www.energytransitionafrica.com/insights/article/price-clean-energy-africa-cost-of-capital>
- [201]. Eskom Holdings SOC Ltd, Tariffs and Charges Booklet 2025–2026, 2025. [Online]. Available: <https://www.eskom.co.za/distribution/wp-content/uploads/2025/07/Tariff-booklet2.pdf>
- [202]. S&P Global Ratings, “Africa Credit Rating Trends 2025 In Review: Divergence and Resilience,” Feb. 19, 2026. [Online]. Available: <https://www.spglobal.com/ratings/en/regulatory/article/africa-credit-rating-trends-2025-in-review-divergence-and-resilience-s101668624>
- [203]. United Nations Development Programme (UNDP), “More Objective Credit Ratings Could Save Billions for African Countries’ Development,” Press release, Apr. 17, 2023. [Online]. Available: <https://www.undp.org/press-releases/more-objective-credit-ratings-could-save-billions-african-countries-development>.
- [204]. Global Emerging Markets Risk Database (GEMs) Consortium, Default and Recovery Statistics: Private Lending 1994-2024. European Investment Bank and International Finance Corporation, October 2025. [Online]. Available: <https://www.eib.org/files/publications/20250177-071025-default-and-recovery-statistics-private-lending-1994-2024-en.pdf>
- [205]. World Economic Forum, From Risk to Reward: Unlocking Private Capital for Climate and Growth. White Paper, in collaboration with KPMG, November 2025. [Online]. Available: https://reports.weforum.org/docs/WEF_Risk_to_Reward_2025.pdf
- [206]. Energy Transition Africa (ETA), “Africa’s Domestic Capital and Clean Energy,” 2025. [Online]. Available: <https://www.energytransitionafrica.com/insights/article/africa-domestic-capital-clean-energy>

Chapter 8: Table 24: Financial Structures and De-risking Mechanisms Across Solar Market Segments

