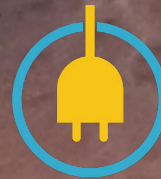




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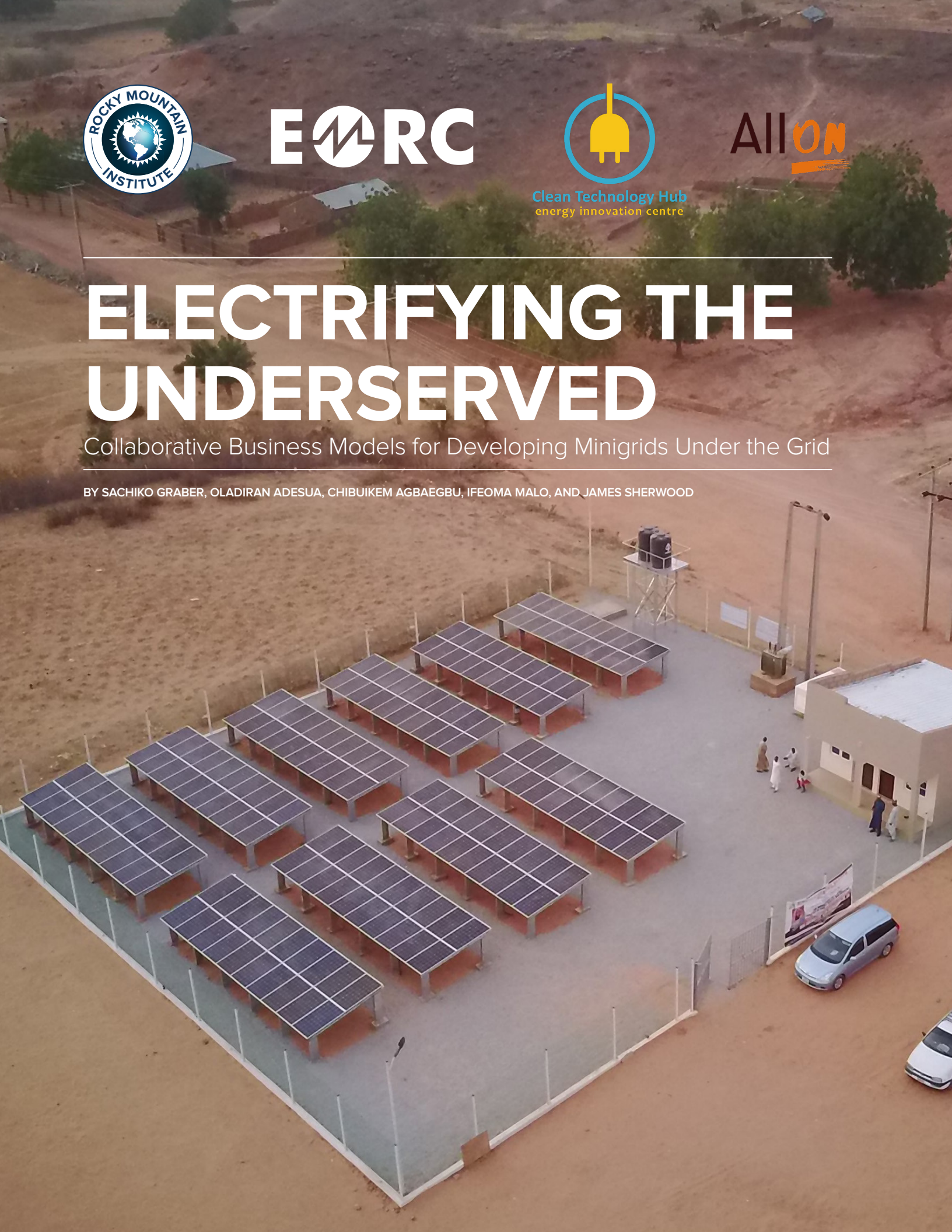
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ELECTRIFYING THE UNDERSERVED

Collaborative Business Models for Developing Minigrids Under the Grid

BY SACHIKO GRABER, OLADIRAN ADESUA, CHIBUIKEM AGBAEGBU, IFEOMA MALO, AND JAMES SHERWOOD



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ABOUT US



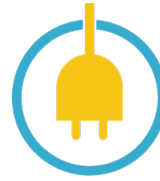
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EXECUTIVE SUMMARY

Thousands of communities across Nigeria are currently underserved by distribution companies (DisCos) and receive unreliable or no electricity. However, there is a tremendous opportunity to better serve these communities using undergrid minigrids, self-contained electricity systems up to 1 megawatt (MW) in size that can provide reliable and high-quality service to local communities. Undergrid minigrids leverage existing distribution infrastructure to achieve lower system cost than isolated minigrids while improving service reliability from the status quo. These systems can help DisCos reduce losses to serve these communities (by ₦1–2 billion per DisCo per year) and create a minigrid market with ₦400 billion in annual revenue, all while saving customers ₦60 billion per year compared to what they spend today (see [Section 1](#)). For undergrid communities served by the DisCo but held back by unreliable power, minigrids offer transformational access to reliable electricity that can enable local development by adding distributed energy resources at the community level. Low levels of reliability and planned investment, combined with attractive existing load profiles, make rural and peri-urban communities excellent candidates to begin developing commercial undergrid minigrid projects.

However, the undergrid minigrid opportunity is a new concept, and exploratory projects are needed to test and refine potential business models. This report is designed to help stakeholders—including minigrid operators, DisCos, investors, and communities—clearly understand the process of developing an undergrid minigrid project. This process begins with a set of critical decisions that form the building blocks of a business model. These include (1) project development roles, including who invests in the project and who enrolls customers; (2) project ownership roles, including both generation and distribution assets; (3) project operations roles, including who bills and collects from customers and who operates and maintains system assets; and (4) commercial terms of operation, including the distribution usage fee calculations and contract term (see [Section 2](#)).

By using these building blocks to prioritize realistic options that can be tested today, this report articulates four business models for deploying undergrid minigrids (see [Section 3](#)):

- Minigrid operator-led, where a private minigrid operator leads development of the minigrid with consultation across the DisCo and community
- Special purpose vehicle-led, where development is led by a special purpose vehicle (SPV), potentially formed by a DisCo's investors, and certain functions are subcontracted to a minigrid operator
- Cooperative-led, where a cooperative formed by the community leads minigrid development
- Collaborative SPV-led, where ownership and operation functions are shared among the minigrid operator, community cooperative, and DisCo investors



Image courtesy of the Nigerian Federal Ministry of Power

Each business model has strengths and weaknesses. For instance, the minigrid operator-led model is fastest to implement, whereas the SPV-led model offers greater potential for reducing DisCo investor losses. Accessing additional grant funding, the cooperative-led model could yield the most affordable customer tariffs. Finally, the collaborative model offers strong loss-reduction and tariff affordability outcomes and also encourages greater alignment of project partners through collaboration. **Exhibit ES-1** summarizes the trade-offs between each option.





















A small set of undergrid minigrid projects is currently under development. These projects, along with other negotiations, have created initial insights on implementation that can guide and improve the next round of project development (see **Section 4**). A common challenge across current efforts has been initial distrust between minigrid operators and DisCos, with each likely to suspect that the other party is not



negotiating in good faith. This can lead to prolonged negotiation of commercial terms, or to the termination of negotiations altogether. However, emerging success stories demonstrate that this is a readily solvable problem through strong stakeholder engagement and communication, both within and across organizations, to develop the trust required to implement complex undergrid projects. Nigeria’s Rural Electrification Agency (REA) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) are implementing the Interconnected Minigrid Acceleration Scheme (IMAS), which will provide an ongoing platform to incorporate these lessons into pilot projects with DisCos across the country.

As undergrid minigrid business models are tested, the approaches described in this report can quickly replicate at scale to improve service to 40 million rural residents across Nigeria and nearly 200 million undergrid households globally. Refining and

EXHIBIT ES-1

Comparison of expected outcomes from the four undergrid minigrid business models

	 Minigrid Operator-Led	 SPV-Led	 Cooperative-Led	 Collaborative SPV-Led
DisCo Investor Loss Reduction Potential				
Speed to Implement				
Less Regulatory Complexity				
Customer Tariff Affordability				

 = less desirable outcome  = average outcome  = more desirable outcome

implementing business models can de-risk the undergrid minigrid concept, unlocking commercial investment by scaling to new stakeholders (such as from minigrid operators to DisCo investors), scaling stakeholder portfolio size (such as DisCos moving from several pilots to dozens), and scaling to new market types (such as from rural locations to more-complex peri-urban communities). Nigeria offers an enabling environment that allows for the innovation needed to achieve scale, as the Nigerian Electricity Regulatory Commission (NERC) has provided a range of policies for many situations (see **Section 5**). Although the undergrid concept discussed in this report uses NERC's *Regulation for Mini-Grids 2016*, a number of other regulations exist that allow for alternative solutions in both rural and urban contexts (see **Appendix A**). To maintain a policy environment that

facilitates undergrid minigrid development, NERC can ensure that new policies and revisions to existing regulation clearly delineate policy applicability for different solutions to avoid regulatory overlap.

Continued development of early undergrid minigrid projects will demonstrate the feasibility of the business models outlined in this report. Although each model is attractive for different reasons, those eager to begin implementation can start with the minigrid operator-led model due to its relative straightforwardness and short timeline to implement. Initial proof of concept can allow undergrid minigrids to scale quickly both within Nigeria and globally, wherever utilities are not able to fully serve all customers and distributed energy resources can help provide cost-effective local power.



Image courtesy of the Nigerian Federal Ministry of Power

INTRODUCTION

Nigerian Electricity Regulatory Commission (NERC) regulation defines minigrids as self-contained electricity systems of less than 1 megawatt (MW) that include both generation and distribution. This regulation allows minigrids to be installed under the grid—where the distribution company (DisCo) is currently underserving communities—with the DisCo’s agreement.¹ **Undergrid minigrids can provide reliable and high-quality service to local communities who are willing and able to pay for power.** For undergrid communities technically served by the DisCo but held back by unreliable power, minigrids offer transformational access to reliable electricity that can enable local development by adding distributed energy resources at the community level.²

This report is intended to support stakeholders who are engaging in the new and largely untested process of developing undergrid minigrid projects. We describe four implementable business models for undergrid minigrid deployment, with a focus on stakeholder roles and the benefits and risks of each model.

BACKGROUND ON UNDERGRID MINIGRIDS

Undergrid minigrids, also referred to as interconnected minigrids, can strengthen electricity service to underserved customers, improve DisCo finances and reduce collections uncertainty, and scale up the broader minigrid market. At the same time, allowing minigrids to share existing distribution infrastructure in undergrid areas can lower the minigrid’s up-front capital cost to improve customer affordability. The economics of undergrid minigrid projects are described in **Box 1**.

