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Hospital Microgrids under Mini-Grid Regulation: A HOMER-Tariff Modelling Approach. The application to Riverpark Estate and the Margaret Lawrence University Teaching Hospital

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Nigeria's power sector is characterised by chronic under-supply, frequent outages, and a widespread reliance on diesel-based backup systems (Adoghe et al. 2023). For hospitals, grid connection alone rarely ensures security of supply; instead, resilience is typically achieved through redundant local generation, often associated with high life-cycle costs, fuel-price volatility, emissions, and governance risks (Babajide and Brito 2021). This paper examines the peri-urban case of the Margaret Lawrence University Teaching Hospital (MLUTH), located within Riverpark Estate in Abuja, Nigeria. Clinical operations at MLUTH require uninterrupted electricity but are currently dependent on an unreliable distribution grid and substantial generator usage amid rising diesel prices. In contrast to conventional microgrid and hospital energy studies, which primarily focus on least-cost system sizing or reporting levelized costs in isolation, this study takes a different approach (Odetoye et al. 2023). It systematically integrates technical system design with regulatory and financial modelling to assess feasibility under real-world constraints. Specifically, it couples HOMER-based microgrid simulation with the cost-of-service tariff framework developed and implemented by the Nigerian Electricity Regulatory Commission (NERC) and the African Forum for Utility Regulators (AFUR), enabling an integrated evaluation of resilience strategies under binding regulatory constraints (Nigerian Electricity Regulatory Commission 2024). Based on on-site data collection, hourly load profiles for both the hospital and the estate are reconstructed. A grid-tied, under-grid hybrid PV–battery–diesel microgrid is modelled, with critical hospital loads prioritized during islanded operation. System outputs—such as installed capacities, energy balances, fuel consumption, and life-cycle costs—are subsequently transferred into the AFUR tariff framework to derive cost-reflective end-user tariffs (NGN/kWh) and financial
indicators including LCOE, NPV, and IRR, in line with current mini-grid regulation (Nigerian Electricity Regulatory Commission 2023).

The analysis considers three configurations, each representing a distinct governance and risk-allocation model currently relevant in Nigeria's mini-grid sector. These are modelled as stand-alone 20-year scenarios to allow direct comparison: (i) an operator-led IPP supplying MLUTH under a long-term power purchase agreement (PPA); (ii) an SPV-led structure that supplies the hospital continuously while serving the estate only during grid outages; and (iii) a collaborative SPV model providing full-time supply to both the hospital and the estate, with defined responsibilities across the developer, the community, and the distribution utility (Sachiko Graber, et al. 2019).

A sensitivity analysis assesses how financing conditions, especially the weighted average cost of capital (WACC) and capital support mechanisms, affect reliability outcomes and tariff viability. The results show that integrating PV and battery storage can substantially reduce diesel reliance, shifting generator usage towards backup-only operation, while maintaining near-zero unmet demand for critical hospital loads. At the same time, the feasibility of cost-reflective tariffs is shown to depend heavily on financing conditions. While concessional or blended finance structures can keep tariffs within regulated mini-grid ranges, higher commercial WACC levels drive tariff requirements beyond current benchmarks, revealing threshold effects that are significant for both bankability and contractual design. The paper positions itself as a methodological contribution rather than a prescriptive intervention. It demonstrates how technical system design and regulatory-

tariff modelling can be integrated to support decision-making on hospital-centred microgrids under realistic outage patterns, financial constraints, and Nigeria's current regulatory landscape.

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