1. <<https://www.afdb.org/en/news-and-events/infrastructure-fund-africa50-helps-egypts-solar-power-sector-take-36247>>; <<https://www.icafrica.org/en/project-preparation/the-fund-finder/facility/africa50-144/>>; <https://www.africa50.com/our-funds/projects/scatec-egypt-benban-solar-plants/>
2. <<https://www.business-sweden.com/insights/articles/how-sweden-unlocked-sub-saharan-africas-largest-solar-project/>>; <<https://cms.law/en/int/expert-guides/cms-expert-guide-to-renewable-energy/angola>>; <<https://energy-news-network.com/industry-news/sun-africa-speed-scale-and-doing-things-differently/>>; <<https://sunafrika.com/about/>>; <<https://www.nortonrosefulbright.com/en/news/1cf392ad/norton-rose-fulbright-advises-ministry-of-finance-of-the-republic-of-angola>>; <https://www.ekn.se/en/ekn-magazine/ekns-magazine/largest-ever-sub-saharan-solar-project/>
3. <<https://www.tatisolarproject.com/about>>; <<https://businessfront.com/energy/news/botswana-tati-solar-sapp/>>; <https://africa.businessinsider.com/local/markets/southern-african-country-secures-dollar100-million-for-first-utility-scale-solar/d105clm>
4. <<https://www.gov.uk/government/news/uk-kenya-partnership-supports-listing-of-kenyas-first-infrastructure-fund-on-the-nairobi-securities-exchange>>; <<https://www.renewables-rising.com/p/east-africa-s-first-infrastructure-investment-fund-goes-live-e4ed>>; <https://www.afdb.org/fr/documents/multinational-spearhead-africa-infrastructure-fund-saif-equity-project-p-z1-h00-132>
5. <<https://www.worldbank.org/en/news/press-release/2026/04/09/portfolio-of-guarantees-pushes-miga-s-total-issuance-over-100-billion>>; <<https://www.miga.org/project/amea-power-portfolio-0>>; <https://www.ameapower.com/amea-power-achieves-financial-close-for-egypts-first-ever-utility-scale-bess-project/>
6. <<https://www.renewables-rising.com/p/off-grid-solar-sector-debuts-first-publicly-listed-green-bond-55e9>>; <https://mercomcapital.com/off-grid-solar-company-d-light-secures-176-million-securitization-facility/>
7. <<https://sunking.com/news-blog/156m-sun-king-securitisation-to-deliver-solar-for-over-a-million-kenyans/>>; <https://www.globalsolarcouncil.org/resources/africa-market-outlook-2026-2029/>
8. <https://www.ifc.org/en/pressroom/2025/sun-king-ifc-and-stanbic-ibtc-bank-close-80-million-debt-facility-to-expand-solar>
9. <https://www.oecd.org/en/publications/blended-finance-case-studies_2fb90b9a-en/infacredit-making-infrastructure-projects-in-nigeria-more-bankable-through-credit-enhancement_bdb679c6-en.html>; <<https://pidg.org/portfolio/infacredit-nigeria/>>; <https://infacredit.ng/capital-providers/>
10. <https://pidg.org/portfolio/dhamana-guarantee-company/>
11. <<https://www.get-invest.eu/fund/demand-aggregation-for-renewable-technologies-dart-programme/>>; <<https://energyalliance.org/project/lowering-costs-for-renewable-energy-developers/>>; <https://energyalliance.org/all-on-geapp-commit-15-million-to-expand-dart-program-and-commission-350kw-mini-grid-in-benue-state-nigeria/>
12. <<https://www.blendedfinance.earth/shared-services/2020/11/12/sunculture>>; <<https://shellfoundation.org/news/bii-shell-foundation-and-sunculture-pilot-innovative-carbon-financing-to-accelerate-access-to-solar-irrigation-systems-for-kenyan-farmers/>>; <<https://www.bii.co.uk/en/story/sunculture-2/>>; <<https://www.africaprivatetequitynews.com/p/sunculture-raises-275m-in-series>>; <<https://pidg.org/portfolio/pidg-sunculture/>>; <https://ug.sunculture.io/carbon/>
13. <<https://www.clasp.ngo/program/productive-use-financing-facility/>>; <<https://www.clasp.ngo/updates/press-release-productive-use-appliance-financing-facility-opens-first-public-auction-window/>>; <<https://energyalliance.org/clasp-and-geapp-expand-productive-use-financing-facility-with-6-1m-boost-for-energy-efficient-appliances-in-africa/>>; <<https://energyalliance.org/sunculture-empowering-africas-farmers-through-solar-powered-irrigation/>>; <<https://www.clasp.ngo/updates/reflecting-on-the-facility/>>; <https://www.fmo.nl/project-detail/63972>
14. <https://coalition.irena.org/-/media/Files/IRENA/Coalition-for-Action/Publication/IRENA_PAR_Coalition_Solar-powered_agri-food_2026.pdf>; <https://preo.org/about/>
15. <https://coalition.irena.org/-/media/Files/IRENA/Coalition-for-Action/Publication/IRENA_PAR_Coalition_Solar-powered_agri-food_2026.pdf>; <https://preo.org/news/project-news/sustainable-dairy-development-lessons-from-heifer-internationals-project-to-solarise-ugandan-milk-chilling-centres/>
16. <<https://www.reuters.com/world/africa/south-africas-charge-launches-off-grid-ev-stations-johannesburg-durban-corridor-2026-05-19/>>; <<https://www.engineeringnews.co.za/article/dbsa-announces-finalisation-of-major-investment-in-ev-charging-station-company-charge-2025-09-17>>; <<https://empowerafrica.com/zero-carbon-charge-secures-5-6-million-to-expand-off-grid-ev-charging-network-in-south-africa/>>; <https://tracxn.com/d/companies/charge/_0x08eD0-VnZTvQY6t-11GwHomMIGuxPCfboRIhcmugKo>; <https://charge.co.za/budget-2026-charge-calls-for-reform/>
17. <<https://techcrunch.com/2025/10/21/spiro-raises-100m-the-largest-ever-investment-in-africas-e-mobility/>>; <<https://techpoint.africa/guide/africa-ev-energy-grid-war/>>

