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For Sustainable Mini-Grids, Development Funders Must Change the Way They Structure Subsidies and Do More to Stimulate Demand

Summary: The World Bank's efforts to improve rural energy access through mini-grids have inadvertently encouraged developers to build oversized systems and maximize the subsidy received instead of encouraging productive consumption and income generation. To achieve a sustainable rural electrification model, new funding packages should prioritize boosting electricity demand in target communities.

Why it matters: The World Bank and African Development Bank's $220 million joint program joint program funding for solar mini-grids in Nigeria has expired.[1] The World Bank is renewing its support with a $750 million program called the Distributed Access through Renewable Energy Scale-Up Platform (DARES). The Global Environment Fund and United Nations Development Program have also separately committed $5.9 million. Given Nigeria's dire fiscal situation and low infrastructure spending, these concessional loans could be crucial for addressing energy poverty. DARES funding is equivalent to ~70% of Nigeria's annual infrastructure budget, highlighting its scale and potential importance.[2] Thus, to understand how the intervention can maximize impact, we discuss the insights from the first cohort of mini-grids in Nigeria.[3]

Mini-Grid Incentives Today

Mini-grids are designed to bring reliable electricity services to unserved populations where grid extension isn't commercially viable, hence the need for subsidies to developers. In Nigeria, the Rural Electrification Agency (REA) provided subsidies in two ways:[4]

1. **Minimum subsidy tender:** The REA conducted energy audits of rural communities, shortlisted the best sites, and invited solar developers to submit proposals to build mini-grids there. The developers included the subsidy amount they required for the project, and the REA awarded the lowest bid a grant, paid after construction.
2. **Performance-based grants:** Developers used their resources to identify project sites and presented them to the REA for verification and approval. After constructing the mini-grid, they received a grant of $600 per connection,[5] with a minimum amount of $18,000. Initially, the grant was $350 per connection, but this didn't generate sufficient interest from developers.

[1] Mini-Grid Funders Group (MGF)
[2] Budget Office of the Federation. Central Bank of Nigeria exchange rate on 31 January 2024: 1192 NGN/USD.
[3] These audited mini-grids were financed with significant amounts of debt and equity; several of them (e.g. Gbamu Gbamu, Egbeke) received grants that covered up to 50% of CAPEX from USAID, GIZ, or the Power Africa Off-Grid Energy Challenge. The other data cited in this memo from the AMDA 'Benchmarking Africa's Mini-Grids 2022' report includes data from World Bank-funded mini-grids.
[4] Rural Electrification Agency
[5] A connection is a household or business connected to the mini-grid.

Lessons Learned

Mini-grid operational and economic performance data is often proprietary. However, reports by industry bodies provide some insights.

Mini-grid utilization and consumption remain low: Of ten audited commercial mini-grids in Nigeria, only three had capacity utilization rates above 50%; four had utilization rates below 10%.[6] This shows that these mini-grids were oversized for the demand in their host communities. At tariffs of 34-86¢/kWh, rural customers can often only afford a few kWh monthly to primarily run household appliances. Figure 1 shows that, on average, a mini-grid connection used roughly the same amount of electricity as a 60W light bulb running for 4 hours daily. Additionally, only ~10% of connections consumed more than 10 kWh monthly (Figure 2). These customers are typically commercial and drive the project's financial viability. Yet, their consumption is low and insufficient to sustain income-generating activities such as mechanized agricultural processing.

Demand stimulation doesn't work without access to financing: Rural consumption is low because most energy-intensive activities, primarily agriculture-related, are not electrified. Instead, customers use manual methods or inefficient fossil fuel machines (Figure 3). Electric-powered alternatives are available in the local market but are often too expensive because customers have low incomes and limited access to credit. An estimated 60% of Nigeria's rural population is excluded from the financial system or can access credit only through informal channels. The few microfinance banks that cover remote communities offer loans at exorbitant interest rates (3-6% monthly) and short tenures (<12 months).[7]

Both grant payment structures create disincentives for long-term sustainability: Grants are paid once connections are verified. When the payment is per connection, developers are incentivized to build oversized mini-grids and receive larger subsidies, even if they are unprofitable because of low demand (Figure 2). Additionally, since the payment is upfront, the developer has no incentive to maintain a reliable service. With such low revenues per connection, shown in Figure 4, maintenance costs may outweigh potential profits.