Rural and peri-urban communities are the most compelling locations to implement undergrid minigrid projects today. They reflect the right community size (fitting within the 1 MW minigrid capacity limit) in areas where it is challenging for DisCos to provide reliable electricity service, and there is greater likelihood of minigrid economic viability because of expensive alternative options. The most viable communities are accustomed to paying for some amount of power and are usually located closer to urban areas; these qualities result in greater economic activity and existing load compared with deeply rural or off-grid locations. At the same time, DisCos’ capital constraints mean they are unlikely to receive sufficient investment to improve service in the near future. Minigrids can serve these rural and peri-urban customers, while their mandate to install meters and improve infrastructure reliability supports a long-term service model even beyond the lifetime of the minigrid project.

This report does not consider undergrid minigrids for serving urban populations—urban customers tend to require different technical solutions given their power needs, are not organized in discrete geographic areas that are well-suited for minigrid communities, and often have access to more reliable power. The non-minigrid solutions presented in **Appendix A** offer alternate methods for improving service in such areas.

¹ The term *undergrid community* is defined in RMI and EMRC’s *Under the Grid* report as an area underserved by DisCos—receiving low-quality or unreliable energy, or not actively served but within DisCo territory—and requiring improved energy supply. Undergrid minigrids may also be known as *interconnected minigrids* if coupled and exchanging power with the main grid.

BOX 1. THE ECONOMICS OF UNDERGRID MINIGRIDS

Undergrid minigrids in Nigeria can offer substantial economic benefit to DisCos, minigrid owners, and communities:

- **DisCos** can reduce financial losses to serve rural customers by 60%–100% from the current average of about ₦7,000 (\$19) per connection per year. A single DisCo transitioning 400 undergrid communities to minigrid service could reduce annual financial losses by ₦1–2 billion (\$3–6 million); this equates to nearly ₦10–20 billion across all DisCos and 4,000 communities across Nigeria.
- **Minigrid owners** could collect approximately ₦400 billion (\$1 billion) in revenue by installing and operating 4,000 undergrid minigrids, while reducing project capital costs by 12–30% through sharing distribution infrastructure (depending on the condition of existing equipment).
- **Undergrid communities** could save ₦54 (\$0.15) per kilowatt-hour (kWh) compared with their current blended electricity cost (including the grid and generator backup), or a total of ₦60 billion (\$170 million) annually across 4,000 communities.

Calculation of these benefits and risks of undergrid minigrid service are detailed in the 2018 Rocky Mountain Institute and Energy Market and Rates Consultants report, *Under the Grid*.³



THE NEED FOR CLEAR BUSINESS MODELS

As a cost-competitive electrification option for at least 4,000 communities across Nigeria’s unique geographies, undergrid minigrids are an exciting mechanism for DisCos to reduce losses while improving service.⁴ However, undergrid minigrids are a new concept, and exploratory projects are needed to test and refine potential business models to support a full-scale roll out.⁵ As stakeholders have begun to explore implementation of undergrid minigrids, many have expressed frustration with the myriad decisions required to shape a project, as well as with the sometimes contentious nature of partnership discussions (see **Section 4** for more discussion of experience to date).

To help stakeholders navigate the complex process of developing an undergrid minigrid project, **this report identifies four implementable business models for deploying undergrid minigrids within DisCo territory and discusses their relative strengths and weaknesses.** We begin by laying out the critical decisions that form the building blocks of a business model and use them to prioritize realistic options that can be tested today, with a particular focus on rural and peri-urban communities where the grid is least reliable.^{6,ii}

This report concentrates on aspects of the minigrid business model that are unique to undergrid systems in Nigeria. In particular, we focus on the roles and responsibilities that are shared among multiple stakeholders through a tripartite contract for an

undergrid minigrid project (see **Box 2**). The number of stakeholders involved presents both a negotiating challenge and an opportunity to balance incentives and risks to create the best possible service for undergrid customers. This analysis reflects the feedback and perspectives from stakeholders across the sector, including DisCos, minigrid operators, investors, government, and development agencies.

The business models identified in this report target undergrid minigrid projects that are smaller than 1 MW and based in communities with existing distribution infrastructure. However, undergrid minigrids are only one of a set of options for a comprehensive approach to integrated planning, and Nigeria’s regulators and policymakers are actively creating and amending policies to enable experimentation. The business models discussed in this report rely on NERC’s minigrid regulation due to the project size and stakeholder roles considered. Other options, such as embedded generation, independent electricity distribution networks (IEDNs), meter asset providers (MAPs), and a potential distribution franchising regulation, overlap in certain respects but are separate policies and are not necessary for the undergrid business models defined here. These policies are discussed in **Appendix A** and may be of particular interest to generation companies (GenCos), private investors, and others.

ⁱⁱ Testing the feasibility of new business models through exploratory pilots is the first step in developing and rolling out innovative utility systems, as explained in RMI’s 2017 report, *Pathways for Innovation*.

ⁱⁱⁱ We use the term “minigrid operator” to refer to a private, for-profit company that is experienced in operating minigrid generation and distribution as well as performing customer engagement and metering, billing, and collections. For purposes of the business models in this report, we focus on the operational skill set rather than the contractual obligations of participants. For instance, the minigrid operator may perform project construction or outsource it to an engineering, procurement, and construction firm, but this does not meaningfully impact the fundamental undergrid minigrid business model.

BOX 2. UNDERGRID MINIGRID PROJECT PARTICIPANTS

The DisCo, minigrid operator, undergrid community, and commercial investor are key participants in any undergrid minigrid project. As described below, they all have different objectives, strengths, and constraints that guide them to play different roles in project development and operation. Other project participants that may be created through the process of implementing an undergrid minigrid, such as a cooperative or special purpose vehicle (SPV), are defined in **Section 2**. The role of other key stakeholders, such as the federal government, regulators, and the Rural Electrification Agency (REA), are discussed throughout the report.

Distribution Company

Project Objective: To reduce financial losses in underserved communities while improving service to customers in their territory

Strengths:

- Large operational portfolio with insight into undergrid communities across the territory
- Owns existing distribution assets in undergrid communities
- Many DisCo investors have expressed interest in minigrid projects
- Existing community relationships and regional customer support teams
- Experience operating distribution network and retail functions

Constraints:

- May not invest in, own, or operate generation according to regulated license conditions⁷
- Limited ability to consistently engage and enumerate customers in small rural communities
- Energy pricing limited to regulated on-grid multiyear tariff order (MYTO) rates⁸
- Difficulty raising capital due to current regulated tariffs
- May lack internal capacity to monitor a large number of distributed minigrid projects

Undergrid Community

Project Objective: To access reliable and affordable electricity service through a trusted provider

Strengths:

- Strong relationships and trust between local leaders and community members
- Keen understanding of local energy needs and realistic consumption patterns
- Incentivized to keep electricity costs low

Constraints:

- Lacks experience developing electricity projects and working with regulators
- May lack technical and/or financial ability to deploy, operate, and maintain minigrid
- May not be a creditworthy counterpart for financing purposes

Minigrid Operatorⁱⁱⁱ

Project Objective: To serve undergrid electricity customers profitably with improved service while scaling their business

Strengths:

- Demonstrated access to private investment
- Existing relationship and experience working with regulator on minigrids
- Technical experience developing and operating minigrid projects
- Experienced minigrid operators have history of higher success reliably collecting payments from rural customers
- Experience collecting project data, and conducting ongoing monitoring and evaluation
- Business structure allows rapid deployment of new technology

Constraints:

- Lacks existing community relationships
- Likely unfamiliar with underserved sites across DisCo territory and with unique undergrid customer dynamics
- Typically has limited capital on hand to immediately deploy projects
- Does not hold long-term concession to serve an undergrid community

Commercial Investor

Project Objective: To invest in, and profit from, a low-risk, scalable undergrid minigrid market

Strengths:

- Incentivized to ensure customer satisfaction to protect revenue flow
- Ready access to capital to fund projects
- Incentivized to move quickly to scale

Constraints:

- Likely lacks specific minigrid implementation expertise and experience working with regulators
- Likely lacks community engagement experience and knowledge of specific community needs
- May view undergrid minigrids as risky due to lack of long-term portfolio data, with limited risk mitigation tools available

BUSINESS MODEL COMPONENTS



The business model for an undergrid minigrid project is defined by three core building blocks that delineate critical decision points in the model, supported by commercial terms of operation. The 15 decision points highlighted in **Exhibit 1** reflect the most critical and potentially contentious issues around development and operation of undergrid minigrid projects. Other supporting activities that are not core to delineating between business models—such as project construction and meter ownership—are important but do not define the business model.^{iv}

The responsibilities of any undergrid minigrid project participant will evolve based on the decisions made through the three business model building blocks. The components and key decisions across these three building blocks, as well as commercial terms of operation, are defined in **Exhibit 1**, with further discussion in **Appendices B** and **C**.

The building blocks defined in **Exhibit 1** can be combined to define unique business models for undergrid minigrid implementation. Each component of the building blocks represents a discrete choice on roles, which are further discussed in **Appendix B**. Meanwhile, the commercial terms of operation include more nuanced contractual decisions separate from the overarching roles in the project. Discussion of the detailed decisions defining the commercial terms of operation are included in **Appendix C**.

The 11 components within the business model building blocks assign specific roles to different project participants. The participants most likely to play a significant role in undergrid minigrid development include the minigrid operator, DisCo, undergrid community, or a new entity developed specifically to implement a minigrid project.^v Two particularly relevant new entities that could be formed are SPVs and cooperatives, which are defined in **Boxes 3** and **4**.

^{iv} These decisions are not unique to undergrid minigrids and will not have significant implications on the business model. They also exhibit a limited number of outcomes; for instance, project construction will likely be determined by the project participant who owns generation, and whether they perform construction themselves or hire a third-party construction firm does not affect the overall business model for the project. Meters are included as part of distribution in **Exhibit 1** for simplicity, but in practice, a variety of metering situations could arise. Although all minigrid customers must be metered, previously existing meters may be owned by the DisCo or individual customers—and new meters will likely need to be procured for at least some customers. A DisCo and minigrid owner may wish to negotiate the long-term ownership of new meter assets based on differences in monitoring systems and other priorities.

^v Other stakeholders, including the regulator and state or national governments, will also be critical to minigrid project development; however, they are not included in the business model analysis because decisions about project ownership and roles will be agreed on by project participants.

