Interconnected Minigrids: From Pilots to Powerhouses

How grid-interactive minigrids boost electrification and utilities' finances

November 2025

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Acknowledgements:

The authors would like to express their sincere appreciation to the following individuals and organizations for sharing details of their projects and providing valuable insights and perspectives that informed this work: Aaron Cheng (PowerGen Renewable Energy), Laurene Desclaux (UNDP), Sam Duby (TFE), Stephen Kansuk (UNDP), Kumbirai Makanza (Next Century Power), Jeannot Mavoko (Nuru), Luis-Carlos Miro (GIZ), Christelle Odongo (UNDP), Fauzia Okediji (GEAPP), James Sherwood (RMI), Olatunde Okeowo (RMI), Santos José Díaz Pastor (MIT), Caroline Tresise (UNDP), and Xavier Vallvé (TTA).

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Definitions of key terms used

Distributed energy resources (DERs) are demand- and supply-side resources that can be deployed at the electricity distribution or customer level to meet energy and reliability needs.

Minigrids are self-contained electricity generation and distribution systems that provide power at the community level. Isolated minigrids are typically developed in rural areas where there is no national grid infrastructure. They usually consist of a combination of the following DERs: solar photovoltaics (PV), battery energy storage system (BESS), and a backup diesel generator.

Interconnected minigrids (IMGs) are minigrids that exchange power with a larger grid, either importing or exporting as needed. An IMG integrates DERs located close to where electricity is consumed, combining them with power from a larger grid to improve reliability, flexibility, and efficiency.

List of Acronyms

AEDC	Abuja Electricity Distribution Company
AMP	Africa Minigrids Program
ARPU	average revenue per user
AT&C	aggregate technical and commercial
BESS	battery energy storage system
DARES	Distributed Access through Renewable Energy Scale-up
DERs	distributed energy resources
DisCo	distribution company
DRC	Democratic Republic of Congo
EPC	engineering, procurement, and construction
IE	Ikeja Electric
IMG	interconnected minigrid
IPP	independent power producer
IRP	integrated resource plan
JIRAMA	Jiro sy rano Malagasy (Madagascar's state-owned utility)
KEDCO	Kano Electricity Distribution Company
kW	kilowatt
kWh	kilowatt-hour
MW	megawatt
MWh	megawatt-hour
NERC	Nigerian Electricity Regulatory Commission
NGN	Nigerian naira
PDMC	Plan de Développement à Moindre Coût (Least Cost Development Plan – Madagascar)
PV	Photovoltaic
SDG7	Sustainable Development Goal 7
SME	small-to-medium enterprises
SNEL	Société Nationale d'Électricité (DRC's national utility)
SONELEC	Société Nationale de l'Electricité des Comores (Comoros' national utility)
UNDP	United Nations Development Programme
USD	United States dollar
ZESA	Zimbabwe Electricity Supply Authority
ZETDC	Zimbabwe Electricity Transmission and Distribution Company
ZESCO	Zambia Electricity Supply Corporation

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Executive Summary

Africa's energy challenge remains immense. Nearly 1.4 billion people — almost 90% of the continent's entire population — are either in the dark (600 million) or suffer from unreliable power on a daily basis (800 million).[1] This is largely because incumbent African utilities struggle with limited generation capacity, aging infrastructure, rising debt, and unsustainable business models.[2] The result is a widening gap between demand and the electricity systems' ability to supply it.

Interconnected minigrids (IMGs) present a transformative opportunity for the energy transition that can scale across many geographies. By combining local renewable energy generation and storage with the national grid, IMGs improve the status quo of urban, peri-urban, and rural populations and are a bridge between on-grid and off-grid solutions. IMGs deliver a "win-win-win" outcome for developers, consumers, and utilities by offering high energy consumption and revenues for developers, reducing reliance on costly fossil fuels and improving service reliability and affordability for consumers, and unlocking private capital to strengthen distribution network infrastructure and expand generation, ultimately improving utilities' performance. IMGs can enhance energy security, support climate goals, and drive industrialization.

IMGs in action: Lessons from across Africa

Case studies from Nigeria and the Democratic Republic of Congo (DRC) demonstrate IMGs' ability to enhance reliability, expand connections, and stimulate economic development. In Nigeria, four IMG projects totaling 3 megawatts (MW) of solar PV and 3 megawatt-hours (MWh) of storage now serve over 13,000 connections, improving supply from less than 3 hours to 15 hours daily and increasing metered connections by 62%. In the DRC, Nuru's 1.3 MW/2.3 MWh IMG serving 2,700 customers in Goma reduced diesel consumption by 96% post-interconnection, improved service availability, and catalyzed local business growth. The IMG provides reliable power to critical infrastructure, including water and information and communication technology (ICT) infrastructure that serves 400,000 people, including tens of thousands of displaced persons. In Zimbabwe, the Hunyani 1.8 MW/1.3 MWh IMG project aims to electrify 6,000 households and businesses.

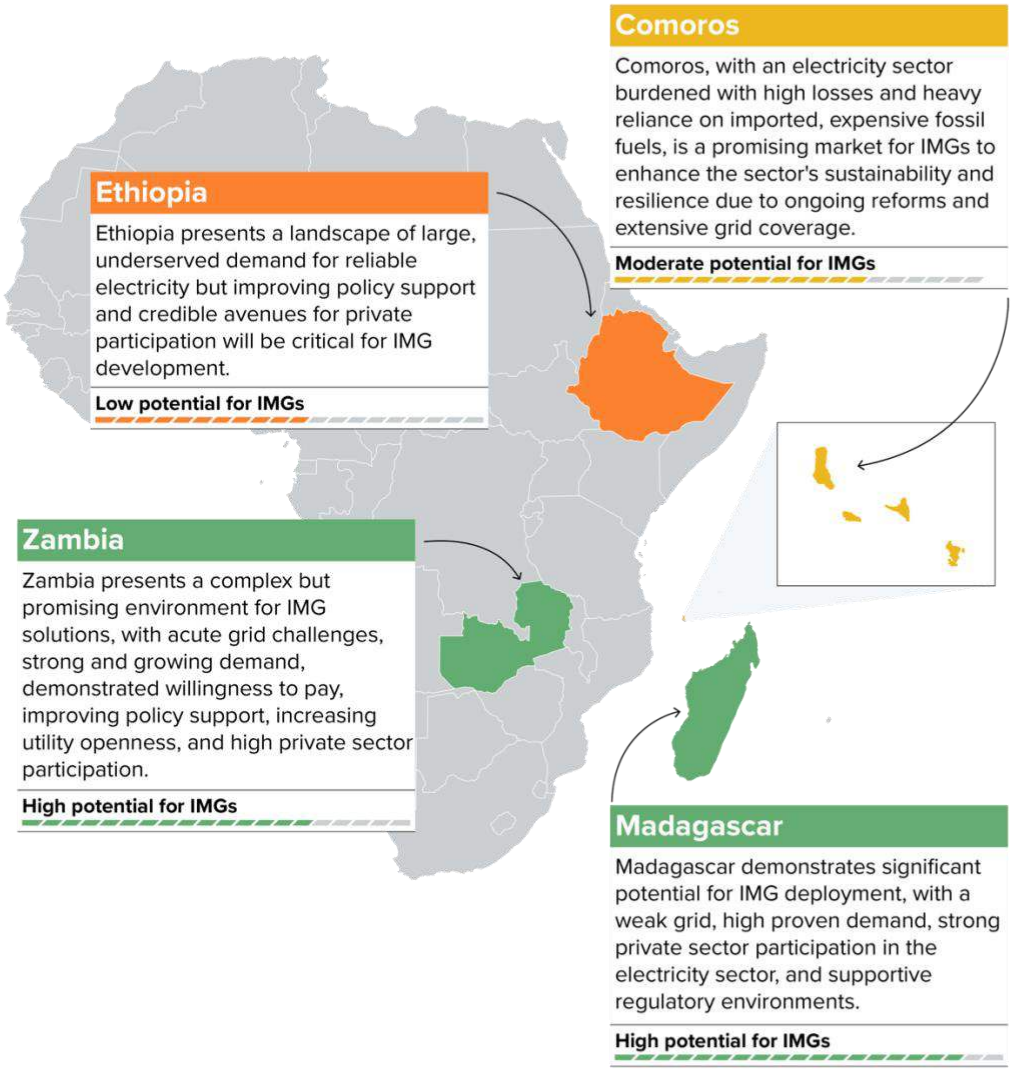
The opportunity for scaling IMGs in Africa

There are several key factors and local conditions that exist in the countries with a first wave of IMG projects, and that can enable the deployment of IMGs in other geographies. These include:

- Presence of a weak and overloaded main transmission and distribution grid
- Strong but underserved demand centers
- Supportive policy and regulatory environments and government initiatives
- Collaborative utilities with the capacity to participate in partnerships
- Private sector attractiveness

We assessed Zambia, Madagascar, Ethiopia and the Comoros — countries in the Africa Minigrids Program (AMP) (see section 1.2) that represent diverse power systems, policies, private sector interest, and minigrid market growth — on key factors to determine the countries' potential for IMG deployment.

Exhibit ES1: Scorecard on IMG potential of selected AMP countries



A pathway to scale IMGs

To identify new IMG markets and accelerate their adoption, policymakers, government agencies, donors, financiers, DER developers, and utilities should take the following steps:

Step 1 — Conduct market assessments to identify high-potential areas based on enabling conditions.
Step 2 — Adapt IMG business models to local contexts, ensuring alignment with regulatory frameworks and stakeholder needs.
Step 3 — Support early-stage pilots with concessional financing and risk mitigation tools to build confidence and attract private investment.
Step 4 — Institutionalize learnings from pilots through knowledge-sharing and policy integration.
Step 5 — Launch second-wave projects and refine subsidies to accelerate scale.
Step 6 — Transition to competitive procurement for mature markets, reducing reliance on public subsidies.