Mini-grids are still vulnerable to fossil fuel price volatility: Solar mini-grids are often designed with backup diesel generators to minimize the cost of battery storage. The World Bank's program assumes three running hours daily for the generator (though many systems run more) and a fuel cost of 250 NGN/liter (68 ¢/liter).[8,9] Today, diesel sells for 1,500 NGN/liter ($1.26/liter) in rural areas and generator running costs have increased. To maintain profitability, developers must hike tariffs or reduce operational hours, resulting in intermittent supply. Higher tariffs will only further decrease affordability.

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[6] Minigrid Investment Report: Scaling the Nigerian Market. Capacity utilization is the ratio of the actual output from a solar plant over the year to the maximum possible output from it for a year.

[7] StartCredits

[8] World Bank

[9] State of the Global Mini-Grids Market Report 2020

Recommendations for Potential Funders

Before funding new mini-grids, development financiers should consider the following to ensure project sustainability and maximize the positive impact on rural livelihoods.

- **Subsidize kilowatt-hours, not kilowatts:** Future grants should be based on actual power delivered to customers, not system capacity. Developers will then be encouraged to pursue demand stimulation efforts at their sites by supporting their customers to access productive, energy-efficient equipment (through additional offerings or partnerships). Alternatively, a portion of the grant could be reserved for meeting high utilization targets.
- **Pursue demand stimulation alongside energy access initiatives:** Demand stimulation is necessary to get profitable mini-grids, and since the ability to pay is so low in many off-grid communities, access to finance becomes critical. Without affordable credit, rural incomes will remain too low to purchase equipment that drives revenue generation and improves livelihoods. Supply-side measures shouldn't be pursued in isolation; they should be co-designed or co-located with demand stimulation and financial inclusion interventions.[10]
- **Define better benchmarks for 'productive use of energy':** Industry standards consider consumers using >10 kWh monthly as 'high-demand,' comparable to running basic household appliances for a few hours daily. As productive use of energy is promoted, there needs to be a focus on electrifying economic activities at scales that boost household incomes and rural livelihoods. The evidence suggests that existing mini-grids have failed to do so significantly because the number of connections has been used as a measure of success instead of energy use and income generation.
- **Publish mini-grid technical and economic performance:** To adequately assess the effectiveness of energy access solutions, development programs should publish data on their projects' technical and financial performance. That way, potential funders can understand the relative benefits of each and improve the designs of future interventions.

Rural mini-grid projects must be adequately sized and utilized to be commercially viable. Development programs should incentivize building mini-grid generation capacity and stimulating demand in target communities to a level that can sustain commercial operations. Without better-designed subsidies, the impact of energy access through mini-grids will remain limited.

[10] The Energizing Agriculture Programme (EAP), implemented by the REA and RMI, is the first program to trial this approach. The EAP aims to pair electricity access with demand stimulation efforts by electrifying agricultural value chain activities at new and existing mini-grid sites.