EXHIBIT 1

Summary of 15 critical decisions, split among three building blocks and the commercial terms of operation, that define an undergrid minigrid business model

	Component	Primary Question	
Commercial Terms of Operation	Building Block 1: Project Development Roles	Invest or Attract Capital	Who is responsible for providing up-front investment?
		Identify Project Site	Which party proposes a community for development and evaluates its feasibility?
		Engage Customers	Who engages customers to negotiate their participation in the project?
		Obtain Regulatory Approval	Who engages the regulator to gain project approval and licenses?
	Building Block 2: Asset Ownership Roles	Own Generation	Who invests in and owns generation assets and makes construction-related decisions?
		Own Distribution	Who invests in and owns existing and new distribution infrastructure, including meters?
	Building Block 3: Project Operations Roles	Manage Customer Relationships	Who is the primary point of customer management during project operation?
		Meter, Bill, and Collect	Who interfaces with customers through metering, billing, and collections?
		Operate and Maintain Generation	Who operates and maintains generation and storage assets throughout the project life?
		Operate and Maintain Distribution	Who operates and maintains the distribution infrastructure throughout the project life?
		Monitor, Evaluate, and Assess Impact	Who will be responsible for monitoring and evaluation, impact assessment, and documenting learnings for future efforts?
	Commercial Terms of Operation	Interconnection	Will the system share power with the main grid, and how will tariffs reflect this?
		Distribution Usage Fee	How will the DisCo be compensated for sharing distribution assets, and how much compensation will it receive?
		Contract Term	How long will the contract run?
		Decommissioning	How are rights and responsibilities divided when the project ends?

BOX 3. SPVS FOR MINIGRID PROJECTS

An SPV is a legal structure used to isolate a subsidiary from the main company’s operations. In the case of undergrid minigrids, investors or minigrid operators could use SPVs to limit project risk, fund projects, or enable a new investor mix. In particular, DisCos may not participate in SPVs engaged in undergrid minigrid projects due to their licensing terms and the Electric Power Sector Reform Act (EPSRA), which limit their ability to own or operate generation assets, but their investors can.⁹

The Role of SPVs

SPVs can be a useful tool for undergrid minigrid implementation, especially where additional stakeholders hope to be involved. For instance, because DisCos may not build or operate minigrids, even through a subsidiary, the DisCo’s parent company (and thereby the DisCo’s investors) may create an SPV minigrid company. This would create a mechanism for the DisCo parent company to invest in undergrid minigrid projects, thereby accessing a share of potential profits. Similarly, an SPV could enable GenCo investors to participate in an undergrid minigrid (see discussion in **Appendix A**).

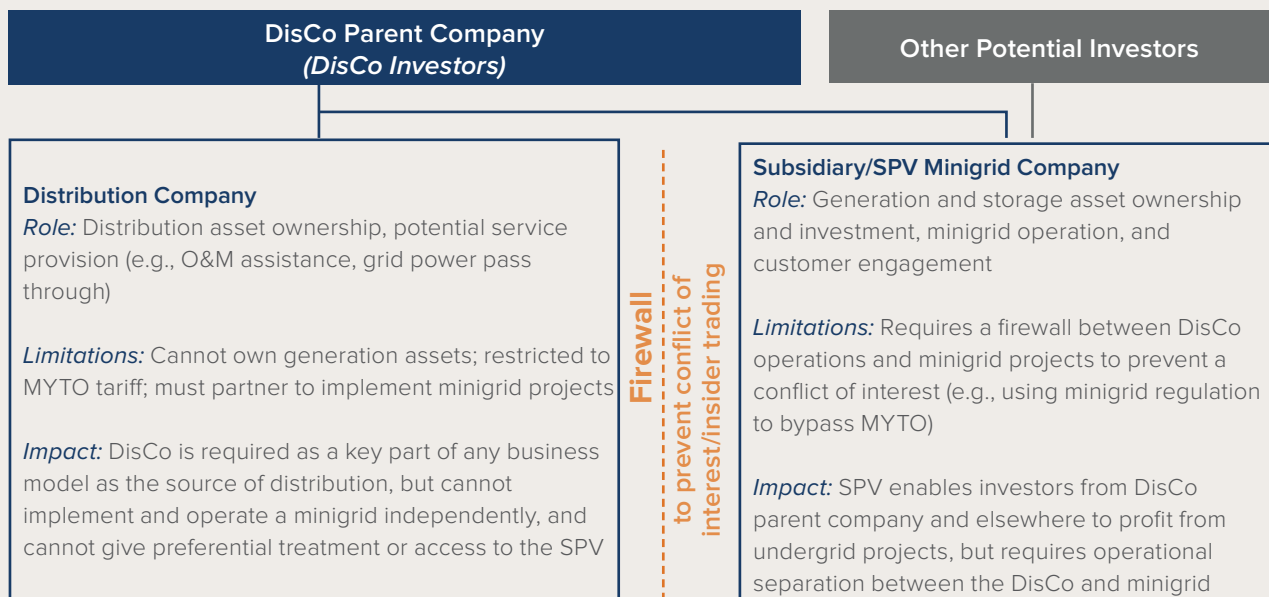
SPV Structure

The legal structure of SPVs involving DisCo investors must follow license conditions in Nigeria carefully to ensure that the DisCo does not directly control or profit from the minigrid.¹⁰ To do so, DisCo investors can create a wholly separate company; one potential SPV–DisCo relationship is depicted in **Exhibit Box 3.1**. The “firewall” noted represents the intended separation of DisCo and SPV decision-making, such that DisCo management does not exert operational control on the minigrid.

The remainder of this report specifically considers SPVs created by DisCo investors, but these need not be the only owners of the SPV. For instance, an investor might consider partnering with an existing minigrid operator to leverage the operator’s experience in developing and operating projects. Other investors might also be included to quickly capitalize projects.

EXHIBIT BOX 3.1

Illustrative SPV structure



BOX 4. COOPERATIVES FOR MINIGRID PROJECTS

An electric cooperative (co-op) is a private utility that provides electricity service without seeking profit and is owned by the customers within a community.¹¹ Co-ops typically seek revenue to cover operations and future reinvestment needs, with any excess returned to members. A co-op in an undergrid community could enable the community members to own their own minigrid, thereby controlling local electricity service and influence over project design and operation. This business model is further discussed in **Section 3**.

The Role of Cooperatives

By elevating the role of local community members, co-ops are one mechanism for increasing community say in their electricity source. They have been used globally to support community-driven rural electrification efforts and support economic development. For instance, co-ops in the United States have continued to demonstrate business models that focus first on community concerns and support local development initiatives.^{12,vi} Similarly, in sub-Saharan Africa, communities in Uganda have benefited from co-op–run minigrids.¹³ In Nigeria, the Bonny Utility Company formed as a co-op to work with oil and gas corporations in the area to provide power and water to the local community.¹⁴

Economic Impact

Although the minigrid co-op model has not, to our knowledge, been tested in Nigeria, there are several mechanisms through which it may reduce minigrid project costs:

- Co-op “profit” is limited to reinvestment and maintenance, reducing customer tariffs.
- As users of the minigrid, community members are incentivized to actively seek reduced tariffs by implementing cost-reduction measures and passing the savings on to customers.
- Co-op–led projects may be better positioned to raise funds through specialized grants and other low-interest capital from nongovernmental organizations, government bodies, or other organizations focused on local community development.
- Local membership can lower operating costs by reducing the expense of customer engagement and minimizing land costs.
- The co-op’s detailed local knowledge can design and implement complementary programs to support economic development and reduce minigrid cost, such as productive use efforts.¹⁵

Despite these potential benefits, proper management is crucial. Co-ops present the risk of mismanagement (e.g., lack of attention to long-term operations and maintenance [O&M] or misuse of funds) if not structured and implemented properly.¹⁶

^{vi} Examples of co-ops for low-income electrification in the United States are available in RMI’s *Breaking Ground* report.

UNDERGRID MINIGRID BUSINESS MODELS

Using the components and decisions presented in **Section 2**, we identify four potential business models for undergrid minigrids. These business models are implementable under today's economic and policy environment in Nigeria and were developed in consultation with industry stakeholders after an exhaustive review of potential roles and activities across actors. The business models presented here are viable to test immediately, although future policy changes, such as an introduction of franchising regulation (see **Appendix A**), may open the door to additional options and variations.

The models proposed in this section represent a wide range of possible implementation and ownership strategies, which are shown in **Exhibits 2–5**. Each model reflects a unique set of project participants and division of roles:

- **Minigrid operator-led**, where a private minigrid operator leads development of the minigrid with consultation across the DisCo and community
- **SPV-led**, where development is led by an SPV (potentially formed by a DisCo's investors) and certain specialized functions are subcontracted to a minigrid operator
- **Cooperative-led**, where a cooperative formed by the community leads minigrid development
- **Collaborative SPV-led**, where ownership and operation functions are shared among the minigrid operator, community cooperative, and DisCo investors



GENERAL CONSIDERATIONS ACROSS BUSINESS MODELS

In addition to the model-specific considerations detailed in the following pages, a set of general considerations also applies. The following are notable across all business models considered:

- All business models support DisCos in achieving loss-reduction targets and revenue protection but are not intended as a mechanism for unreasonable profit. Revenue sharing with the DisCo is limited in each model to the distribution usage fee (see **Appendix C**) and any direct electricity sales to the minigrid.
- All undergrid minigrid projects present investment risks due to the immature minigrid market and the potential for improvements in grid reliability.
- All business models require a high degree of collaboration and trust between partners but run the risk of conflict during contract decisions and other negotiations.¹⁷ In particular, communities could disengage if they are not comfortable negotiating with the same DisCo that currently underserves them (the DisCo must be party to any tripartite agreement). At the same time, helping to provide an undergrid community with a minigrid may improve the community's perception of the DisCo as a company that is working hard to improve service to underserved customers.
- Business models involving DisCo investors may introduce the risk of a conflict of interest between the DisCo and its investors, and in the DisCo's level of service in rural areas. To address this risk, a firewall between the DisCo and any DisCo investor-owned SPV will be important (see **Box 3**), as will continued regulatory oversight of DisCo service levels.
- Any refurbishment of the existing distribution network would require investment. If the minigrid owner invests in network improvements, the tripartite agreement must define terms for asset transfer or buyout at the termination of the project (see **Appendix C**).
- Monitoring and evaluation are primarily led by the DisCo in all models presented here, since the DisCo is responsible for ensuring service to communities within its territory. At the same time, other parties will have an interest in monitoring and evaluating the effectiveness of minigrid operations.

Project success is highly dependent on stakeholder alignment due to the number of organizations involved in undergrid minigrid projects. Beginning stakeholder engagement early and ensuring a high level of trust among different participants in the undergrid minigrid project is critical.^{vii}

^{vii} Several additional considerations are common to all minigrid projects (not only undergrid projects). These include the identification of viable sites for project development, load management, and other cost-reduction opportunities, and are not discussed in this report.