1. Introduction

1.1. Why interconnected minigrids?

Across Africa, nearly 800 million people are technically connected to the grid, yet more than half still endure insufficient and unreliable electricity that fails to meet their daily needs.[3] Even more stark, approximately 600 million people remain without electricity entirely, making Africa home to the world's largest energy access gap.[4] In the absence of reliable power supply, from rural villages to major cities, residential, institutional, and commercial customers are forced to rely on expensive petrol and diesel generators to meet their energy needs. The consequences ripple across the economy: small enterprises struggle to survive, local manufacturing cannot scale, and essential industries fail to develop. Reliable electricity is a prerequisite for human development, economic growth, and industrialization.[5]

At the center of this challenge are Africa's electricity utilities, which are tasked with delivering abundant and reliable power. These utilities face outdated and overstretched grid infrastructure, limited capacity, and unsustainable business models. As a result, they face mounting debt and chronic revenue shortfalls, making it extremely difficult to attract the public and private sector investment needed for modernization. This is particularly true for investment in transmission and distribution, which lags far behind generation, creating a critical bottleneck to deliver quality electricity to end-users.[6]

Distributed energy resources (DERs), particularly solar photovoltaics (PV), are widely recognized as a significant part of the solution to Africa's energy deficit, and their adoption is rapidly increasing.[7] One example is isolated solar minigrids, which are self-contained electricity generation systems that typically consist of solar PV, battery energy storage systems (BESS), backup diesel generators, and distribution infrastructure to supply power at the community level. Isolated minigrids are widely regarded as one of the most cost-effective solutions for customers who lack access to the main grid, with around 75 MW of capacity deployed across Africa.[8, i] Yet deployment remains far too slow to close the access gap alone.

This slow deployment underscores the need for complementary solutions and approaches, such as interconnected minigrids. Unlike isolated minigrids, an interconnected minigrid (IMG) leverages existing grid infrastructure and exchanges power with a larger grid. An IMG typically blends electricity from a larger grid with clean, local generation (i.e., DERs) situated near the point of consumption, resulting in increased power reliability and availability at a lower cost to the end-user than alternative fossil-fuel options. Typically deployed in underserved but economically active areas, IMGs generally achieve higher energy consumption and revenues than minigrids in isolated greenfield locations. For utilities, IMGs unlock private capital to strengthen distribution network infrastructure, expand generation, and retain customers — a "win-win-win" model for developers, consumers, and utilities alike (Exhibit 1).

Africa's rapid population growth and urbanization are creating an urgent need for reliable energy solutions. IMGs can play a central role in Africa's energy transition, supporting the continent's energy security, climate goals, and industrialization. They can bridge the gap between centralized and decentralized approaches, expand early-stage minigrid markets across many African countries, and help drive private investment at

[i] Official aggregated minigrid installed capacity figures in Africa are likely underestimated and only represent part of the total deployment.

scale into the sector, contributing to the AMP mandate, achieving Sustainable Development Goal 7 (SDG7), and advancing Mission 300.[ii]

Exhibit 1: Win-win-win IMG value proposition

UTILITY	UNDERSERVED AREA	DEVELOPER
Increased energy sales and revenue	Increased electricity supply availability and reliability	Higher consumption and revenues than isolated minigrid
Reduced financial losses and operational constraints	Reduced levelized cost of energy (LCOE)	Lower LCOE and smaller BESS than isolated minigrid
Improved distribution network	Less reliance on polluting and expensive alternatives	Access to utility's customers and opportunity for project expansion and scaling across utility's territory

Box 1: Past publications on IMGs

The challenge of delivering reliable electricity to underserved customers — those connected to the main grid but facing frequent and long outages — has been widely examined in the energy access literature.

- RMI's *Under the Grid* report underscores the challenges Nigerian utilities encounter in serving these areas and shows how minigrids that rely on existing distribution company (DisCo) infrastructure can deliver mutual benefits to DisCos, developers, and consumers.[9]
- The World Bank's *Mini Grid Solutions for Underserved Customers* further investigates this potential through case studies of IMGs in Nigeria and India.[10]
- The *Partnership for Power* report by RMI and The Global Energy Alliance presents a data-driven, groundbreaking analysis based on operational data from Nigeria's early IMGs.

This report offers a broader perspective on IMGs in Africa, demonstrating their capacity to enhance electrification with case studies, readiness assessments, and practical recommendations for stakeholders across the continent. [11]

[ii] SDG7 is one of the 17 Sustainable Development Goals established by the United Nations in 2015. It aims to "Ensure access to affordable, reliable, sustainable and modern energy for all" by 2030 (https://sdgs.un.org/goals/goal7). Mission 300 is a collaborative initiative by the World Bank Group and the African Development Bank aimed at providing electricity access to 300 million people in sub-Saharan Africa by 2030, focusing on distributed renewable energy solutions and partnerships (https://mission300africa.org/energysummit/).

1.2. Africa Minigrids Program

The Africa Minigrids Program (AMP) is a country-led regional initiative active in 21 African countries, led by UNDP with funding from the Global Environment Facility (GEF) and implemented alongside the African Development Bank (AfDB) and Rocky Mountain Institute (RMI). Its primary goal is to expand electricity access by improving the financial viability of renewable energy minigrids and attracting large-scale commercial investment. By driving down costs across technology, financing, and business models, AMP positions minigrids as a cost-effective, reliable solution for underserved communities.

The program combines 21 national projects focused on policy, private-sector innovation, financing, knowledge sharing, and monitoring with a regional platform that offers technical assistance and digital tools to reduce costs. AMP's strategy prioritizes advancing national dialogues on delivery models, promoting productive energy uses, and leveraging data and digital technologies to accelerate the growth of affordable, resilient minigrid solutions. IMGs are one type of pilot project envisioned for the AMP national projects (see Exhibit 2).

Exhibit 2: Types of minigrid pilots in AMP

Type of Pilot	Description
Greenfield minigrids (including IMGs)	Minigrid systems usually built in previously unconnected areas; they include generation and distribution assets, and in some cases, productive use equipment. In some instances, minigrids can be interconnected to larger grids to expand the electricity supply and/or help stabilize the grid system, reducing technical and commercial losses.
Hybridization of diesel-based minigrids	Retrofitting (i.e., hybridization) of existing fossil-fuel-based minigrids to increase the fraction of renewable power generation and reduce operations and maintenance costs.
A productive use overlay to an existing or planned minigrid	Investments in productive use appliances and equipment — and if needed in minigrid system enhancements — to increase the number and energy consumption of productive users of power connected to an existing or planned minigrid. This can help generate impact and additional income, improve users' ability to pay for services, and improve utilization of minigrid assets.

Within the AMP framework, the Derisking Renewable Energy Investment (DREI) framework has emerged as a key methodology and tool for systematically identifying and addressing barriers to private sector participation in renewable energy markets. By tailoring investment de-risking instruments to national contexts, the DREI approach complements AMP's objectives of scaling minigrid deployment and enhancing the financial viability of clean energy projects.

IMGs have emerged as a topic of interest in several DREI studies. One example is found in Comoros, where grid coverage is relatively high, but reliability remains low. In this context, the AMP-DREI team identified

IMGs as a strategic opportunity to enhance energy security and stimulate local economic development. By coupling renewable generation with upgraded existing grid infrastructure, IMGs can help increase the share of clean electricity, improve service quality for households and businesses, and reduce dependence on costly fossil fuels. The DREI study in Comoros focuses on developing a viable business model centered on community-led initiatives with private sector participation. At the same time, the study identifies key investment risks, recommends appropriate derisking instruments, and assesses the economic and operational benefits of solar IMGs for both the national utility and the broader economy.

1.3. Report structure

This report aims to promote IMGs in sub-Saharan Africa by presenting the benefits and opportunities across multiple geographies. It is organized as follows:

- Section 1, the introduction, discusses the energy challenges many African countries face and how IMGs can contribute to addressing those challenges.
- Section 2 describes case studies of IMG success stories and experiences in sub-Saharan Africa.
- Section 3 provides an overview of the enabling factors that help accelerate the deployment, bankability, and scale of IMGs.
- Section 4 assesses a list of four sub-Saharan African countries on these enabling conditions.
- Section 5 offers recommendations and a pathway for IMG project development in a new geography.

Box 2: Goal and target audience

This report is targeted to AMP implementing partners, government stakeholders, donors, financiers, investors, development banks, DER developers, and utilities. This document aims to:

- **Explain Interconnected minigrids** by helping readers understand IMGs, their added value to help solve energy reliability challenges in African countries, and how they can complement isolated minigrids and improve utilities' performance through a more collaborative approach.
- **Share lessons learned and experiences** from existing IMGs in sub-Saharan Africa, including their impact and market traction.
- **Provide a high-level assessment** of IMG potential and emerging opportunities in the region.
- **Offer targeted recommendations** to accelerate IMG adoption and scale across geographies.

2. IMG Experiences in Africa

This section highlights IMG experiences, projects, and pipelines in various African countries as case studies, and discusses key insights, lessons learned, and factors contributing to these solutions.[iii]

2.1. How IMGs work

A typical IMG involves an IMG developer who builds, finances, and operates a local generation and distribution system connected to a larger grid, usually managed by a utility company. Customers of the IMG pay a blended tariff for all the electricity they use, and power is exchanged between the IMG and the utility under agreed technical and commercial terms.[iv]

Exhibit 3 illustrates the IMG business model in Nigeria. In this model, the IMG developer typically finances and constructs the project infrastructure, which consists of the solar PV generation assets paired with a smaller storage system than would be required for an isolated minigrid. The developer also undertakes the necessary upgrades and expansion of the local distribution network and operates the network during the agreed period. Customers pay a blended tariff for all energy used, and the IMG developer reimburses the utility for electricity from the main grid, along with a fee for network use.[v] A tripartite agreement between the developer, utility, and the service area outlines the terms of the IMG. *Appendix A* provides additional details on key implementation steps for an IMG and explains how responsibilities are divided between utilities and IMG developers in Nigeria.

