UKNIAF
United Kingdom Nigeria Infrastructure Advisory Facility

Microgrids, Interconnectivity, & Grid Stability

August 2024

The context

In 2003, UKNIAF worked on a project that trialled integrating a solar microgrid with Nigeria's national grid. The aim was to develop a replicable model for future microgrid interconnections, bearing in mind the national energy poverty rate and emerging global best practices around the deployment of microgrids to reduce energy access gaps. Interconnected microgrids enable the widespread use of neighbourhood-accessible distributed energy resources (DERs). While this technology can potentially lead to a dramatic improvement in the reliability and robustness of the power supply, it has several challenges that must be navigated.

The UKNIAF team tried to address some of these in a pilot collaboration with the Rural Electrification Agency and the Abuja Electric Distribution Company (AEDC).

Aerial view of the FMPWH advanced microgrid system

UKNIAF's intervention

UKNIAF's regional and international experts team supported the Rural Electrification Agency (REA) in clarifying and testing the configuration for integrating microgrids on the national grid using an existing microgrid (developed by EmONE). The project was executed using a multi-stage approach encompassing design and modelling studies, grid interconnection, and an impact study on grid stability.

Before UKNIAFs' involvement, the mini-grid system actively supplied reliable, renewable power to the complex where the Federal Ministry of Power (formerly Federal Ministry of Power, Works, and Housing) is based. However, despite having grid-interactive capability, the micro-grid did not export the excess capacity generated to the grid. Therefore, the excess capacity of approximately 12 MWh (over the weekend) was curtailed. In other words, the micro-grid had to draw back on electricity generation since increased production did not lead to any benefits.

This flagship project is one of the first to power the Federal Government's operations with renewables, establishing the highest commitment to the country's ambitious sustainable energy targets. It has also paved the way for other government-owned and privately-owned commercial infrastructure to be powered by clean energy.

UKNIAF worked with the AEDC to test and study the FMoP microgrid's grid export capability and its impact on grid stability. The test confirmed that with grid export from the microgrid, the grid system benefits from additional cleaner energy sources, excess generation, and stability of the grid parameters due to the generation of reactive power and installed energy storage.

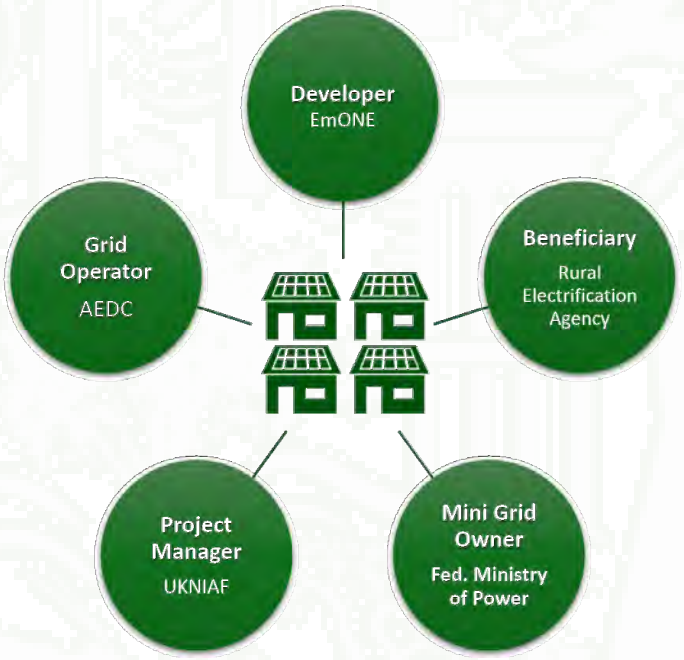
The micro grid pilot by the numbers

Photo Voltaic Capacity	**1.52 MWp**
Energy Storage Capacity	**2.28 MWh**
Generators	**2.5MVA (2MW) 2x1MVA Cummins, 1x0.5MVA Perkins**
Grid	**33/11KV 2.5MVA Transformer**
Grid Supply	**33KV OHL from AEDC**

What did we learn?

A clear description of the roles & responsibilities of the different actors in the process is crucial.

The roles and responsibilities of different actors were an issue raised at the start of the pilot, and the team, with UKNAF coordination, needed to revisit it as work progressed to navigate potential conflicts.



UKNIAF conceptualised and managed the project and provided general coordination across the project timeline. Other parties were the beneficiary, the operator, and the mini-grid developer.

All parties must agree on a workable commercial structure from the beginning.

The commercial structure could be based on an existing tariff framework or some other parameters if all parties agree.

With the UKNAF pilot, the Multi-Year Tariff Order (MYTO) and the Mini-Grid Regulations, designed by the Nigerian Electricity Regulatory Commission (NERC), provided a sound basis for commercial discussions between the parties.

The NERC Mini-grid Regulation establishes a procedure for determining the tariff for mini-grids—either using the Multi-Year Tariff Order (MYTO) methodology agreed to by all the parties and approved by NERC or set by the agreement between the registered micro-grid operator and the community. This is provided that at least sixty percent (60%) of the customers within the community consent to the pricing. In determining the tariff, it is now also important to factor in interconnection costs and projected revenue from the export/import of power from the grid.

Clear regulatory guidelines need to be in place

Relevant regulatory provisions related to the pilot project were reviewed at its commencement. The team met with the Nigeria Electricity Regulatory Commission (NERC) to clarify whether any regulatory gaps required addressing. This is critical, as evidence shows that many mini-grid projects in Africa fail because of inadequate regulatory guidance and oversight. The project team found that NERC updated its Guidelines on grid interconnection, which established specifications and procedures for interconnected mini and micro-grids.

Targeting economic & social infrastructure simultaneously with one micro-grid is strategic.

The microgrid pilot project confirmed that it is possible and strategic to target simultaneous electricity delivery to economic and social infrastructure through interconnected micro-grids. This way, the project boosts the energy resilience of critical service providers (and other key social/public infrastructure) who act as off-takers of electricity generated.

Zankli Medical Center was chosen as the off-taker for the exported power into the AEDC distribution network in the off-grid test scenario. This success of the off-grid test power export to Zankli further highlights the potential of targeting critical service providers along distribution networks as specific beneficiaries of distributed renewable energy solutions

To avoid additional costs, the design needs to align with grid features reflecting where it will be interconnected.

In its original design, the Mabushi micro-grid system was structured to be interoperable with the national grid. The micro-grid includes a centralised management system and hardware components designed with grid interconnection, export, protection, and stability functionalities, making the model interoperable with the primary grid. Without these features, extra costs would have been incurred while purchasing additional hardware components or implementing upgrades to enable the interconnection.