MINIGRID OPERATOR-LED MODEL

Overview

The minigrid operator-led model is the easiest to implement in the short-term. It maximizes minigrid operator autonomy while limiting the risks and responsibilities of the DisCo and community throughout the project lifetime. At the same time, financial risk from ownership of the system is borne primarily by the minigrid operator, who is solely responsible for raising capital.

How It Works

As indicated in **Exhibit 2**, the minigrid operator independently leads most of the project activity, from site proposal and project capitalization to ongoing customer engagement and system O&M. The DisCo plays a relatively minimal role, taking the lead only on sharing distribution assets and evaluation. This allows the DisCo to focus more on core operations while still benefiting financially from the distribution usage fee. This business model has the most straightforward division of roles among stakeholders and is most practical to implement in the near-term.

■ Leading role
 ■ Supporting role
 ■ Minimal role

EXHIBIT 2

Minigrid operator-led model

Role	Minigrid Operator	DisCo	Undergrid Community
Invest or Attract Capital			
Identify Project Site			
Engage Customers			
Obtain Regulatory Approval			
Own Generation			
Own Distribution			
Manage Customer Relationships			
Meter, Bill, and Collect			
Operate and Maintain Generation			
Operate and Maintain Distribution			
Monitor, Evaluate, and Assess Impact			

Benefits and Risks of the Minigrid Operator-Led Model

Benefits

- It is the **fastest** model to implement given the limited number of parties involved in negotiations.
- For DisCo investors, there is **limited investment required**.
- It **leverages minigrid operator experience and capacity** for project development, operation, maintenance, and community engagement.
- **Customer trust** can be attracted by a new private minigrid operator, who the community recognizes to be motivated by project success.

Risks

- There is **limited ownership/autonomy** for the DisCo.
- The **minigrid operator bears the brunt of risk** and responsibility for project success—financially and operationally.
- The **minigrid operator is solely responsible for raising capital**, which may limit the ability to scale quickly to a larger portfolio of sites.
- The **community may have limited input** on project-level decisions and therefore limited “ownership” of the project.



SPV-LED MODEL

Overview

The SPV-led model is more complicated but unlocks investment from additional parties, which may also help scale. Although an SPV (see **Box 3**) created to own and operate minigrids can involve any investor, we focus here on an SPV created by the DisCo’s investors. The SPV enables DisCo investors to own minigrid projects while separating the development and operation of the minigrid from the DisCo.^{viii} This model may take longer to implement than the minigrid operator-led model due to the need to form a new legal entity and the increased amount of negotiation across a larger number of parties to divide roles and agree to contract terms.^{ix}

How It Works

The SPV may leverage DisCo expertise by reassigning staff from across the firewall, but it does not necessarily include staff with minigrid operational experience. Therefore, the SPV subcontracts to an experienced minigrid operator to manage customer relationships; meter, bill, and collect from customers; and advise on other ongoing operations.^x As indicated in **Exhibit 3**, the DisCo shares responsibilities with an SPV. The DisCo shares distribution assets, but the SPV—a separate legal entity funded by the DisCo’s parent company—leads the investment, installation, operation, and maintenance of the minigrid. This division of roles offers a unique mechanism for DisCo investors to invest in and capture minigrid profits, which may otherwise not be possible (see **Box 3**). From the community’s perspective, this business model is not significantly different from the minigrid operator-led model.

EXHIBIT 3

SPV-led model

Role	Minigrid Operator	DisCo	SPV	Undergrid Community
Invest or Attract Capital	Minimal role	Minimal role	Leading role	Minimal role
Identify Project Site	Supporting role	Supporting role	Supporting role	Minimal role
Engage Customers	Supporting role	Supporting role	Supporting role	Minimal role
Obtain Regulatory Approval	Supporting role	Supporting role	Supporting role	Minimal role
Own Generation	Minimal role	Minimal role	Supporting role	Minimal role
Own Distribution	Minimal role	Supporting role	Minimal role	Minimal role
Manage Customer Relationships	Supporting role	Minimal role	Supporting role	Minimal role
Meter, Bill, and Collect	Supporting role	Minimal role	Supporting role	Minimal role
Operate and Maintain Generation	Supporting role	Minimal role	Supporting role	Minimal role
Operate and Maintain Distribution	Minimal role	Supporting role	Supporting role	Minimal role
Monitor, Evaluate, and Assess Impact	Supporting role	Supporting role	Supporting role	Supporting role

■ Leading role ■ Supporting role ■ Minimal role

^{viii} It is also possible that the SPV may be formed by investors not connected with the local DisCo’s parent company. In this case, the model remains the same but with less ability to leverage local DisCo expertise by reassigning staff.

^{ix} SPVs may be formed in a variety of ways and in a variety of locations, both domestically and internationally, and may introduce complex taxation considerations—both positive and negative—that should be factored into evaluation of project economics.

^x It is not necessary for the SPV to hire a minigrid operator, but maintaining high levels of service from the minigrid will require an entity or staff with sufficient experience. We propose a minigrid operator, assuming that the SPV does not include a partner with minigrid experience or the capacity to regularly engage customers at the local level.



SPV-LED MODEL (CONTINUED)

Benefits and Risks of SPV-Led Model

Benefits

- It offers the **most proactive role** to DisCo investors for reducing financial losses and improving service to customers.
- It can **increase the capital available for investment** by engaging new investors, which may support quickly scaling to additional communities.
- **DisCo operational capability may be leveraged** by transferring staff to the sister SPV company.
- It offers the **highest profit potential** for SPV investors compared to other business models.

Risks

- Other investors may be **unwilling to invest in an SPV** alongside the DisCo parent company if they perceive DisCo liquidity risk.
- The **SPV lengthens the process and adds legal complexity** to align multiple partners, attract and hire experienced staff to support minigrid projects, and begin project implementation.
- The **SPV may lack technical experience** with developing and operating minigrid systems.
- The **community may have limited input** on project-level decisions and therefore limited ownership.





COOPERATIVE-LED MODEL

Overview

The community cooperative-led model maximizes community ownership and buy-in to the minigrid project (see **Box 4**).¹⁸ Local co-op leadership can strengthen customer engagement, allow for quick response to customer needs, and incentivize cost reductions without compromising reliability. A co-op may also be able to access attractive grants or financing not otherwise available.^{xi} However, developing the co-op structure to govern a minigrid may take time and lacks precedent in Nigeria.

How It Works

The community creates a co-op to govern the local electricity project, and the co-op engages the DisCo and minigrid operator on behalf of the undergrid community. As indicated in **Exhibit 4**, the co-op invests in, or attracts investment for, the minigrid. The co-op also owns minigrid assets within the community and ensures reliable ongoing project operations, but outsources generation, storage, and distribution O&M functions to a third-party minigrid operator with greater specialized expertise.^{xii} Given the complex logistics involved in organizing and coordinating roles, entities such as Nigeria’s REA or state government agencies can provide support to communities in the early phases of project development.^{xiii}

EXHIBIT 4

Cooperative-led model

Role	Minigrid Operator	DisCo	Co-op	Undergrid Community
Invest or Attract Capital	Minimal role	Minimal role	Leading role	Minimal role
Identify Project Site	Minimal role	Supporting role	Supporting role	Leading role
Engage Customers	Supporting role	Supporting role	Leading role	Minimal role
Obtain Regulatory Approval	Supporting role	Supporting role	Leading role	Minimal role
Own Generation	Supporting role	Minimal role	Leading role	Minimal role
Own Distribution	Minimal role	Supporting role	Minimal role	Minimal role
Manage Customer Relationships	Supporting role	Minimal role	Leading role	Minimal role
Meter, Bill, and Collect	Supporting role	Minimal role	Leading role	Minimal role
Operate and Maintain Generation	Leading role	Minimal role	Minimal role	Minimal role
Operate and Maintain Distribution	Leading role	Supporting role	Minimal role	Minimal role
Monitor, Evaluate, and Assess Impact	Supporting role	Supporting role	Supporting role	Supporting role

■ Leading role
 ■ Supporting role
 ■ Minimal role

^{xi} This might include, for example, fundraising through community contribution; grants from development partners, donors, or the government; or access to low-cost financing backed by these entities.

^{xii} In addition to outsourcing operational elements to a minigrid operator, a co-op could form an SPV with an operator or other entity to help raise capital. Similarly, depending on local preference, the co-op could also contract the minigrid operator to provide billing and collections services to increase transparency.

^{xiii} For example, REA’s Electricity Users Cooperative Society encourages community participation through provision of affordable and sustainable electricity in rural areas.



COOPERATIVE-LED MODEL (CONTINUED)

Benefits and Risks of Cooperative-Led Model

Benefits

- **Community ownership** should improve project security, local commitment, and trust as well as reduced labor cost from the community.
- **Grants and partnerships** may be available to support community-owned systems.
- **Lower tariffs** are enabled through lower return required and increased grant funding access by the cooperative model.
- It offers the **opportunity for DisCo or investors** to build local capacity and share knowledge.
- **Risk is shared** among members of the community.

Risks

- Project viability depends on local **technical capacity, operations, financial, legal, and negotiation skills** as well as the strength of existing community organizations.
- **Raising capital** may be relatively difficult for a community without support from local, state, or federal government agencies.
- It could be **difficult to identify the project operator** with no clear process in place.
- Local ownership could create bias or cause **friction** within the community (or entrench existing local authority structures).



Image Courtesy: Power Africa, photo by Xaume Olleros.



COLLABORATIVE SPV-LED MODEL

Overview

The collaborative SPV model creates a unique SPV that shares ownership across project participants, maximizing buy-in from all project participants while sharing risk and leveraging individual strengths. This model brings together DisCo investors, a community co-op, and a minigrid operator under an SPV to drive buy-in and incentivize all parties to create a successful and affordable project (see **Box 3** and **Box 4**). The collaborative model is relatively aspirational given the challenges of coordinating across many stakeholders. However, the model is worth exploring, as shared ownership decreases risk by “guaranteeing” cooperation and incentivizing all parties to ensure long-term project success.^{xiv}

How It Works

As indicated in **Exhibit 5**, the minigrid operator, DisCo investors, and undergrid community cooperative come together through an SPV (or other legal structure). Individual stakeholders’ needs are balanced by the need to compromise. The owners collectively develop, own, and operate the project. Although some roles will have to be led by a single stakeholder (such as the DisCo owning distribution), the general approach is for all parties to share responsibilities, risks, and profits across the minigrid. A firewall between the SPV and the DisCo remains important in this model.