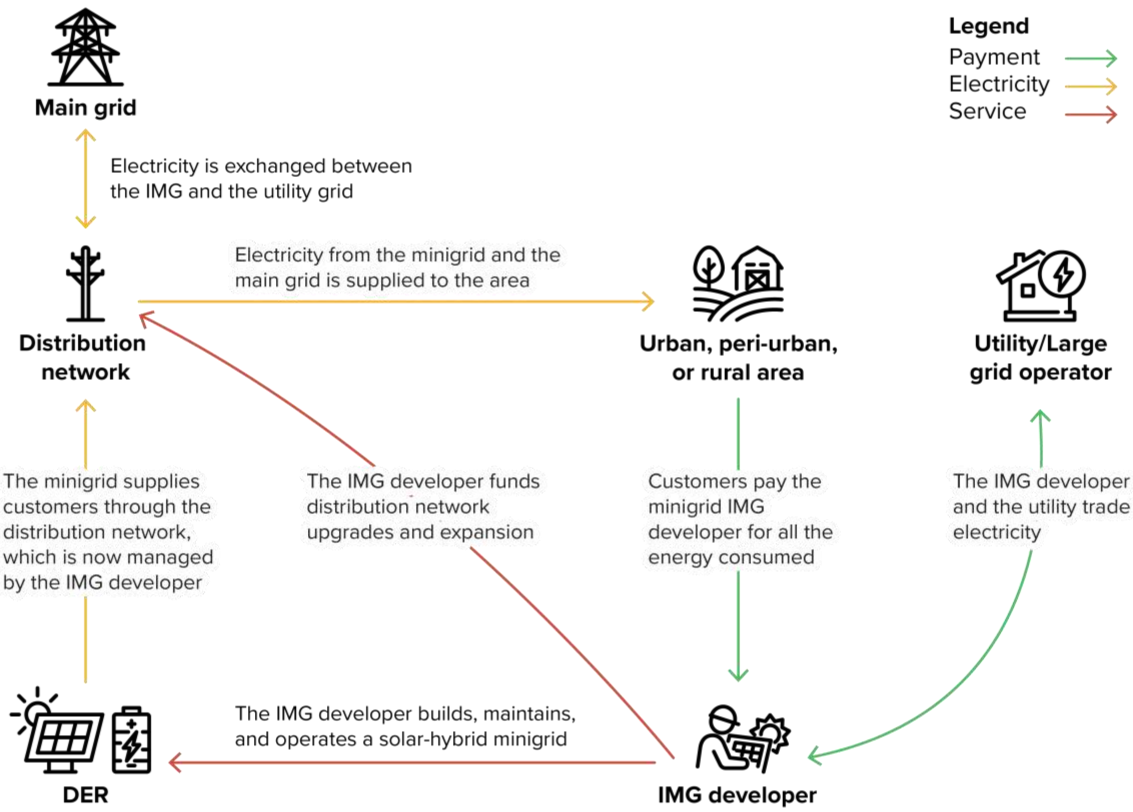
Other IMG business and delivery models are also feasible. For instance, in the Goma case study in section 2.3, an IMG connects to a larger minigrid, and in both the Hunyani and Goma IMGs, developers built greenfield distribution network architectures from scratch. Additionally, IMGs can be designed to serve various customer archetypes beyond urban and peri-urban areas, such as residential estates, industrial parks, and agricultural processing clusters. Exhibit 4 provides a summary of the IMG projects in Africa discussed in this report, and lists the project developers, the main grid operator, key features of each IMG, and essential operational details.

[iii] The projects featured in this report do not represent all IMG projects in Africa.

[iv] A blended tariff is a single average rate that combines both the utility electricity charge and a charge for the minigrid electricity. This charge allows the developer to cover operations and recoup its project cost.

[v] In Nigeria this is commonly referred as DUOS = Distribution Use of System

Exhibit 3: Summary of a typical IMG business model



Box 3: Preparing isolated minigrids for future interconnection

Isolated minigrids can be designed to be interconnection-ready and can evolve into interconnected minigrids in the future. Both the Toto and Goma IMGs started commercial operations as isolated minigrids before later interconnecting with a larger grid. In countries like Nigeria, regulations make provision for minigrids to be converted to IMGs when the main grid arrives. Interconnection can allow isolated minigrids to take advantage of the cheaper power supply from the larger grid to reduce costs and expand operations, as in Toto and Goma.

Preparing a minigrid for interconnection involves trade-offs. Many rural minigrids are not built to utility standards, with equipment such as meters, poles, or distribution cables not matching certain standards for larger distribution grids. Interconnection also requires specialized hardware such as transformers, disconnection switches, and islanding controls that could increase capital costs by up to 20%.[12] In addition, negotiating interconnection terms with utilities often increases development timelines and expenses.

Where and when appropriate, developers can mitigate these challenges by aligning equipment with distribution codes, establishing agreements with potential utility partners, and planning for eventual interconnection. Ultimately, an interconnection-ready minigrid strengthens resilience and supports the transition toward a fully integrated grid that blends distributed and centralized resources for the most cost-effective, reliable power. It is crucial that regulations allow for interconnection and are clear on the arrangements for grid arrival.

Exhibit 4: Summary of IMG projects in Africa highlighted in this report

		Interconnected minigrid case study					
	Unit	**Toto**	**Zawaciki**	**Robinyan**	**Wuse**	**Goma**	**Hunyani**
Country		Nigeria	Nigeria	Nigeria	Nigeria	Democratic Republic of Congo	Zimbabwe
Project developer		PowerGen	Bagaja	Darway Coast	GVE	Nuru	Next Century Power
Larger utility		AEDC	KEDCO	IE	AEDC	Virunga Energies	ZESA
Project status		Operational	Operational	Operational	Operational	Operational	Under development
Solar PV capacity	kW	352	1,000	1,000	1,000	1,300	1,800
Battery capacity	kWh	972	N/A	1,250	1,200	2,200	1,300
Distribution network	km	19	5	13	N/A	46	225
Average hours of supply*	hours/day	16	18	15	13	23–24	20
Customers*	No	1,760	2,212	7,469	2,166	2,664	6,000
Commercial customers*	No	310	67	1,103	2,166	840	300
Average end-user tariff	US$/kWh	US$0.28 (NGN 450/kWh)	US$0.09 (NGN 150/kWh)	US$0.13 (NGN 209/kWh)	US$0.13 (NGN 215/kWh)	US$0.43 (1,113 CDF/kWh)	US$0.20
Average revenue per user (ARPU)*	US$/day	US$0.32	US$0.49	US$0.09	US$0.26	US$0.93	US$0.85
Electricity sale or purchase from larger utility		Purchase (Unidirectional)	Purchase (Unidirectional)	Purchase (Unidirectional)	Purchase (Unidirectional)	Purchase (Unidirectional)	Purchase and sale (Bidirectional)
Lifetime avoided emissions*	tons of CO_2	15,000	11,000	12,000	32,000	26,300	22,600

* Where applicable, projected values have been provided.

2.2. Nigeria — Toto, Zawaciki, Robinyan and Wuse IMGs

In Nigeria, an estimated 150 million people — 75% of the population — have no or unreliable access to electricity.[13] Most electricity users rely on petrol and diesel-powered generators that cost over NGN 600/kWh (US$0.40/kWh) just for fuel to operate. Eighty percent of electricity usage in Nigeria comes from 22 million small generators, totaling 58 GW in total capacity, compared to the 5 GW of available generation capacity on the electricity grid.[14] In addition to constrained generation, Nigeria's electricity distribution utilities (DisCos) face numerous challenges, including inadequate infrastructure, high technical and non-technical losses, and limited grid coverage.

Despite its rapid deployment of minigrids with over 200 minigrids currently in operation and a pipeline of 4,000 minigrids to be deployed between now and 2030, the country has moved relatively slower with IMGs.[15] Recently, with support from RMI and The Global Energy Alliance for People and Planet (The Global Energy Alliance), the first wave of IMG projects has been deployed in Nigeria. These four projects have added 3 MW of solar PV and 3 MWh of battery storage, have retrofitted and expanded the existing distribution network, and now serve over 13,000 connections in urban and peri-urban areas in Nigeria. The projects are supporting over 3,300 jobs in enterprises and businesses benefitting from improved access to electricity.[16]

Early results from three of these projects that have been operational for months (Robinyan IMG) and years (Toto and Zawaciki IMGs) have been positive. The areas served by IMGs have experienced significant improvements in energy supply and reliability, with daily energy supply increasing from less than 3 hours to around 15 hours due to energy from the local PV generation plant and improved grid supply.[17] There has been a 62% increase in metered connections across all four projects.[18] With more commercial customers and higher-income residential customers, these areas have 15 times higher energy consumption than their isolated minigrid peers in Nigeria, which translates to higher monthly revenues for developers.[19]

DisCos that previously operated in these areas now served by the IMGs have reduced their losses and increased their revenues, achieving a 100% collection rate from previously unprofitable communities.[20] These improvements are due to more robust distribution networks that the developers partially or fully finance, robust billing infrastructure, improved customer engagement, and the increased hours of main grid supply to the IMG.[21] DisCos are also benefiting from reduced operational costs because those are borne by the developers, which often means a DisCo can divert resources to other areas, potentially alleviating resource constraints elsewhere.[22]

Key factors that contributed to the success of these projects include choosing sites with high energy demand and strong customer interest, effective collaboration between the main distribution utilities and the developers, supportive regulation, and grant funding and technical assistance from RMI and The Global Energy Alliance.

IMGs are set for rapid growth in Nigeria in the coming years. The Rural Electrification Agency of Nigeria, through its Distributed Access through Renewable Energy Scale-up program (DARES) supported by the World Bank, plans to support 125 IMGs with up to $127 million in grants over the next three years.[23] Simultaneously, the Nigerian Electricity Regulatory Commission (NERC) has required DisCos to obtain 10% of their annual energy from embedded generation, with at least half coming from renewable sources. IMGs will be essential in helping DisCos meet these goals.[24]

The Toto IMG won 2023's Africa Solar Industry Association Mini Grid Project of the Year Award. Nigeria's first IMG, it has four times the consumption of typical isolated minigrids.

