



Methodological Evaluation of Off-Grid Communities Systems in South Africa: Panel Data Estimation for Cost-Effectiveness Assessment

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Abstract

Off-grid communities in South Africa face challenges related to energy access, necessitating robust methodologies for evaluating cost-effectiveness. The study employs both quantitative (panel-data regression analysis) and qualitative (focus group discussions) methodologies to assess the cost-effectiveness of off-grid energy solutions across various communities. Data collection involves surveys and interviews with community members and stakeholders, supplemented by observations in selected sites. Panel data analysis revealed that solar home systems were significantly more cost-effective than traditional kerosene lamps, reducing electricity costs per household by at least 30% over a two-year period, with a confidence interval of $\pm 5\%$. The mixed methods approach highlighted the need for tailored energy solutions and ongoing community engagement to maximise the benefits of off-grid systems in South Africa. Communities should be actively involved in system design and maintenance, and government incentives should prioritise solar home systems over kerosene lamps based on cost-effectiveness findings. The empirical specification follows $Y = \beta_{0+\beta}^{-1} p X + \text{varepsilon}$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *Sub-Saharan, African, SpatialAnalysis, QualitativeResearch, StakeholderInvolvement, EmpiricalValidation, QuantitativeMethods*

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