EXHIBIT 5

Collaborative SPV-led model

Role	SPV			DisCo	Undergrid Community
	Minigrid Operator	DisCo Investors	Co-op		
Invest or Attract Capital	Leading	Leading	Leading	Minimal	Minimal
Identify Project Site	Leading	Leading	Supporting	Supporting	Leading
Engage Customers	Leading	Minimal	Leading	Supporting	Minimal
Obtain Regulatory Approval	Leading	Minimal	Leading	Supporting	Minimal
Own Generation	Leading	Leading	Leading	Minimal	Minimal
Own Distribution	Minimal	Minimal	Minimal	Leading	Minimal
Manage Customer Relationships	Leading	Minimal	Leading	Minimal	Minimal
Meter, Bill, and Collect	Leading	Minimal	Leading	Minimal	Minimal
Operate and Maintain Generation	Leading	Minimal	Supporting	Minimal	Minimal
Operate and Maintain Distribution	Leading	Supporting	Supporting	Supporting	Minimal
Monitor, Evaluate, and Assess Impact	Supporting	Supporting	Supporting	Leading	Supporting

■ Leading role
 ■ Supporting role
 ■ Minimal role

^{xiv} This model is most consistent with the recently proposed Regulatory Framework for Distribution Franchising due to the high degree of collaboration between the community, DisCo, and new service provider.



COLLABORATIVE SPV-LED MODEL (CONTINUED)

Benefits and Risks of the Collaborative SPV-Led Model

Benefits

- **Inclusive ownership structure** gives all key stakeholders a clear role in project ownership and operation, incentivizing them to work for project success.
- **Attracting investment** may be easier with multiple owners and reduced risk.
- The model **leverages the strengths of each stakeholder**, including minigrid operator project experience, DisCo expertise, and local community knowledge.
- There is an **internal system of checks and balances** created by multiple stakeholders.
- **Risk is shared** among all project participants.

Risks

- The **complicated ownership structure** may slow decision-making processes, add legal and regulatory complexity throughout project development, and require negotiation of profit-sharing between participants.
- **All parties are exposed to risk**, meaning everyone will lose if the project fails.
- **Disagreement between parties** could put the project at risk.



KEY BUSINESS MODEL FINDINGS

Each business model described in this report offers significant benefits, but each poses unique challenges and risks as well. Different business models will be more or less appealing in different situations, given the stakeholders involved and the specific community context.





















Exhibit 6 summarizes the trade-offs between business models to help stakeholders prioritize based on the outcomes they desire.^{xv} For instance, the minigrid operator-led model is fastest to implement, whereas the SPV-led model offers greater potential for reducing DisCo investor losses. By reducing installation and operational costs, as well as potentially accessing grant funding, the cooperative-led model could yield the most affordable customer tariffs. Finally, although the collaborative model offers strong loss-reduction and




tariff affordability outcomes, it also encourages greater alignment of project partners through collaboration.

Importantly, the business model for a particular undergrid minigrid project need not remain static—a transition from one model to another over time is possible. For example, a project may begin using a minigrid operator-led business model, but after several years of operation, the local community might decide to form a cooperative and purchase the project from the minigrid operator that owns the asset. Similarly, a minigrid operator-led project might be acquired by an SPV led by DisCo investors; this could allow for DisCo investors, who may take longer to begin an active role in undergrid minigrid project, to purchase and consolidate ownership across dozens or hundreds of projects.

EXHIBIT 6

Comparison of expected outcomes from the four business models based on stakeholder input^{xvi}

	 Minigrid Operator-Led	 SPV-Led	 Cooperative-Led	 Collaborative SPV-Led
DisCo Investor Loss Reduction Potential				
Speed to Implement				
Less Regulatory Complexity				
Customer Tariff Affordability				

 = less desirable outcome
  = average outcome
  = more desirable outcome

^{xv} Ranking of expected outcomes for different models has been validated with stakeholders, including DisCos, investors, minigrid operators, development agencies, and government agencies.

^{xvi} Other outcomes, such as investment requirements, O&M cost, ownership, and long-term project sustainability, are not assessed here due to their dependence on specific stakeholder perspective.

SCALING THE UNDERGRID SECTOR

Through minigrids and other alternative solutions (see **Appendix A**), utilities and minigrid operators can improve service to 40 million rural residents across Nigeria, with the potential to impact nearly 200 million undergrid households globally.¹⁹ To implement projects at this magnitude, the sector must ramp quickly from individual projects (see **Section 4**) to large-scale deployment. This will require rapid learning to refine business models and implementation approaches in order to de-risk the model and unlock long-term investment.

To begin installing and testing undergrid minigrids as soon as possible, the first commercial projects will likely be minigrid operator-led (see **Exhibit 6**). This model is the fastest to implement and is represented by the commercial projects already under development in Nigeria (see **Section 4**). As initial projects prove the concept and provide experience with commercial terms of operation (see **Appendix C**), the business models defined in this report can be leveraged through several scaling mechanisms:

- **Scale to new stakeholders:** The first demonstration projects should de-risk the concept of undergrid minigrids to attract new participants and investors to the sector. This will serve as a way to increase investors' confidence about customers' ability and willingness to pay. Stakeholders who see minigrid operator-led projects as a missed opportunity may emerge at this point (e.g., DisCo investors). These new participants may pursue new project development using one of the business models shown here or may look to use an SPV- or cooperative-led model to acquire existing minigrid operator-led projects.
- **Scale to larger portfolios:** Once a stakeholder begins to develop undergrid minigrid programs, they can scale the concept to create a larger portfolio. For example, a DisCo investor could implement hundreds of undergrid minigrids by identifying

appropriate communities within the DisCo's service territory. Rapid scaling by DisCo investors could also be achieved by developing a platform for engaging partner organizations to implement an SPV-led model. Similarly, state governments, local governments, or developers could raise a larger round of capital to develop large portfolios of undergrid projects. In all cases, as the concept continues to be de-risked, a multisite portfolio may facilitate investment through larger deal sizes.

- **Scale to new market types:** Early undergrid minigrids will enable cost reduction and streamlined processes that can be applied across new market types. For instance, minigrids in rural communities may be easier to implement in the near-term due to limited competition with on-grid and other service models. However, the scale and learnings from these communities can quickly enable minigrids to expand into peri-urban areas and provide lessons applicable to urban distributed energy resource solutions.

Given the magnitude of the market opportunity, scaling can happen across all of these dimensions over the upcoming months and years.

EXPERIENCE TO DATE

Undergrid minigrids remain a new concept, but a small set of projects is already under development (see **Box 5**). Combined with other negotiations, stakeholder consultations, and exploratory conversations, initial insights can guide and improve the next round of project development.

Overall, the primary lesson to be learned is the importance of strong stakeholder engagement and communication, both within and across organizations. Greater cross-sector engagement can help develop the trust required to implement sustainable and complex undergrid projects, while increased intraorganizational coordination across departments can expedite project development by avoiding misunderstanding related to an unfamiliar project type. This lesson reflects common challenges seen in undergrid minigrid project development to date.

Early project experience demonstrates an initial mutual distrust between minigrid operators and DisCos, who may suspect that the other party is not negotiating in good faith. This can lead to prolonged negotiation of commercial terms, or to the termination of negotiations altogether. For instance, some DisCos feel threatened by the encroachment of minigrid solutions into their customer base or doubt project viability due to the more expensive cost structure of minigrid projects. There have also been logistical challenges with long timelines and the difficult process of securing affordable sources of project capital.

Although these challenges present barriers to project implementation, there are many ways to address them:

- **Develop a shared understanding** of early projects as trials and promote financial viability and project sustainability rather than maximizing returns.
- **Reduce the risk** of project failure through contractual mechanisms that address future changes in tariffs, grid availability, and community needs (see **Appendix C**).
- **Approach relationships between project participants as sustainable partnerships** that enable mutual benefits, rather than competitions where one party will end up as the loser.
- **Involve a broad base of stakeholders** early in project development, including local community associations and leadership, state governments, and any key commercial off-takers to ensure buy-in and build a broad base of support.
- **Enable each project participant to take an ownership stake** to ensure strong buy-in and long-term sustainability. Although the aspirational collaborative SPV business model is one opportunity to do this, simpler options could include a community providing financial or in-kind contributions to project development (e.g., land or labor) or a DisCo providing in-kind advisory support on the existing distribution operations or customer enumeration.
- **Facilitate project replicability** by standardizing components, contracts, and processes (e.g., due diligence or monitoring and evaluation) to reduce future project development time and expense.

BOX 5. UNDERGRID MINIGRID PROJECTS UNDER DEVELOPMENT

Note: The projects discussed here are the only ones known to the authors at the time of this report, but others may be under development privately.

Torankawa, Sokoto State

A minigrid project in Torankawa, Sokoto State, was commissioned in 2019 as a collaboration between the Department of Renewables and Rural Power of Nigeria's Federal Ministry of Power, Works, and Housing; Kaduna Electricity Distribution Company (KEDC); and the Torankawa Community Association for Electricity. Project generation assets consist of a 60 kilowatt (kW) solar photovoltaic (PV) array, a 216 kilowatt-hour (kWh) battery bank, and a 100 kilovolt-ampere (kVA) backup diesel generator. Power distribution and metering assets include a 4 kilometer local distribution network and 335 smart meters. The project was designed to operate in both grid-connected and island modes and was sized to serve 350 local households and 20 small businesses in addition to community street-lighting, mosques, and a local irrigation farm.²⁰

The Federal Ministry of Power pioneered this undergrid minigrid to demonstrate its technical, economic, and political feasibility. Although it was not a commercial project (as it relied on extensive government funding and support), the project has proven to be technically feasible and politically stable, with 24-hour service and 0% commercial and collection loss (using a prepaid payment system). Cooperation of several institutions was key to the project, as KEDC rehabilitated the 33 kV line connecting Torankawa to the main grid, the Torankawa community contributed land and ensured the offtake of power, and the Ministry of Power and Nigerian Sovereign Green Bond provided funds and will concession the project to a private minigrid operator.²¹

Mokoloki, Ogun State

Nigeria's first commercial undergrid minigrid project is currently under development in Mokoloki community, Ogun State, with commissioning planned for 2019. The minigrid operator-led project is a partnership between the community, Ibadan Electricity Distribution Company (IBEDC), and Nayo Tropical Technology and offers an opportunity to test the financial viability of a fully commercial project.^{xvii}

The Mokoloki project is expected to include 180 kW PV, 144 kWh lead-acid battery, and a 62 kW backup diesel generator. It is designed to serve an initial peak load of 55 kW from nearly 200 households, 28 commercial enterprises, and eight public connections. The project will be based on the first tripartite contract that includes a provision for the minigrid operator to pay a distribution usage fee to the DisCo.