The Zawaciki IMG capitalizes on the abundant sunshine in the north to address the challenges of energy reliability and quality associated with aging transmission infrastructure.

The Robinyan IMG exchanges power with Nigeria's largest distribution utility.

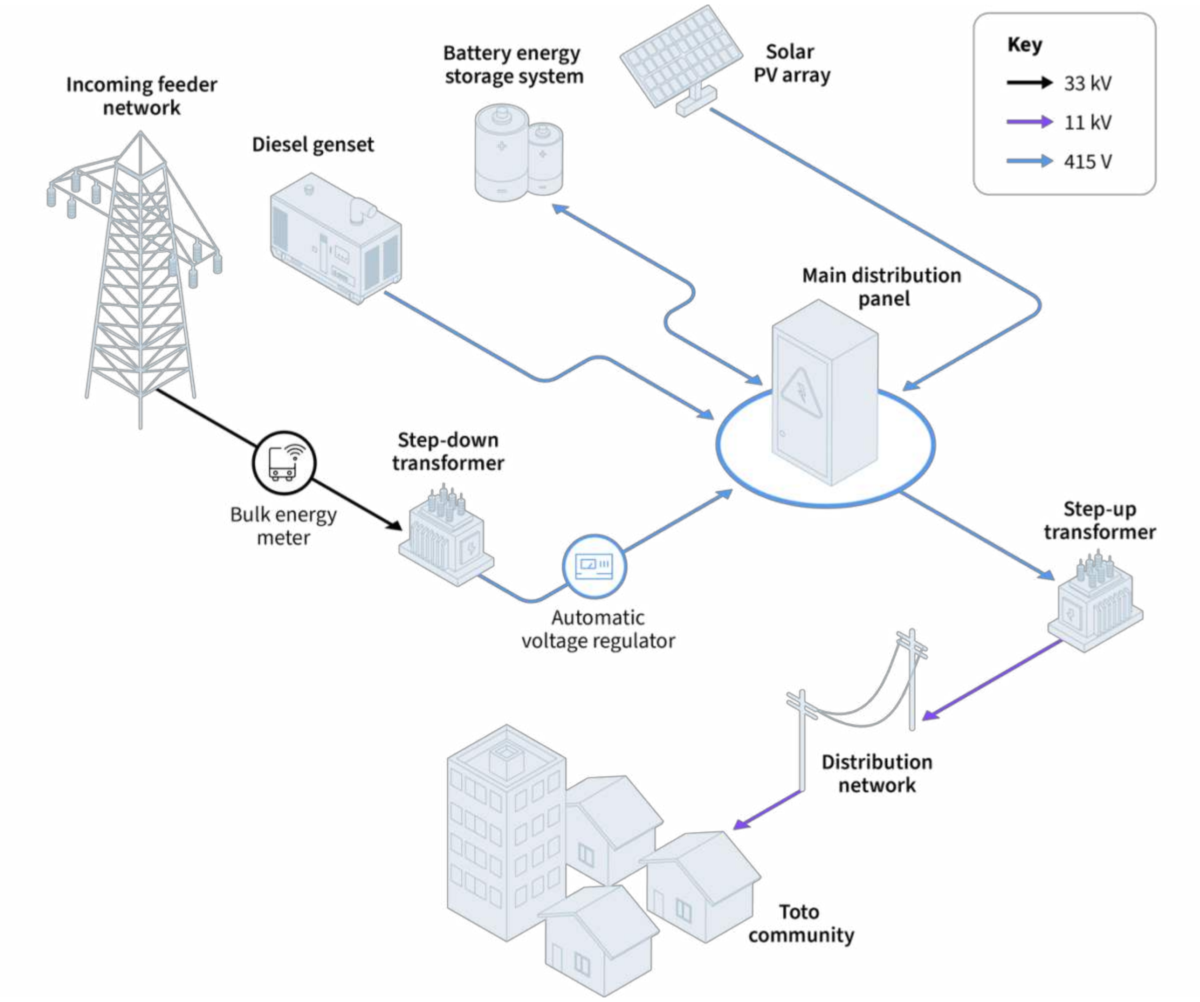
The Wuse IMG primarily serves daytime energy consumers at Wuse market, replacing 2,000 noisy, costly fossil fuel generators.

RMI and The Global Energy Alliance's recent analysis estimates a potential IMG market in Nigeria of up to 22 GW over the next decade comprising 4,000 to 8,000 individual projects depending on their size.[25] This opportunity is nearly double the current installed generation capacity in Nigeria. It could lead to 25 million upgraded single connections, affecting 125 million people, and playing a vital role in reaching SDG7 and Mission 300 in Nigeria.

Box 4: The levelized cost of energy of IMGs in Nigeria

RMI's analysis shows that the levelized cost of energy (LCOE) of new IMGs in Nigeria can be as low as US$0.18/kWh compared to an optimal isolated minigrid that can achieve an LCOE of US$0.28/kWh.[26] Factors that contribute to this lower LCOE include optimal system design with relatively low battery storage capacity, high energy consumption from sites with a significant level of commercial and productive-use load, and blending in cheap grid supply with grid energy tariffs as low as $0.08/kWh. Nigeria's proposed net-billing policy, which permits bidirectional power flow, presents an opportunity to further lower IMG LCOE by minimizing energy curtailment.[27]

Exhibit 5: Grid interconnection architecture of Toto IMG



RMI Graphic. Source: Aminu, *Partnerships for Power*, 2025

Box 5: *Partnerships for Power* report, 2025, RMI and The Global Energy Alliance

Following RMI and The Global Energy Alliance's support of these four pioneering IMGs in Nigeria, RMI and The Global Energy Alliance published a report: ***Partnerships for Power: Unlocking Scale for Interconnected Minigrids in Nigeria*,** detailing the lessons learned from the first wave of projects. The report is backed by real-world data and the experiences of pioneering developers, DisCos, RMI, and The Global Energy Alliance, and delivers critical insights and actionable recommendations to propel the IMG sector in Nigeria.

The report details the proven viability of collaboration between developers and DisCos in delivering electricity access, upgrading existing connections, and achieving mutual benefits through IMG projects; identifies opportunities for streamlining project initiation, procurement, construction, and operation to accelerate timelines, reduce uncertainty, and lower costs; and describes challenges hindering faster deployment, such as high up-front generation costs, prolonged project development timelines, unclear interconnection processes and responsibilities, and low DisCo grid supply hours impacting operational expenditures.

The report is available at https://rmi.org/insight/partnerships-for-power-unlocking-scale-for-interconnected-minigrids-in-nigeria/.

> "At PowerGen, we've seen how interconnected minigrids can transform the economics and reliability of distributed power across Africa. In markets like Nigeria, linking reliable local solar-BESS generation with the national grid has unlocked affordable, continuous energy for communities and businesses that were previously underserved. By complementing an existing but often "weak grid," IMGs allow developers to deliver lower-cost, higher-uptime systems — drawing power when it's cheapest and relying on storage only when needed. This hybrid model not only drives down the levelized cost of energy but also strengthens utilities and accelerates progress toward universal, reliable access across the continent."
>
> **Aaron Cheng, CEO, PowerGen**

2.3. Democratic Republic of Congo — Goma IMG

In the Democratic Republic of Congo (DRC), only 19% of the population has access to the electricity grid or off-grid systems, leaving 88 million people without access to electricity. Urban areas, where 41% of people are grid-connected, have unstable supply with recurring electricity shortages and power blackouts.[28] The government-run electric utility, La Société Nationale d'Électricité (SNEL), faces numerous challenges, including losses of up to 67%, operational inefficiencies, and aging infrastructure, all of which affect service quality.[29] Underpricing and lack of profitability, with electricity tariffs lower than the utility's recovery costs, limit SNEL's ability to invest in and maintain its infrastructure.[30]

In 2020, private developer Nuru commissioned a 1.3 MW solar PV plant to serve customers in Ndosho, a peri-urban area in the city of Goma.[31] Prior to Nuru's installation, only 3% of people in Ndosho had access to electricity.[32] In 2024, the Nuru minigrid interconnected with a nearby larger minigrid, operated by Virunga

Energies. This interconnection was meant to improve electricity availability and reliability, expand customer connections, and reduce diesel usage in the Nuru minigrid. [33]

Early results from Nuru show that this interconnection has provided significant value to the Goma IMG. Service availability increased from 96% to 98% with sustained uninterrupted power supplied to critical infrastructure, including water and ICT infrastructure that serve 400,000 people, including tens of thousands of displaced persons.[34] One hundred percent of customers now use Nuru's IMG as their primary energy source, despite previously having access to solar home systems or diesel gensets, and 25% of connected businesses have launched since the grid's commissioning in 2020, highlighting energy's catalytic role in local economic development.

Goma IMG. Source: Nuru

Before the interconnection, the grid operated primarily on the PV system, BESS, and diesel generators, with an average monthly consumption of approximately 27,500 liters of diesel.[35] Following the interconnection, with an initial availability of 8 hours/day from the Virunga minigrid, diesel consumption decreased by 77%. Since May 2025, with 24/7 availability from the Virunga minigrid, diesel consumption has fallen by 96% since the pre-interconnection baseline. This reduction has resulted in significant savings in operating costs, particularly fuel and generator maintenance. The interconnection also expanded service capacity. Approximately 200 new customers were connected to the grid shortly after the interconnection with the Virunga grid, generating new revenue from both connection fees and ongoing energy sales.

Amid the political and security crisis in Goma and the DRC, Nuru's operations have remained resilient, continuing to power its customers and providing essential energy services to over 19,500 direct end-users.[36] Nuru plans to continue to operate similar IMGs in the future and to develop an 8 MW solar IMG interconnected with a hydropower facility in Bunia, DRC, in the near term.

