



Off-grid Community Systems in Nigeria: A Panel Data Estimation for Cost-Effectiveness Evaluation

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Abstract

Off-grid community systems in Nigeria aim to provide sustainable energy solutions for rural areas without access to national electricity grids. A mixed-methods approach combining econometric analysis with qualitative field studies was employed. Panel data from multiple off-grid communities were used to estimate costs, benefits, and sustainability indicators. The estimated cost-effectiveness ratio varied significantly across different community settings, with some configurations showing a return on investment within 5 years, while others took up to 10 years or more. This study provides empirical evidence for the long-term viability of off-grid systems in Nigeria and highlights the importance of tailored system design based on local conditions. Policy recommendations include targeted subsidies for less cost-effective configurations to accelerate adoption, alongside continued research into community engagement strategies. Off-Grid Systems, Cost-Effectiveness Analysis, Panel Data Estimation, Sustainable Energy Solutions The empirical specification follows $Y = \beta_{0+\beta}^{-1} p X + \text{varepsilon}$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *Geographic, Sub-Saharan, Panel Data, Econometrics, Sustainability, Energy Access, Rural Development*

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