Interconnected Minigrid Acceleration Scheme

The Interconnected Minigrid Acceleration Scheme (IMAS) is a nationwide non-site-specific open competitive tender designed to select local minigrid companies partnering with Nigerian DisCos. The winners of the tender will be supported in deploying their proposed minigrid projects with an in-kind partial capital grant (in the form of procured distribution and metering equipment) and technical assistance, for a total value of €3 million. It aims to provide a minimum of 15,000 customers (including residential, public, commercial, or productive users) in grid-connected but poorly served areas across Nigeria with access to reliable electricity services at an affordable tariff via privately led interconnected solar minigrid projects by the end of 2020.

The tender was launched in 2019 and is championed by the Federal Ministry of Power, with execution and management by the REA. IMAS is supported by the European Union and the German government through the Nigerian Energy Support Programme (NESP) implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).²²

^{xvii} RMI supported the development of this project as a strategic advisor to IBEDC.

ENABLING ENVIRONMENT

The business and regulatory environment have significant implications for undergrid minigrid implementation. Although this discussion centers on the Nigerian context, similar concerns will apply to undergrid minigrid projects elsewhere as well.

BUSINESS CONSIDERATIONS FOR UNDERGRID MINIGRIDS

- **Contract Term and Period:** Most minigrid projects today are developed with an assumed lifetime of 20–25 years. However, since the current license period for DisCos is 10 years, if an undergrid minigrid project’s contract includes a term of 10 years or more, the risk of a change in DisCo ownership should be considered. This change could impact financial planning for investments to upgrade existing distribution infrastructure. Confusion around distribution ownership and investment costs could be mitigated through tripartite agreement terms (see **Appendix C**), or potentially through future regulatory assurances by NERC or the Bureau of Public Enterprises to protect the minigrid investment from changes in DisCo ownership.
- **Consumer Engagement:** Undergrid minigrids represent a new business model unfamiliar to electricity consumers who are accustomed to being served by a DisCo or government utility. In addition, minigrid operators or SPVs may have limited knowledge of specific communities before engaging in the project. Successful undergrid minigrids will need to address consumer creditworthiness, customer perception of electricity as a free service, community hostility, history of collection efficiency, and customer mix. Projects need to adopt an effective and transparent system of consumer engagement, as has been done with isolated minigrids.²³
- **Ensuring Commercial Sustainability:** Minigrid projects today are cost-competitive with other electricity alternatives in undergrid communities

because of low grid reliability and high self-generation costs. However, as alternative electrification options change, it will be important to continue to identify mechanisms for cost reduction for customer affordability and long-term sustainability. Government and development partners can incentivize undergrid minigrid development by providing import duty waivers, land leases, investment guarantees, foreign exchange risk reduction, and technical support. The REA and NESP IMAS program is an example of targeted undergrid minigrid support that could be replicated at scale in the future (see **Box 5**).

REGULATORY CONSIDERATIONS FOR UNDERGRID MINIGRIDS

NERC is the primary regulatory oversight body for undergrid minigrids. Currently, the minigrid operator, SPV, undergrid community, or community cooperative can initiate and lead undergrid minigrid project engagement with NERC, whereas licensing terms and the EPSRA limit the role of DisCos (see **Box 3**).²⁴

The *Regulation for Mini-Grids 2016* provides the framework for the development and operation of isolated and undergrid (referred to as interconnected in the regulation) minigrids.²⁵ However, several other regulations provide additional measures for improving service in undergrid areas. As described in **Appendix A**, these include regulations on IEDNs, MAPs, and embedded generation.

The Regulatory Framework for Electricity Distribution Franchising proposed by NERC in 2019 offers an additional mechanism for undergrid service improvement. This document addresses DisCo funding and infrastructure gaps, power supply deficit, and customer dissatisfaction. According to the NERC consultation paper on the development of this regulatory framework, *distribution franchising* refers to “the business model applied by a DisCo

to authorize a [third-party ‘franchisee’] to provide electric distribution utility services on its behalf in a particular area within the DisCo’s area of supply.”²⁶ The consultation paper suggests several potential business models for distribution franchising (see **Appendix A**), but the distributed generation (DG)-based model is particularly relevant to this discussion of undergrid minigrids. The DG model enables a franchisee to deploy additional generation supply to meet an electricity deficit at the local distribution network level in addition to managing the network’s distribution function and metering, billing, and collection operations.

The similarity between the DG-based franchising model and undergrid minigrids could pose confusion among potential project participants. If the franchising framework is approved as a regulation, we recommend that it be clarified to eliminate

regulatory overlap with undergrid or interconnected minigrids. In addition, NERC can elaborate on the terms of both the DisCo–minigrid developer and DisCo–franchisee relationships to provide clarity on whether the undergrid minigrid process will be subsumed under the franchising structure.

Other key areas of consideration to facilitate an enabling environment for undergrid minigrids include current and future political realities, raising of developmental funds to support scaling, development of new policies and regulations that may interact with the minigrid regulation, clear enforcement of current regulations, and any changes to the on-grid tariff structure or performance. Many of these considerations, as well as opportunities for limiting risk to undergrid minigrid projects, are highlighted in previous publications.²⁷

CONCLUSION

The four business models presented in this report demonstrate a wide range of implementation strategies and ownership options for undergrid minigrids. A great deal of choice is afforded to project participants, who can identify the business model best suited to their needs, timeline, and other requirements. This report does not recommend a single model for all situations and all stakeholders; rather, we hope it provides stakeholders with a set of tools and information to identify the most suitable business model for them.

Undergrid minigrids show promise as a solution for serving thousands of underserved Nigerian communities, but the concept remains largely untested to date. Continued development of pilot projects will be required to demonstrate the feasibility of

each business model, requiring careful planning and coordination among all stakeholders; REA and NESP’s IMAS program is one ongoing platform for this experimentation. Although each business model is attractive for different reasons, stakeholders eager to begin implementation can start with the minigrid operator-led model due to its relative straightforwardness and short timeline to implement.

Although this report focuses on business models within the Nigerian context, the concept of undergrid minigrids—as well as SPV and cooperative ownership structures—has global applicability where utilities are not able to fully serve all customers and distributed energy resources can help provide cost-effective local power.

APPENDIX A: ALTERNATIVE SOLUTIONS FOR UNDERGRID SERVICE

OVERVIEW

Minigrids are defined by Nigerian regulation as “any electricity supply system with its own power Generation Capacity, supplying electricity to more than one customer and which can operate in isolation from or be connected to a Distribution Licensee’s network ... [and] generating between 0 kW and 1 MW of Generation Capacity.”²⁸ This definition is important in distinguishing undergrid minigrids from other sorts of power solutions.

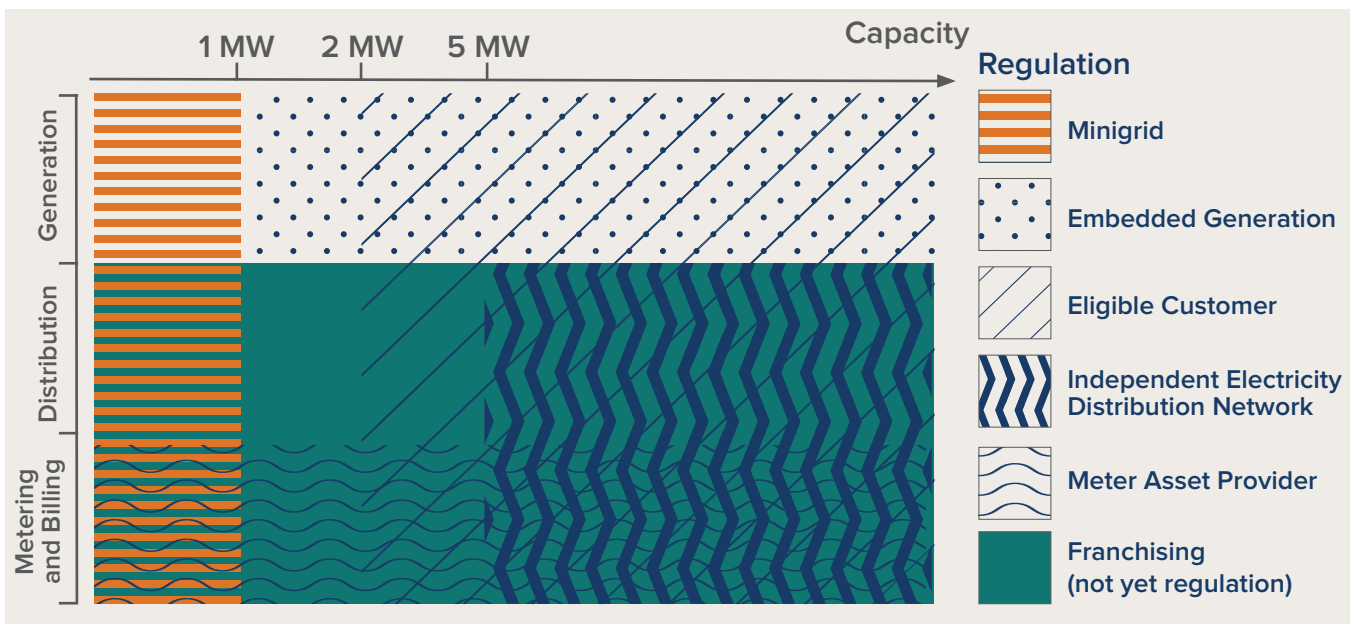
Minigrids are not the only solution for improving power supply in undergrid communities. Although they are not considered in this business model analysis, at least four other relevant regulations also govern pertinent service options: embedded generation, independent electricity distribution networks (IEDNs), meter asset providers (MAPs), and distribution franchising.^{xviii} A combination of these solutions will likely be required to achieve high-

quality, reliable service to Nigeria’s undergrid populations. **Exhibit A-1** shows how these different regulations relate to each other in applicability and installed capacity.

The alternative solutions for undergrid service described in this section offer solutions for communities not appropriate for minigrid service (e.g., with greater than 1 MW load) as well as mechanisms for involving different project participants. As noted in **Box 3**, there are limitations on generation companies (GenCos) and distribution companies (DisCos) having direct involvement in minigrid projects, although their investors could use special purpose vehicle (SPV) models to engage in project ownership and operation. However, other mechanisms for improving undergrid service can enable the participation of a variety of stakeholders.

EXHIBIT A-1

Coverage of various Nigerian Electricity Regulatory Commission (NERC) regulations across functional roles and installed capacities (undergrid minigrids are encompassed by the minigrid regulation)



^{xviii} Distribution franchising is a concept being considered by NERC, but it has not yet been published as a Nigerian regulation.

EMBEDDED GENERATION

How It Works

Embedded generation facilities connect directly to existing transmission and distribution networks. Embedded generation solutions involve, at a minimum, the embedded generator and the DisCo; they may also serve eligible customers directly through that regulation.^{29,xix}

Excess capacity from embedded generation (or any generation) facilities might be considered as a new source of power to improve service to undergrid communities. However, these communities could be served through the existing DisCo and likely through the existing power purchase agreement (PPA) between the embedded generator and the DisCo. If there is a challenge with customer service, a MAP could be introduced to provide that service.