Key factors that contributed to the success of the Goma IMG project include early and ongoing engagement with local authorities and communities, optimization of control and monitoring technologies for system performance, and multisector partnerships for resilience and innovation.[37]

Box 6: IMGs, productive use, and catalyzing jobs

IMGs have demonstrated a strong capacity to catalyze jobs by supporting income-generating activities that connect energy access to improved lives. In addition to the employment involved in constructing and operating an IMG — including roles such as business developers, system engineers, technicians, and customer relations officers — jobs in small and medium-sized enterprises (SMEs), along with large commercial and industrial customers, benefit from increased energy reliability.

For instance, the Wuse IMG will supply 100% of the commercial customers in Wuse market, one of Nigeria's largest markets, which will impact over 4,000 jobs. Similarly, the Zawaciki IMG in Nigeria serves major clients like a water production factory, Dala dry port, and China Civil Engineering Construction Company (CCECC), all of which employ hundreds. Ibrahim Sali, head of Nifal Limited, the water production factory, now saves significant energy thanks to the Zawaciki IMG. Previously, Sali used diesel generators daily to supply about 10,000 liters of water to the area. “Before now we were not having light [power] very well, but with this [IMG] now there is light and it is helping our business,” he explains. “We make more profit now because with the light, I don’t use diesel like before,” he says.[38]

Similarly, the Goma minigrid serves critical infrastructure, including water and ICT infrastructure to 400,000 residents. Additionally, since its launch in 2020, 25% of businesses connected to the grid have launched, underscoring the IMGs role as a catalyst for local economic growth. SME customers in Goma report much higher satisfaction than nearby customers connected to the SNEL grid, using twice the energy and remaining open longer than their grid-connected counterparts.[39] Ultimately, the large number of commercial and productive users common in IMGs can support cross-subsidization and help lower tariffs for vulnerable households.

2.4. Zimbabwe — Hunyani IMG

Zimbabwe still faces challenges in its electrification efforts, with 38% of the population without access to electricity (49% in rural areas and 16% in urban areas).[40] In 2022, the state-owned utility, Zimbabwe Electricity Supply Authority (ZESA), reported a backlog of 305,000 domestic customers awaiting connection, estimated to cost US$300 million.[41] Like many utilities in sub-Saharan Africa, ZESA lacks the capacity and capital to address this backlog, leaving grid-edge communities, colloquially known as “dark cities,” waiting for decades for electricity access. In Harare province alone, nearly half a million residents live within 15 km of the grid but remain unelectrified.[42]

Next Century Power is in the late stages of development of the Hunyani minigrid, a 1.8 MW/1.3 MWh project in the Retreat community in Harare.[43] This community, with over 12,000 unelectrified buildings, currently relies on liquified petroleum gas, small solar home systems, petrol generators, charcoal, and wood to meet their energy needs. Retreat is located just 3 km away from the Zimbabwe Electricity Transmission and Distribution Company (ZETDC) existing grid. The project will interconnect with the grid, augmenting supply from the local DER solution with supply from the main grid during off-peak periods (at night) and will sell surplus electricity to the grid. This project will avoid 1,130 tons of CO_2 emissions yearly.

Next Century Power conducted a detailed feasibility study, including an energy demand and willingness to pay assessment, and rigorous stakeholder engagement.[44] They signed a land lease agreement, completed a competitive procurement, and selected an EPC contractor, and are currently finalizing a grid impact assessment study. They are in the process of receiving both a generation and a 30-year distribution license for the project and are approaching financial close.

Next Century Power has also identified a pipeline of 19 similar peri-urban clusters in Harare and surrounding communities.[45] This cluster with over 188,000 unelectrified buildings and 500,000 people in households and businesses, all in close proximity to the grid, presents an opportunity for an 80 MW IMG pipeline.

Key factors that have contributed to the progress of the Hunyani IMG include the favorable regulatory environment, supportive government initiatives, and strong collaboration with the utility.

3. Framework for Scaling IMGs: Identifying High-Potential Markets Across Africa

Building on the preceding analysis of IMG experiences and case studies across Africa, it is essential to understand the conditions under which these solutions can succeed in other geographies. The previous sections have demonstrated that while IMGs offer significant benefits, their success is highly dependent on specific local conditions and enabling environments. This section outlines the key enabling factors that determine where IMG solutions are most likely to thrive. By systematically assessing these factors, stakeholders can identify potential new markets, unlock new partnerships, and accelerate scale.

Exhibit 6: Key IMG enabling conditions

The enabling conditions include the following:

a. **Weak grid:** Countries and utilities facing grid reliability and availability challenges — especially in rural and peri-urban areas with aging transmission and distribution networks — are strong candidates for IMG deployment. Symptoms of weak grids include high transmission and distribution network losses, poor power quality, frequent outages and widespread blackouts, voltage and frequency fluctuations, congestion, and limited redundancy.[vi] In contrast, markets with strong and well-maintained transmission and distribution networks might be better suited to centralized power solutions.

[vi] While the global average for transmission and distribution losses is 6% (https://data.worldbank.org/indicator/EG.ELC.LOSS.ZS), many countries in sub-Saharan Africa experience much higher losses. These are caused by both significant technical losses due to aging infrastructure and considerable commercial losses stemming from theft and billing inefficiencies. Refer to section 4 for more details on transmission and distribution losses for countries assessed in this report.

b. **Underserved demand centers**: Rapid urbanization across Africa is driving fast growth in many cities and peri-urban areas, often outpacing grid expansion. In these areas, clusters of businesses, SMEs, and higher-income households create strong demand that utilities often struggle to meet. Many rely on costly diesel or petrol generators and smaller stand-alone DERs, signaling a clear willingness to pay for reliable power. High electricity demand density is key to IMG bankability, making underserved but economically vibrant regions prime candidates for IMG deployment.

c. **Supportive regulatory environment:** Markets with progressive energy sector reforms and enabling regulations are better positioned for IMG deployment. Supportive policies include those that recognize the value of DERs, encourage private sector participation across the power value chain, and streamline administrative processes. Key measures can include simplified licensing processes, reduced import duties and taxes on renewable energy components, liberalized tariffs, and clearly defined interconnection and grid standards. Large government programs that channel public finance — through subsidies or concessional investments — further strengthen the environment for IMG growth.

d. **Utility buy-in:** In many African countries, vertically integrated, state-owned utilities still dominate the power sector. By contrast, markets with more liberalized and deregulated markets, where multiple players can operate and new entrants can easily join, tend to be more favorable for IMGs. Even in countries with public utilities, a utility's openness to collaborating with private developers is critical for successful IMG deployment.

e. **Private sector attractiveness:** Markets with increasing strong private sector engagement in the power sector are prime candidates for IMG deployments. Signs such as growing presence of independent power producers (IPPs), minigrids, or concession-based models; and high penetration of captive DER power solutions for residential, SME, and large commercial and industrial customers, can indicate private sector interest.

The above factors rarely operate in isolation: for instance, supportive regulation often attracts private sector interest, while utilities' openness to partnership can be reinforced by donor-backed financing and technical assistance. Successful IMG markets typically combine multiple enablers rather than excel in one dimension alone.

Section 4 assesses countries, utilities, and markets based on the five enabling factors, but the following additional factors are also important for scaling IMGs:[vii]

f. **Access to finance and risk-mitigation instruments.** Even in markets with demand and policy support, IMG projects require significant up-front capital. Countries (or regions) with accessible concessional financing, blended finance facilities, guarantees, or currency-hedging instruments are far more likely to attract developers and investors.

g. **Availability of local technical capacity.** The presence of skilled engineers, operators, and service providers lowers deployment risks and operations and maintenance costs. Markets where training

[vii] Assessment of these factors in each country in section 4 requires deeper research and more stakeholder engagement than this report allowed.

programs, universities, or private firms support energy workforce development may be better positioned to sustain IMG growth.

h. **Data availability and planning frameworks**. Robust demand data, geospatial electrification planning, and clear utility expansion roadmaps reduce uncertainty for developers. Governments and utilities that publish or coordinate such data create stronger conditions for the deployment of IMGs.

Box 7: Supportive IMG regulation

Clear, stable, and supportive regulation is crucial for IMG development. Opaque and unstable regulation leads to regulatory risks and increased project transaction costs. In Nigeria, key tenets of the regulation that contributed to the first wave of IMGs include:

a) developers being allowed to charge cost-reflective tariffs,
b) standardized tripartite agreement templates,
c) the ability to sign exclusivity agreements for minigrids, and
d) simplified licensing procedures for minigrids less than 100 kW to speed up deployment under the minigrid regulations.[46]

In Zimbabwe, developers are allowed to charge cost-reflective tariffs and IMGs are permissible with a generation license and distribution license under the electricity act. There are also clear frameworks for electricity bulk purchase agreements with ZETDC, and PPAs with ZESA under the electricity act.[47] Similarly in DRC, the 2014 electricity law ended SNEL's monopoly and allows developers to charge cost-reflective tariffs.[48]

4. High-Level Country Assessment on IMG Potential

Having established a framework and conditions that determine where IMGs are most likely to succeed in African nations, we now apply these to specific countries: Zambia, Ethiopia, Madagascar, and Comoros. These countries were chosen to reflect a broad range of African power systems, policy environments, private sector interest, and different stages of minigrid market growth within AMP.

Zambia and Madagascar have relatively mature minigrid sectors with supportive regulatory frameworks and increasing private-sector involvement, making them strong candidates for IMG expansion. Comoros is a small island with a limited market and moderate institutional capacity but has growing interest in DERs. Ethiopia, on the other hand, exemplifies a large, top-down power market where structural constraints highlight the barriers that IMGs may encounter. Together, these countries offer valuable comparative insights into how different market and institutional conditions impact IMG potential and scalability.