Annexures

1. AP News, Kenya unveils tax breaks for EV parts and charging stations to speed up shift to electrics, 2026, <<https://apnews.com/article/kenya-ev-tax-breaks-charging-ccbadb5d392440f8aa503d6b1dd2236b>>
2. Mobility Rising, Kenyan EV sales grow 31 times in 3 years, 2026, <<https://www.mobility-rising.com/p/kenyan-ev-sales-grow-31-times-in-3-years>>
3. Corporate Knights, Battery swapping is reigniting Kenya's love of electric motorcycles, 2026, <<https://corporateknights.com/transportation/battery-swapping-is-reigniting-kenyas-love-of-electric-motorcycles/>>
4. Clean Technica, Spiro Targets 1 million Electric Motorcycles & 3,000 Battery Charging & Swapping Stations in Kenya, <<https://cleantechnica.com/2023/09/11/spiro-targets-1-million-electric-motorcycles-3000-battery-charging-swapping-stations-in-kenya/>>
5. The values presented in this case study are indicative and are based on secondary research and primary consultations with select stakeholders.
6. BasiGo, 2026, <<https://www.basi-go.com/>>
7. Semafor, Kenya's electric bus startup BasiGo ramps up inter-city expansion, 2026, <<https://www.semafor.com/article/03/18/2026/kenyas-electric-bus-startup-basigo-ramps-up-inter-city-expansion>>
8. Roam, Roam and County Bus Service Partner to Deploy 200 Electric Buses on Kenyan Roads by 2026, 2025, <<https://www.roam-electric.com/newsletter-move-on-the-road>>
9. BasiGo, 2026, <<https://www.basi-go.com/pricing>>
10. The values presented in this case study are indicative and are based on secondary research and primary consultations with select stakeholders.
11. P4g Partnership, Scaling Electric Public Transport in Africa: A BasiGo Case Study, 2026, <<https://p4gpartnerships.org/sites/default/files/2026-02/BasiGo-PracticalAction-Case-Study-ScalingElectricPublicTransport.pdf>>
12. Kenya Power Limited Company, <<https://newsroom.kplc.co.ke/articles/kenya-power-kicks-off-customer-transition-to-e-mobility-tariff>>
13. Annex I, Table A1 (Comparative Economic Assessment of Solar Water Pumping Systems in Ethiopia and Uganda), source note a: Case study in Ethiopia 1.
14. Annex I, Table A1 (Comparative Economic Assessment of Solar Water Pumping Systems in Ethiopia and Uganda), source note b: Case study in Ethiopia 2.
15. Annex I, Table A1 (Comparative Economic Assessment of Solar Water Pumping Systems in Ethiopia and Uganda), source note c: Global petrol prices.
16. Annex I, Table A1 (Comparative Economic Assessment of Solar Water Pumping Systems in Ethiopia and Uganda), source noted: DEFRA 2025.
17. Annex I, Table A1 (Comparative Economic Assessment of Solar Water Pumping Systems in Ethiopia and Uganda), source note e: Ethiopian Subsidies.
18. Annex I, Table A1 (Comparative Economic Assessment of Solar Water Pumping Systems in Ethiopia and Uganda), source note f: Uganda Case Study 1.
20. Annex I, Table A1 (Comparative Economic Assessment of Solar Water Pumping Systems in Ethiopia and Uganda), source note g: Discount rate.
21. Annex I, Table A1 (Comparative Economic Assessment of Solar Water Pumping Systems in Ethiopia and Uganda), source note h: Tax rate in Uganda.



CONTACT US

International Solar Alliance

Surya Bhawan, National Institute of Solar Energy Campus

Gwal Pahari, Faridabad-Gurugram Road, Gurugram

Haryana – 122003, India

Email: info@isa.int | **Website:** www.isa.int