How It Differs from Undergrid Minigrids

Embedded generation facilities are defined in regulation as over 1 MW in capacity. This automatically places embedded generation in a different class from minigrids, which are defined as less than 1 MW.³⁰ Although a separate operator could be brought on to engage, bill, and collect from customers, this function is more reflective of a MAP supporting an embedded generation project.

INDEPENDENT ELECTRICITY DISTRIBUTION NETWORKS

How They Work

IEDNs are separate distribution licensees that operate in specific areas within a DisCo territory, either in areas where there is no existing distribution network (not relevant for undergrid communities) or where DisCos are not able to meet customer demand or provide sufficient access to electricity service.³¹ IEDNs provide an equivalent to DisCo service, including electricity distribution, customer metering, and billing at on-grid rates. IEDNs connect to generators, including embedded generators, but do not generate power themselves.

How They Differ from Undergrid Minigrids

Embedded IEDNs are similar to undergrid minigrids in the sense that they serve specific, isolated geographic areas that are underserved by DisCos and represent a solution in underserved areas where the main constraint is the capacity of the DisCo to distribute power and engage customers. However, where the constraint involves a shortage of available power, minigrids may be more helpful because they are able to provide new generation assets. Because they do not generate power, IEDNs do not qualify as minigrids under current regulation (and vice versa).

^{xix} End-use customers or customer groups are eligible if they are unserved or underserved and consume an average of 2 MWh/h or more.

METER ASSET PROVIDERS

How They Work

MAPs are intended to provide a specific service to bridge the metering gap and provide meters for DisCo customers. Deployed meters are paid for by all customers via a dedicated account, which is paid separately from the distribution charge.³²

How They Differ from Undergrid Minigrids

MAPs offer one mechanism for improving billing and payment collection in rural areas by metering customers and therefore ensuring both customers and DisCos that customers are accurately billed for electricity consumed. However, they do not address generation, transmission, and distribution capacity constraints, whereas minigrids cover more of these aspects of electricity service. Thus, MAPs are most appropriate in undergrid areas where metering is the main source of tension, but undergrid minigrids may be best where there are additional concerns around the DisCo–community relationship, DisCo challenges with non-cost-reflective tariffs, or other capacity shortages.

DISTRIBUTION FRANCHISING

How It Works

Electricity distribution franchising, as recommended in the consultation paper released by NERC in May 2019, is a mechanism for DisCos to subfranchise both territory and operations to improve electricity service.^{xx} Franchising arrangements may be implemented under potential business models, including a *Metering, Billing, and Collection (MBC)* model, which outsources metering, billing, and collection to the franchisee to boost revenue collection efficiency; *Total Management of Electricity Distribution Function model*, where the franchisee

manages the distribution network, including investment in network upgrade; and a *Distributed Generation (DG) model*, where the franchisee may need to deploy additional generation supply to meet the electricity deficit at local distribution network level—as well as managing the distribution functions of the network.

Communities, DisCos, and the distribution franchisee would work together to implement this model in a very similar mechanism to that governed by the tripartite contract for undergrid minigrids. Similar risks would apply, including the need to balance the benefits of competition between service providers (ensuring low customer cost) with the need for DisCos to run networks profitably. However, since this agreement is not yet regulation, undergrid minigrid projects may serve as a testing ground for business models that would also apply to distribution franchising. In this way, DisCos and other stakeholders may use undergrid minigrids to test the concept of distribution sharing and third-party operation.

How It Differs from Undergrid Minigrids

Like undergrid minigrids, distribution franchising would open electricity markets to greater competition. The regulation is expected to increase Nigeria's generation capacity outside of the bulk trader's jurisdiction, improve distribution networks, increase customer satisfaction, improve technology, and yield overall better electricity service.³³ Undergrid minigrids represent a subset of distribution franchising arrangements that are limited to systems of less than 1 MW, in which the minigrid operator acts as the distribution franchisee to operate a local area of the distribution network and serve customers directly.

^{xx} Although there is not yet a regulation on distribution franchising in Nigeria, the topic is discussed in a 2019 NERC consultation paper due to the similarities to undergrid minigrids and implications for improving service in undergrid areas.

POTENTIAL FOR GENERATION COMPANY INVOLVEMENT

In gathering stakeholder feedback for this report, several GenCos expressed interest in the undergrid minigrid concept. Of specific interest was the potential for existing generators to participate in minigrid projects as a supply resource, supplementing the need for new minigrid generation capacity while allowing for the use of idle generator capacity. However, this is not a straightforward arrangement under existing regulation, particularly because minigrids are limited to 1 MW of generation capacity, and the GenCo assets are not necessarily located near the appropriate undergrid minigrid communities.

GenCos may be able to support improved power supply to rural and peri-urban customers in other ways. In particular, existing generators can directly serve IEDNs. Although this arrangement does not represent a “minigrid” in a regulatory sense, and the applicable capacity is larger, it effectively results in a similar approach of sharing existing capacity directly with an underserved rural community (or communities).

There are a variety of regulatory, economic, and operational dynamics that GenCos, and other stakeholders exploring how existing generation assets can participate in minigrids, can consider. These include the following:

- Leveraging nearby, pre-existing generation capacity could help reduce the capital cost of a minigrid project and has the potential to lower operating costs depending on the resource(s) it would supplement.
- Reliability will be a critical consideration, particularly if power needs to be wheeled across transmission and distribution lines to reach the minigrid—if the combined generation, transmission, and distribution assets cannot reliably provide power, then the new solution would be no better than the status quo.

- New and expensive infrastructure that might be required to connect a minigrid (or IEDN) with a generator, depending on the existing interconnection configuration, would increase the capital cost of the project.
- In certain arrangements, a generator might be required to procure new licenses (e.g., an embedded generation license), which would incur additional expense.

GenCo involvement in minigrids should continue to be reassessed as the regulatory and grid landscapes evolve.

APPENDIX B: ADDITIONAL DETAIL ON BUSINESS MODEL BUILDING BLOCKS

Business model building blocks 1–3 encompass key roles related to project development, asset ownership, and project operations. This section discusses the strengths and weaknesses of relevant stakeholders in the context of each building block.

BUILDING BLOCK 1: DECISIONS ON PROJECT DEVELOPMENT ROLES

Decision points on project development include determining who **invests capital, identifies sites for project development, engages customers**, and leads the **regulatory approval process**. The ideal party for leading project development has access to finance, local community knowledge, and a strong relationship with the regulatory commission, among other qualities

(demonstrated in **Exhibit A-2**). While DisCos or an SPV (to some extent) may have strong insight into DisCo territory and therefore an understanding of viable communities for minigrid projects, minigrid operators bring project development experience and relationships with investors, financiers, and the regulatory commission. Note that investors are not included as a separate party here because they would be involved in project development (and ownership and operation) through one of the other parties listed.

EXHIBIT A-2

Considerations for decisions on project development

	Strengths	Weaknesses	Takeaway
DisCo	Best understanding of full territory for effective site identification	Limited trust of financiers and regulator due to current financial situation; limited local knowledge	May lack stakeholder trust
SPV	Can leverage close relationship with the DisCo for effective site identification	As a new company, may lack technical experience; disagreement on stakeholder roles and ownership could delay project	Likely has limited experience to manage project
Minigrid Operator	Relationship with the regulator; site selection and customer engagement expertise; can access finance and technical assistance	Must earn buy-in of the community and the DisCo to proceed effectively	If experienced in Nigeria, well-positioned to manage project
Government	Able to attract capital	Exposes risk of politically driven site selection	Poorly positioned to implement at scale
Co-op	Well-positioned to access grants from government and donors	Limited access to private capital; limited experience with regulatory process or technical expertise	Lacks some critical relationships and expertise

BUILDING BLOCK 2: DECISIONS ON ASSET OWNERSHIP ROLES

Decision points on asset ownership determine who **owns generation and storage infrastructure, invests in and builds new distribution, and owns meter assets**. The owner of assets must be legally permitted to own generation and distribution assets and ideally demonstrates experience with project development. As demonstrated in **Exhibit A-3**, minigrid operators tend to have the most relevant experience to minigrid project ownership, although the SPV and co-op also reflect benefits in terms of DisCo and community buy-in, respectively.

EXHIBIT A-3

Considerations for decisions on asset ownership

	Strengths	Weaknesses	Takeaway
DisCo	Owns existing distribution; may not sell existing distribution assets permanently ³⁴	Likely lacks finance to invest in distribution projects; likely has limited capacity for ongoing engagement; may not own generation assets ³⁵	Has a clear role in ownership of distribution infrastructure, but cannot own generation
SPV	May install and operate generation, distribution, and metering assets	May have limited experience with project/asset ownership	Maximizes control of DisCo investors over minigrids
Minigrid Operator	Experience installing and operating generation, distribution, and metering assets	Lacks experience with grid code and distribution code standards	Well-positioned to own and install generation and metering assets
Government	Experience contracting installation of minigrid assets	Limited capacity to invest and operate sustainably	Poorly positioned to implement at large scale
Co-op	Community ownership offers project security and potential for a reduced tariff	Likely has limited experience with asset ownership	Maximizes community ownership
Independent Power Producer (IPP) or Third-Party Operator	May own generation assets	Would require a PPA to sell power to the minigrid system operator because IPP does not operate or distribute	Provides an opportunity to decrease cost of electricity

BUILDING BLOCK 3: DECISIONS ON PROJECT OPERATIONS ROLES

Decision points on minigrid operations include determining who **manages customers; meters, bills, and collects; operates and maintains the system;** and **evaluates the project.** The ideal party for leading project operations must have strong community trust and engagement, as well as the technical capability to operate the system. **Exhibit A-4** reflects the existing experience of minigrid operators in building community trust and operating and managing minigrid projects.

EXHIBIT A-4

Considerations for decisions on project operations

	Strengths	Weaknesses	Takeaway
DisCo	Existing local commercial team	Evidence of low collection efficiency; may not engage in the generation of electricity	License constraints limit their participation
SPV	May be able to transfer staff from the DisCo with operational expertise	Likely has limited experience operating a minigrid system	May need to outsource minigrid operations
Minigrid Operator	Greatest knowledge of minigrid system O&M; experience building customer trust and billing	Limited experience with long-term monitoring and evaluation	Experience in both engaging community and operating minigrids
Government	Experience with monitoring and evaluation of projects, especially through development agencies	Likely lacks capacity for ongoing and sustained system operations (not a project operator)	Poorly positioned for leading operational role
Co-op	Strong community relationships should support effective engagement and billing operations	Limited experience operating minigrid systems	May need to outsource system O&M

APPENDIX C: ADDITIONAL DETAIL ON COMMERCIAL TERMS OF OPERATION

Minigrid financial models respond to a range of factors and are especially sensitive to grid interconnection and availability, distribution usage fee, and contract length, which are explored here. Decommissioning addresses a perception of risk, which also impacts minigrid finances. Each of these elements is discussed in more detail below.