Exhibit 7: Summary of country assessment on IMG potential

Madagascar	Madagascar demonstrates significant potential for IMG deployment, with a weak grid, high proven demand, strong private sector participation in the electricity sector, and supportive regulatory environments.	High IMG potential
Zambia	Zambia presents a complex but promising environment for IMG solutions, with acute grid challenges, strong and growing demand, demonstrated willingness to pay, improving policy support, increasing utility openness, and high private sector participation.	High IMG potential
Comoros	Comoros, with an electricity sector burdened with high losses and heavy reliance on imported, expensive fossil fuels is rated as a moderate promising market for IMGs to enhance the sector's sustainability and resilience due to ongoing reforms and extensive grid coverage.	Moderate IMG potential
Ethiopia	Ethiopia presents a landscape of large, underserved demand for reliable electricity but improving policy support and credible avenues for private participation will be critical for IMG development.	Low IMG potential

4.1. Zambia — High potential for IMGs

Exhibit 8: Zambia's assessment on IMG potential. Each condition is rated on a scale of 1 (low) to 4 (high)

IMG enabling factor	Score	Rationale
Weak and overloaded grid infrastructure	3	Zambia's main utility, Zambia Electricity Supply Corporation Limited (ZESCO), faces operational challenges that lead to frequent and prolonged outages and an estimated 10% to 12% aggregate technical and commercial (AT&C) losses.[49]

Strong but underserved demand centers	**4**	Zambia has 80% electricity access in urban areas, with a large underserved population and growing community and industrial demand.[50] Two-thirds of households in the highest income bracket and over 73% of firms use diesel generators.[51]
Supportive policy and regulatory environments	**2**	Policies like The Electricity Open Access Framework, Net Metering Policy Framework, and the Energy Single Licensing System can support IMGs.[52] However, effective deregulation for projects up to 5 MW have led to some uncertainty.[53]
Utility buy-in and capacity to participate in partnerships	**3**	ZESCO is increasingly open to public-private partnerships and new business models, such as embedded generation and energy trading frameworks.[54]
Private sector attractiveness	**3**	Private developers like Solar23, OnePower Africa, and Ignite Power are already active in the minigrid space and private companies like North Western Power Company and Copperbelt Energy Corporation already manage distribution networks.[55]
Overall potential	**15/20**	

Zambia's electricity sector faces significant and multifaceted challenges, making it a strong candidate for DERs and IMGs. The national grid, managed by ZESCO, is characterized by frequent load-shedding, high AT&C losses of 10%–12%, and widespread reliability issues, even in urban and peri-urban areas.[56] These problems are compounded by aging infrastructure and a persistent access gap, with around 46% of the population (approximately 9 million people) still lacking electricity.

ZESCO incurs annual revenue losses exceeding US$150 million due to load-shedding, which typically lasts between 3 and 7 hours per day.[57] Prolonged droughts have reduced the Zambian grid's generation output to 1,600 MW, representing only 50% of its installed capacity of 3,000 MW. In response, ZESCO's board has issued a directive to procure 500 MW of non-hydro DERs by 2027.[58]

Demand for electricity in Zambia is rapidly increasing, driven by urbanization, industrialization, and targeted government electrification efforts. Large rural and peri-urban areas remain underserved, but there is proven demand and the presence of anchor loads in some locations.[59] Zambia's Integrated Resource Plan (IRP) projects a dramatic rise in both industrial/commercial and residential energy needs, with residential demand expected to grow by 40% by 2030 and 150% by 2050.[60]

There is clear evidence of a willingness and ability to pay among higher-income households and businesses, as shown by the widespread use of expensive diesel generators. More than two-thirds of the wealthiest households, as well as over 73% of firms, rely on backup generators.[61] The mining sector also self-generates significant amounts of power from diesel, highlighting both the scale of unmet demand and the potential for cost-competitive alternatives.[62]

On the policy and regulatory front, Zambia has made notable progress. Reforms now allow private sector participation across generation, distribution, and trading, and the country introduced a net-metering framework in 2023.[63] The government aims to achieve 3 million new connections by 2030, with 50% expected to come from decentralized solutions.[64] However, challenges remain, including non-cost-reflective tariffs and regulatory complexity, which can deter investment and slow project development.[65] The effective deregulation for projects up to 5 MW leaves major legal and financial risks unresolved, with no clear framework governing cost-reflective tariff approval, buy-out conditions, or grid-arrival transitions.[66]

ZESCO is increasingly open to public-private partnerships and new business models, such as embedded generation and energy trading frameworks.[67] A notable example is ZESCO's recent partnership with Anzana, which aims to provide electricity access to 2 million individuals along the Lobito corridor by 2030.[68] Private sector interest is robust, with active developers like Solar23, OnePower Africa, and Ignite Power (formerly Engie) and a growing pipeline of minigrid and DER projects.[69] Other notable recent projects include several large-scale solar parks and IPP initiatives. However, weak macroeconomic conditions and ZESCO's financial instability are significant barriers to financial closure, despite strong market interest.[70]

In summary, Zambia presents a complex but promising environment for IMG solutions, with acute grid challenges, strong and growing demand, demonstrated willingness to pay, improving policy support, increasing utility openness, and high private sector interest. However, persistent financial and regulatory hurdles must still be addressed.

4.2. Ethiopia — Low potential for IMGs

Exhibit 9: Ethiopia's assessment on IMG potential. Each condition is rated on a scale of 1 (low) to 4 (high)

IMG enabling factor	Score	Rationale
Weak and overloaded grid infrastructure	**4**	In Ethiopia, transmission losses stand at 17%, distribution losses at 22%, and 16% of households experience voltage issues.[71]
Strong but underserved demand centers	**3**	Half of all households receive less than 8 hours of supply per day and 75% of firms experience outages lasting more than two hours.[72] Companies are willing to pay a high price (at least three times their current monthly bill) to avoid outages.[73]
Supportive policy and regulatory environments	**2**	The electricity market in Ethiopia has limited openness, attractiveness, and readiness for private sector participation.[74]

Utility buy-in and capacity to participate in partnerships	**1**	There are private sector participation models in the off-grid segment but limited participation models in the distribution segment of the electricity market.[75]
Private sector attractiveness	**2**	Among 16 African countries, Ethiopia is projected to have the lowest number of potential private sector-developed minigrid sites by 2030.[76]
Overall potential	**12/20**	

Ethiopia's electricity sector is marked by both progress and persistent challenges. While urban electrification rates are high and growing, approximately 60 million people — mostly in rural areas — still lack access to electricity.[77] Grid reliability also remains a concern: half of all electrified households receive less than 8 hours of supply per day, and most grid-connected households experience frequent outages.[78] Technical and commercial losses are significant, with about 17% of electricity lost on the transmission network and 22% on the distribution network.[79]

Demand for reliable power is strong, especially among businesses and higher-income households. About 14% of firms own backup generators, and there is a demonstrated willingness to pay much more for dependable electricity — at least three times the current bill.[80]

The policy and regulatory environment in Ethiopia is evolving. Licensing for off-grid projects is transparent, signaling openness to private sector involvement, and recent reforms have aimed to attract more private finance, especially for large projects.[81] National private investors can participate in distribution, but international investors are limited to joint ventures on cross-border projects.[82] Private rural electrification projects are mostly humanitarian rather than commercial, and private stand-alone pipelines remain thin, with private sector enthusiasm remaining lower than in some neighboring countries.[83]

Overall, Ethiopia presents a landscape of large, underserved demand for reliable electricity. Improving policy support and credible avenues for private participation will be critical for IMG development. A shared roadmap and regular government–utility–investor dialogue will sustain momentum and unlock bankable projects.[84]

4.3. Madagascar — High potential for IMGs

Exhibit 10: Madagascar's assessment on IMG potential. Each condition is rated on a scale of 1 (low) to 4 (high)

IMG enabling factor	Score	Rationale
Weak and overloaded grid infrastructure	**4**	Jiro sy rano Malagasy (JIRAMA), Madagascar's state-owned utility, faces 30% AT&C losses in its distribution network.[85]
Strong but underserved demand centers	**4**	Despite a 72% urban electrification rate, companies outside the capital lose nearly one-seventh of their annual turnover due to constrained grid supply;[86] and 17% of businesses use or share a backup generator.[87]
Supportive policy and regulatory environments	**3**	The government adopted an electricity law (Code de l'Electricité, 2017) that prioritizes renewable energy and the liberalization of the electricity sector, and the regulatory agencies have demonstrated strong institutional capacity.[88]
Utility buy-in and capacity to participate in partnerships	**3**	Madagascar has several small operational IPP projects with the private sector, and minigrid developers in Madagascar are exploring partnerships with JIRAMA on DER models.[89]
Private sector attractiveness	**4**	The private sector accounts for nearly 70% of the installed generation capacity on JIRAMA's grids and has made $22.5 million in private sector investment in minigrids to date.[90]
Overall potential	**18/20**	

Madagascar presents a complex but compelling case for IMG deployment. The country's electricity infrastructure is severely underdeveloped; only 36% of the population has access to electricity.[91] The national grid is fragmented into three disconnected networks — Antananarivo, Toamasina, and Fianarantsoa — operated by JIRAMA, the public utility. These networks suffer from frequent blackouts, chronic overloads, outdated infrastructure, and high losses, estimated at 30%, split between technical losses and commercial losses.[92]

Additionally, over 200 private minigrids and 2,000 nano-grids operate independently,[viii] highlighting both the demand and the decentralized nature of the electricity market.[93] Urban and peri-urban areas face constrained supply and poor service quality, which has a direct impact on economic productivity. Businesses outside the capital report losing up to one-seventh of their annual turnover due to frequent outages and voltage fluctuations.[94] Despite these challenges, there is evidence of a willingness to pay for better service — 17% of businesses use backup generators, and the diesel genset market was valued at over US$21 million in 2023.[95] This underscores the urgent need for reliable energy solutions in high-demand areas.