List of Figures

FIGURE 1: Average monthly consumption per mini-grid connection in 2020 by the installation year. A 60-watt incandescent lightbulb's consumption for 4 hours daily and 30 days weekly is included as a reference point.[11]

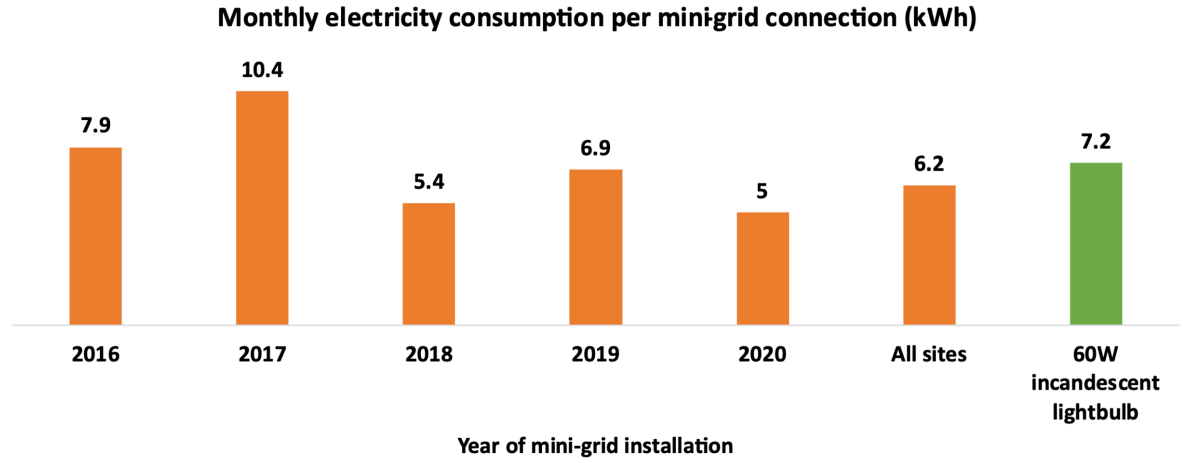
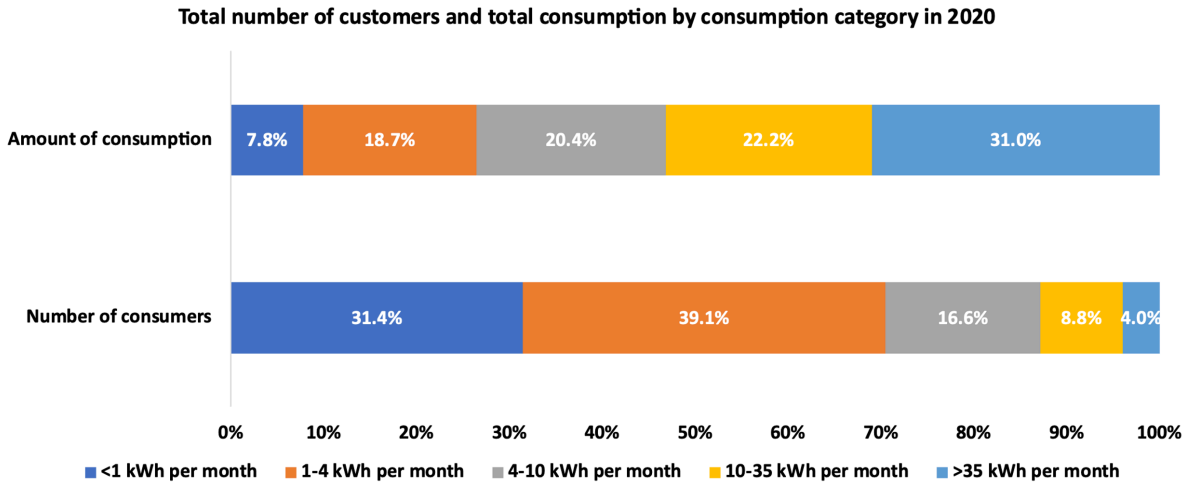


FIGURE 2: Number of customers and consumption by different electricity consumption categories for African mini-grid connections in 2020.[12]



[11] Benchmarking Africa's Minigrids Report 2022

[12] Benchmarking Africa's Minigrids Report 2022

FIGURE 3: A diesel-powered rice mill in Saachi Nku community, Niger state. Photo taken by the author in November 2023.

FIGURE 4: Average revenue generated by a connection by the installation year.