SYSTEM INTERCONNECTION

Because undergrid minigrids can operate as an islanded system or actively share power with the main grid, in this report we define interconnection as the pass-through of power between the minigrid and main grid. This interconnection can reduce customer tariffs by incorporating lower grid energy prices into the average cost of energy. However, this calculation for user tariff can be complicated, and interconnection can reduce system size and capital expenditure only if grid power is reliably available. Meanwhile, islanded systems are less complicated and likely faster to implement. If the system is interconnected, detailed analysis will be required to identify appropriate feed-in tariffs (minigrid power sold to grid), PPAs (grid power sold to minigrid), and tariff rates and structures.

Interconnection requires that grid power be reliably delivered at the agreed-upon time of day. Reasons to interconnect include:

- Interconnection increases DisCo involvement and investment to increase DisCo buy-in and long-term support of the project.
- If grid is reliable, interconnection can reduce overall costs and tariffs because grid power is cheaper than minigrid power.

If the timing of reliable grid power is not guaranteed, then islanding the undergrid minigrid system will be the cheapest option. Reasons not to interconnect include:

- Without reliable grid power, the minigrid must be sized the same as if it were off-grid (or burn more diesel).
- The DisCo can focus on serving core customers.
- Exchanging power adds regulatory complexity in tariff and PPA setting.
- Lack of clarity on updates to the on-grid tariff schedule creates uncertainty about cost savings.

The decision of whether to interconnect a minigrid with the main grid will require careful economic analysis and realistic assumptions about grid availability, including metrics such as:

- Total grid availability (hours/day)
- Reliability of grid service at a given time of day (%)
- Likely change in grid availability over time
- Quality of grid power and technical feasibility to interconnect

DISTRIBUTION USAGE FEE

A basic mechanism for determining the distribution usage fee is described in Annex 8 of the *Regulation for Mini-Grids*.³⁶ However, the regulation explicitly creates opportunity for negotiation around the fee. DisCo revenue opportunities will need to be balanced with the requirement to keep minigrid tariffs low. To determine an optimal usage fee, stakeholders should consider different pricing mechanisms, payment frequency, payment magnitude, the impact of the usage fee on customers, and plans to adjust the fee over time.^{xxi}

^{xxi} Depending on the distribution assets present, the DisCo may also need to ensure appropriate accounting treatment of assets temporarily transferred to the minigrid, including whether they remain part of the DisCo's regulated asset base for return purposes.

Pricing Mechanism

The base pricing mechanism used to determine interconnected minigrid usage fee payments from the project operator to the DisCo could include a wide variety of options, including:

- Fixed fee (per unit of time)
- Per-unit fee (per kWh delivered)
- Revenue-based fee (per minigrid revenue)
- Profit-based fee (per minigrid profit)

The first two pricing mechanisms are explored in detail due to their greater administrative ease; the latter two options may be interesting to further explore as

undergrid minigrids scale, but both present challenges in administrative complexity. **Exhibit A-5** indicates key considerations for assessing fixed and per-unit fees.

Payment Frequency

Usage fee payments from the minigrid operator to the DisCo should be reliable, with a fixed frequency. Annex 11 of NERC's *Regulation for Mini-Grids* recommends a monthly payment cycle.³⁷ This timing seems appropriate to balance administrative complexity of payments (it will not overwhelm the minigrid operator) with providing regular revenue to the DisCo.

EXHIBIT A-5

Considerations for deciding between a fixed or per-unit distribution usage fee

	Fixed fee	Per-unit fee
Description	Fixed payment per unit of time; known cost/revenue structure	Fixed payment per kWh delivered; flexible cost/revenue structure
General Comments and Considerations	Not tied to minigrid financial performance; this option is recommended in NERC regulations	Inherently linked to consumption and financial performance of minigrid
Financial Risk to DisCo	Lower risk: guaranteed, predictable revenue	Higher risk: uncertain revenue based on minigrid performance
Financial Risk to Operator	Higher risk: same fee if cost/revenue structure changes	Lower risk: losses due to poor performance are limited
Financial Risk to Customer	Higher risk if system underperforms: operator may raise tariffs to cover the fixed cost of the usage fee	Lower risk: usage fee contributes the same cost to each kWh purchased
Incentive for DisCo Support	Less incentive to support minigrid operations	Greater incentive to facilitate minigrid system success
Incentive for Operator Performance	Greater incentive to support minigrid operations and increase profit ratio per unit sold	Usage fee structure does not provide additional incentive to perform based on profit ratio
Logistical Considerations	If system performs significantly better or worse than expected, renegotiation of the usage fee may be required	Requires ability to accurately measure and track units of electricity consumed and third-party auditing of energy sold
Impact on Minigrid Profitability	Could result in lower overall profitability and equity return if less energy is sold than expected or vice versa	Negligible given volumetric approach, which maintains a consistent per-kWh component

Usage Fee Magnitude

The magnitude of the usage fee is a critical negotiation point that determines the financial benefit of the minigrid project to the DisCo and dictates the minigrid tariff requirement. This is distinct from the payment mechanism, because it defines how large the fee will be rather than how the fee will be paid. The usage fee magnitude could be tied to a range of metrics, including the following:

- Change in DisCo profit with minigrid project
- Change to DisCo revenue with minigrid project
- Value of distribution asset depreciation
- Cost of capital and taxes
- DisCo breakeven point (ensuring DisCo is exposed to zero net cost in the community)
- Operator-avoided cost due to distribution sharing

Implications for Customers

Customer well-being must be considered when determining usage fee structure and magnitude. A higher usage fee will likely require a higher minigrid tariff, assuming the operator requires a constant return. The fee must create sufficient payment for the DisCo to share distribution without overburdening the customer. While the magnitude of a fixed vs. per-unit fee should be approximately the same (assuming accurate load prediction), each fee structure carries different risks (described in [Exhibit A-4](#)).

Fee Adjustments

With an anticipated project contract length of 10–20 years, it may be desirable to adjust usage fees over time. Adjustments could be prompted by changing costs, tariff adjustments, or other external factors (e.g., change in foreign exchange) to ensure that the DisCo, minigrid operator, and undergrid community all continue to benefit from the minigrid project. To reduce the risk of future disagreement during renegotiation, it may be possible to predefine a system that will enable the automatic adjustment

of usage fee magnitudes. For example, the pricing mechanism could be linked to:

- DisCo cost base and revenue requirement, using a similar system to MYTO
- Generation cost indexation for DisCos based on existing PPAs and vesting contract
- A predetermined escalation rate, perhaps in line with the minigrid operator's projected tariff increases over time
- Volume of energy consumed (a tiered system for magnitude determination could allow for increasing usage fee payments with demand growth)
- An exchange rate to account for inflation and changes in the value of money over time

Whether or not a process is predetermined for adjusting the usage fee, renegotiation may be required in the end. The timing for renegotiation (e.g., annually) as well as process (e.g., upon request by either party) should be defined from the outset.

CONTRACT TERM

Shorter contract terms will minimize financial risk to DisCos while enabling rapid testing of business models. Shorter terms also allow DisCos a chance to reclaim full control of the undergrid community immediately upon grid improvement. However, as infrastructure projects, minigrids may require longer contract terms to maintain commercial viability. A minimum contract term of 10 years is likely required to achieve the required return on investment while maintaining an affordable customer tariff. Developers will likely prefer a longer contract term, in line with their asset life span.

DECOMMISSIONING

Although NERC regulation specifies a few scenarios that justify early contract termination, it leaves flexibility with

regard to the decommissioning process. The regulation also does not address the risk of project failure due to grid improvement (and thus competition between the undergrid minigrid and a cheaper on-grid alternative). Several decommissioning scenarios are discussed below.

Decommissioning Process

If one or more parties invokes its right not to renew the tripartite contract after the initial term, or if the project fails for other reasons, there are four primary outcomes:

- The minigrid operator could continue to own and operate the generation assets as embedded generation, selling power back into the grid based on a new PPA.
- If the minigrid operator does not want to continue operating the generation, another generation licensee may purchase generation assets from the minigrid operator according to a predetermined depreciation schedule, accounting for cost of assets and any improvements made. The DisCo may also purchase the metering assets at a depreciated value from the minigrid operator.
- The minigrid operator may remove nondistribution assets from the community and restore previous grid connections. The DisCo will own all new distribution installations, improvements, extensions, and network expansions in either case.
- If the system was not originally interconnected with pass-through of power, a new tripartite agreement could be developed based on interconnected minigrid and DisCo networks. In this case, the minigrid would operate as interconnected with an agreement for the minigrid to offtake electricity from the grid and sell excess generation back to the grid.

Reducing the Risk to Undergrid Minigrid Investments if the Grid Improves

The primary objective of Nigeria's power sector is to provide affordable and reliable electricity across the country. While undergrid minigrids are a practical way

to achieve this objective in many rural communities today, over time it may be possible for the main grid to provide similar reliability at a lower cost. This eventual grid improvement poses a risk to most off-grid electrification solutions, which base their financial model on the availability of revenue streams over a certain period of time to recoup equity and repay debt. In the case of isolated minigrids, this risk is reflected in *Regulation for Mini-Grids* section IV.19.2, which protects the minigrid in the case of grid expansion. Similarly, the business case for undergrid minigrids may be challenged if the grid is able to expand or improve availability, which could leave “interconnected” systems with stranded assets or the inability to retain customers (if customers attempt to revert to receiving energy from the main grid rather than the more expensive minigrid). Several mitigation strategies can reduce the risk associated with grid improvement.

To minimize the risk of grid improvement negatively impacting an undergrid minigrid project and to support project sustainability:

- **DisCos** can partition off underserved rural and peri-urban sections of their territory, such as a specific feeder that they are unable to serve reliably, to be served by off-grid options to reduce the risk of inconsistent energy pricing between neighboring communities.
- **Minigrid operators** can deploy strategies to minimize the risk of stranded assets. For instance, containerized hardware solutions could be moved to other sites if the grid improves locally to eliminate any lost investment.
- The **regulator** can update the tripartite contract template to include a clause enabling compensation to the minigrid operator in the case of grid improvement within the first five years of operation. This would parallel the similar clause in the isolated minigrid contract, defining a process for determining compensation and sharing the financial risk between multiple parties. As an alternative, the minigrid project participants could mutually agree to a similar clause in their individual tripartite contract.

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