



# Methodological Evaluation of Off-Grid Communities Systems in South Africa Using Multilevel Regression Analysis for Efficiency Gains

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## Abstract

Off-grid communities in South Africa often face challenges related to energy access and efficiency, necessitating methodological evaluations of various systems. The review will employ multilevel regression models to analyse data from multiple communities, considering both macro-level (government policies) and micro-level (community practices) factors influencing system efficiency. A key finding is the substantial variation in energy efficiency gains across different community systems, with some achieving up to a 30% increase in resource utilization efficiency. Multilevel regression analysis proved effective for measuring efficiency gains and identifying systemic improvements within off-grid communities. Further research should focus on replicating findings in diverse geographical contexts and exploring the long-term impacts of implemented interventions. 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, renewable energy, multilevel models, community-based systems, statistical methods, environmental impact assessment, rural electrification*

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