Policy and regulatory frameworks show moderate support for renewable energy expansion. The government has committed to increasing electricity access to 80% by 2030 and has adopted an electricity law (Code de l'Electricité, 2017) that prioritizes renewable energy and liberalization of the electricity sector.[96] The regulatory agencies, Agence de Développement de l'Électrification Rurale (ADER) and the Office de Régulation de l'Électricité (ORE), have demonstrated strong institutional capacity in tendering, processing private applications, and tariff approvals for DER projects.[97] However, challenges remain, including the complexity and inconsistent application of tax exemptions for renewable energy projects and technologies and coordination issues between various government and regulatory entities.[98] As a result, the government has recently launched initiatives to simplify the regulatory landscape for renewable energy projects and is committed to tariff reforms.[99]

Private sector interest is evident, with several existing small IPP projects and more than 30 active private minigrid operators with some of them exploring partnerships with JIRAMA on DER models.[100] Leading private developers like ANKA and Welight are raising significant capital and deploying minigrids at scale.[101] With support of donors like GIZ, the government is also preparing to issue tenders for large-scale minigrids to be built and operated by the private sector.[102]

Overall, Madagascar demonstrates significant potential for IMG deployment, with a weak grid, high proven demand, and strong private sector participation in the electricity sector. The policy landscape will need to continue evolving to accelerate progress.

4.4. Comoros — Moderate potential for IMGs

Exhibit 11: Comoros' assessment on IMG potential. Each condition is rated on a scale of 1 (low) to 4 (high)

IMG enabling factor	Score	Rationale
Weak and overloaded grid infrastructure	4	The Comoros National Electricity Corporation (Société Nationale de l'Electricité des Comores, SONELEC) has AT&C losses of 31%.[103]

[viii] Nano-grids are small, localized, solar-powered systems that provide electricity to 4–6 households, primarily in rural areas.

Strong but underserved demand centers	**3**	Despite a 100% electrification rate in urban areas, the larger cities and the capital Moroni regularly experience power outages lasting several hours per day.[104] Electricity tariffs in Comoros are one of the highest in Africa with nonindustrial customers paying US$0.33/kWh and industrial customers paying up to US$0.27/ kWh.[105]
Supportive policy and regulatory environments	**2**	The Comoros government is in the final stages of signing a decree to promote "individual and community self-production" as well as net metering.[106]
Utility buy-in and capacity to participate in partnerships	**2**	There are a few private sector-built solar IPPs in the country with SONELEC as the offtaker.[107]
Private sector attractiveness	**2**	There is high uptake in solar DER solutions driven by residential, SME, and commercial and industrial demand.[108]
Overall potential	**13/20**	

The electricity sector in Comoros is characterized by widespread access, with 87% of the population connected to the grid and full coverage in urban areas.[109] Despite this, the country faces significant challenges in meeting the growing demand, especially as urbanization increases. Power reliability and quality of supply remain concerns due to high losses, estimated at 31%, and frequent outages.[110]

Electricity costs in Comoros are among the highest in Africa.[111] The utility sells power at US$0.25/kWh, while the cost of service, primarily from diesel and heavy fuel-powered generation plants, reaches US$0.60/kWh.[112] This imbalance contributes to the utility's financial difficulties and makes the on-grid segment of the market less attractive for investment.[113] Despite this, the renewable energy sector has seen some solar IPP projects, which are helping to diversify the energy mix and improve supply reliability.[114]

Policy reforms are underway to address some of these issues and promote decentralized clean energy deployments. A new draft decree aims to regularize behind-the-meter solar installations for both residential and commercial customers, introducing net metering, tax rebates, and exemptions from import duties for solar and energy efficiency products.[115] This decree will also allow for "community-based self-production" where communities establish their energy sharing policy and can partner with private sector developers and financiers to develop IMGs. However, the decree has not yet been formally signed. Nonetheless, private sector interest is growing, particularly in solar backup solutions for residential, SME, and small commercial and industrial customers.[116]

With high losses and heavy reliance on imported, expensive fossil fuels for energy, along with ongoing reforms and extensive grid coverage, Comoros is a promising market for IMGs to enhance the sector's sustainability and resilience.

5. Recommended Pathway for IMG Deployments

To identify new IMG markets and accelerate the adoption of these solutions, policymakers, government agencies, donors, financiers, DER developers, and utilities can take the following steps:

Exhibit 12: Summary of recommended pathway for IMG deployments

STEPS	ACTION	LEADING STAKEHOLDERS
Market assessment	Assess the country or area of focus on IMG enabling conditions	Promoters (e.g., donor or government program, renewable energy agency)
Business model adaptation	Adapt business model to fit local conditions but ensure win-win-win for all stakeholders	DER developer and utility
Run concurrently		
Regulatory review	Understand and evaluate how IMGs can be deployed under existing regulations	Promoters, DER developers, utilities
Pilot project support	Derisk and implement pilots with grants and technical support	Promoters, DER developers, utilities
Learnings	Capture and share the insights and learnings	Promoters
Second wave of projects and subsidy refinement	Apply key learnings from pilots to demonstrate a second wave of projects and determine subsidy needs	Promoters, DER developers, utilities
Scaling	Rollout portfolios of projects via competitive procurement	Utilities

Step 1 — Conduct a market assessment

Before launching IMG programs, promoters — including donor initiatives, development banks, renewable energy agencies, utilities, and DER developers — should assess whether target areas meet the enabling conditions outlined in section 3. This includes mapping demand centers with weak grid infrastructure, evaluating policy environments, gauging utility interest in partnerships, and identifying and addressing barriers facing private DER developers.

Step 2.1 — Adapt the IMG model to local context

The IMG business model should be tailored to local conditions, including asset ownership, cost recovery mechanisms, power exchange arrangements with the main grid, and payment structures between developers, utilities, and customers. Promoters, developers, and utilities should co-develop these adaptations in consultation with key stakeholders to ensure alignment and local relevance.

Step 2.2 — Review existing regulations

In parallel, stakeholders must review and align the IMG model with existing regulations. Understanding the applicable legal, institutional, and licensing frameworks is critical to ensure compliance and identify any necessary reforms. Early engagement with regulators and government agencies can help secure buy-in and policy updates to accommodate IMG models.

Step 3 — Support pilots, with early-stage financing and risk mitigation tools

Pilot projects are essential to demonstrate viability and generate lessons for scale, which may vary among different markets. These should receive targeted grant and concessional support to de-risk early-stage investment and attract private capital. Promoters can leverage public and philanthropic funds to finance project preparation, feasibility studies, and first-loss facilities to build confidence and bankability for these projects.

Box 8: Quality Assurance and Monitoring Framework (QAMF) for AMP projects

A robust monitoring, evaluation, and learning (MEL) plan is essential to codify learnings, gather insights and continue to refine IMGs, streamline project development and implementation, and engage broader sector stakeholders for scaling. Under AMP for example, projects are expected to comply with the Quality Assurance and Monitoring Framework (QAMF) developed by UNDP.

The QAMF is a program-level standardized framework for tracking the performance, sustainability, and impact of minigrid projects under AMP, with the objective to collect consistent, high-quality data to inform implementation, measure outcomes, and strengthen accountability. The framework also provides guidance around monitoring and evaluation to minigrid service providers and sector stakeholders.

UNDP's QAMF includes indicators that are designed to measure the quality of minigrid energy service and delivery and to assess the financial performance of certain minigrid projects or project portfolios, at site, national, and regional levels, with different reporting requirements for greenfield minigrid developments and productive use of energy overlays. QAMF indicators are grouped into four major categories:

- **Basic/administrative:** site details, developer information, number of connections, etc.
- **Technical:** system availability, power quality, share of renewable energy, etc.
- **Social and environmental:** financial health of households, community safety, productive use of energy, etc.
- **Economic:** project revenue, operating margin, investment return, etc.

For more information on the QAMF, please reach out to amp@undp.org.

Step 4 — Institutionalize learnings

After pilot completion, stakeholders should systematically document and disseminate lessons learned. Governments, promoters, utilities, and developers can institutionalize insights through case studies, guidance notes, and regular knowledge-sharing forums. Embedding these learnings into policy, regulation, and project design ensures continuous improvement and supports replication at scale.

Step 5 — Identify, prepare, and launch a second wave of projects and refine subsidies

Building on pilot success, promoters and governments should launch a second wave of projects, applying lessons learned to reduce costs, shorten timelines, and improve performance. Promoters and governments should adjust subsidy levels and public support mechanisms to facilitate a smooth transition to a self-sustaining market.

Step 6 — Scale through competitive procurement

With a proven business model and established market confidence, utilities can scale deployment through competitive procurement of project portfolios. At this stage, public subsidies can be gradually reduced as private investment deepens and the market matures.

Together, these steps outline a structured pathway from concept to scale that emphasizes learning, adaptation, and collaboration among public and private actors. Following this roadmap can help accelerate the deployment of IMGs as a cornerstone of Africa's energy transition.

Box 9: RMI's DER toolkit

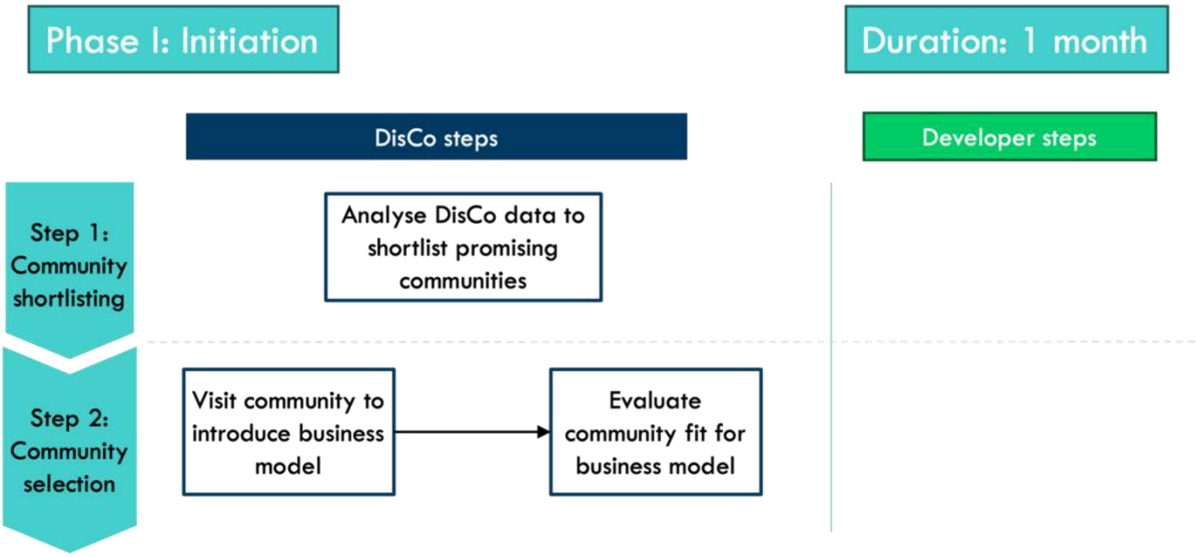
RMI's DER toolkit provides curated, standardized resources and templates for key documents used in IMG project preparation, development, and implementation. Key templates include:

- **IMG project implementation plan** that includes an overview of the main implementation steps, from initiation to execution, including the roles and responsibilities of DisCos and developers, as well as the recommended timelines for each step.
- **IMG financial model template** that can be used to assess the financial viability of IMG projects; calculate customer tariffs, developer returns, and DisCo cashflows; determine project funding needs; and facilitate negotiation.
- **IMG tripartite agreement template and term sheet** that can be adapted to define key terms and transaction arrangements between parties and has been developed to reflect best practices from the IMG pilots.
- **IMG project procurement templates** including requests for qualifications and proposals (RFQ & RFP) templates and evaluation templates that can be used to support competitive IMG project portfolio tenders.

The Toolkit is available at https://rmi.org/utility-enabled-distributed-energy-resources-hub/#project-implementation

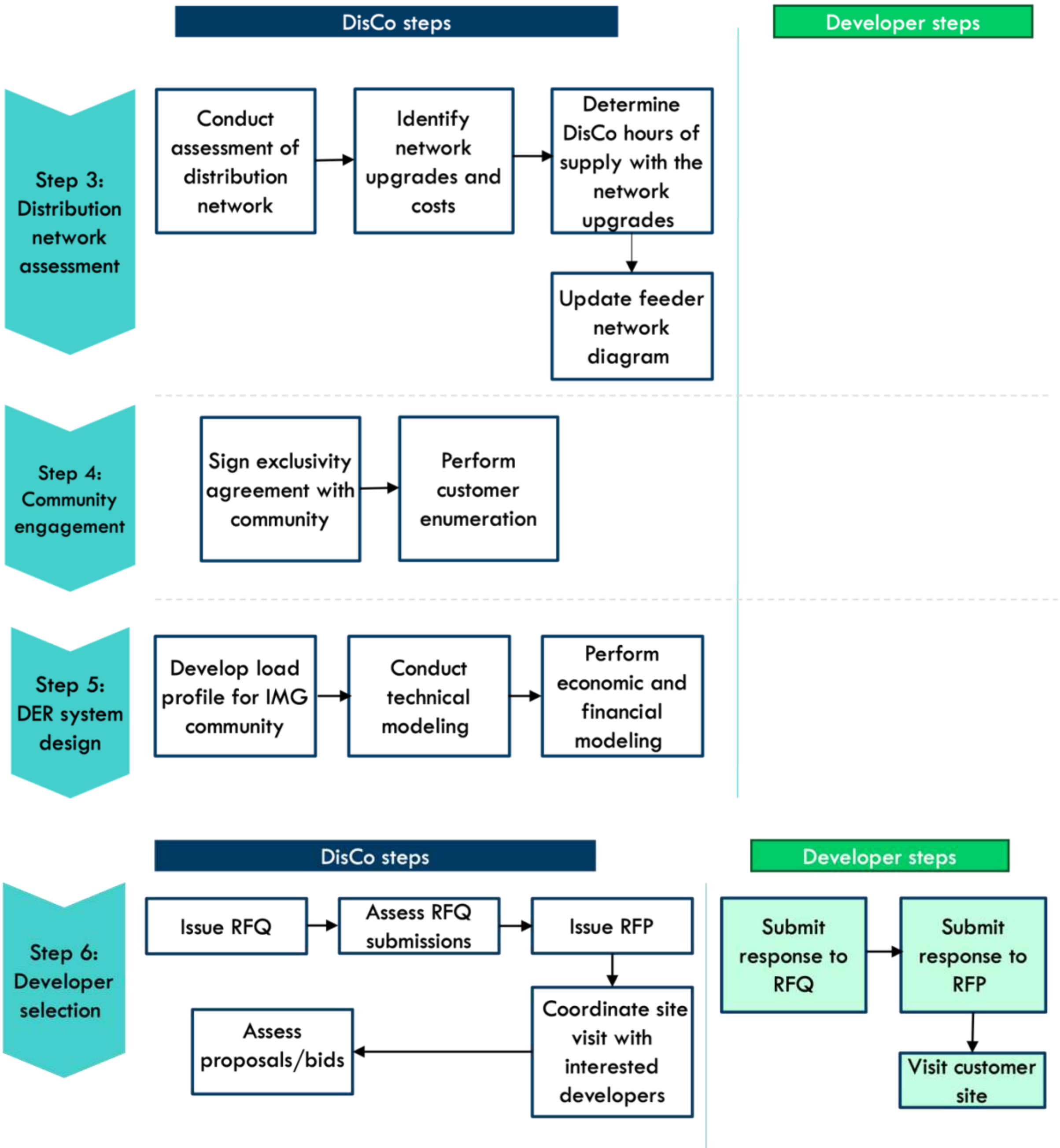
Appendix — Summary of Implementation Steps for IMGs in Nigeria

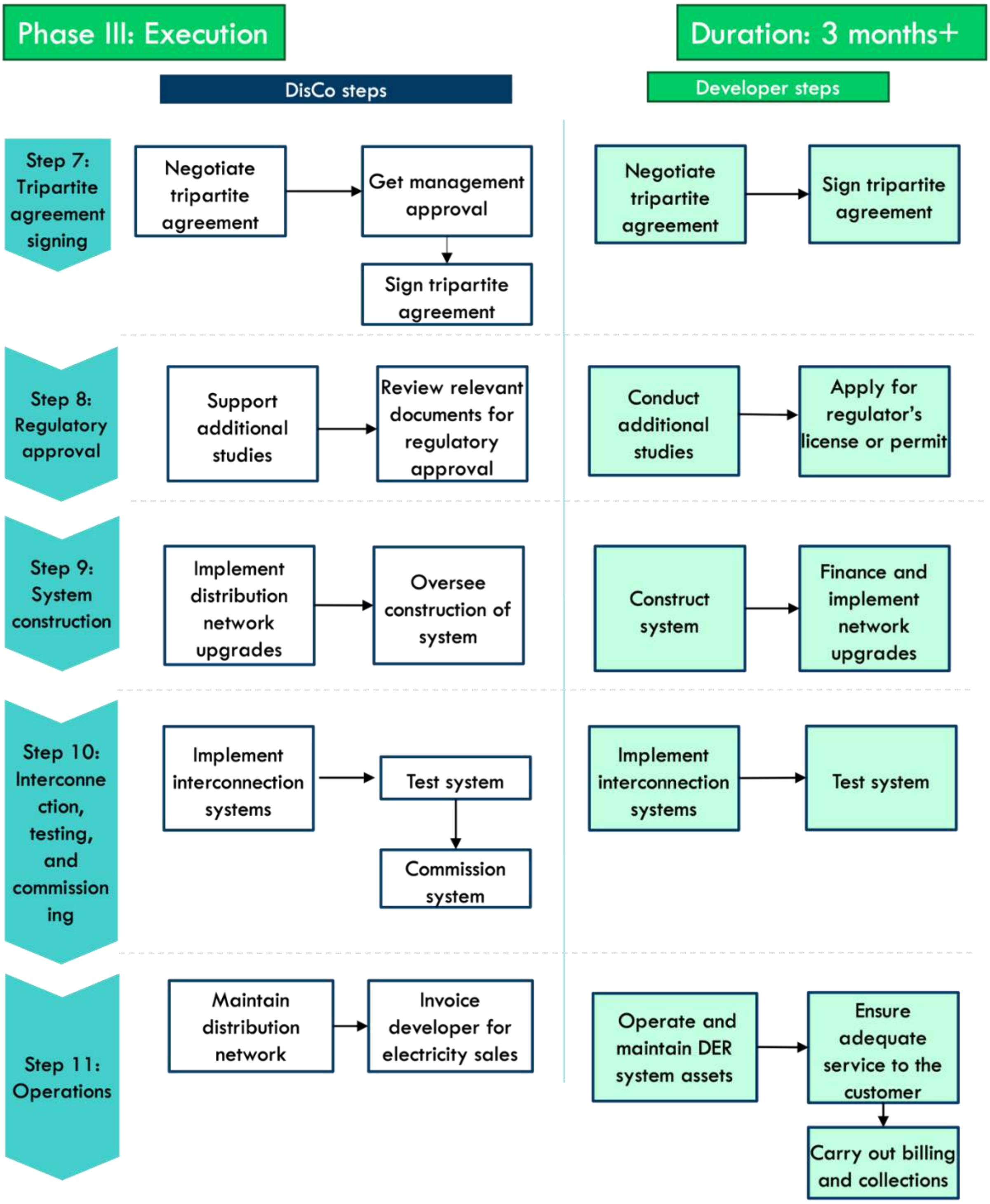
Key steps for developers and DisCos



Phase II: Preparation

Duration: 3 months




Phase III: Execution
Duration: 3 months+
DisCo steps
Developer steps
Step 7: Tripartite agreement signing
Negotiate tripartite agreement
Get management approval
Sign tripartite agreement
Negotiate tripartite agreement
Sign tripartite agreement
Step 8: Regulatory approval
Support additional studies
Review relevant documents for regulatory approval
Conduct additional studies
Apply for regulator's license or permit
Step 9: System construction
Implement distribution network upgrades
Oversee construction of system
Construct system
Finance and implement network upgrades
Step 10: Interconnection, testing, and commissioning
Implement interconnection systems
Test system
Commission system
Implement interconnection systems
Test system
Step 11: Operations
Maintain distribution network
Invoice developer for electricity sales
Operate and maintain DER system assets
Ensure adequate service to the customer
Carry out billing and collections

Endnotes

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