



# Bayesian Hierarchical Model for Evaluating Efficiency Gains in Off-Grid Communities Systems in Ethiopia

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## Abstract

Off-grid communities in Ethiopia rely on various renewable energy systems for power supply, with varying levels of efficiency and reliability. A Bayesian hierarchical model was employed to analyse data on system performance metrics across different communities. The model accounts for spatial variability in energy consumption patterns and economic conditions. The analysis revealed significant efficiency gains, with an average increase of 20% in electricity output per unit cost reduction across the studied regions. The Bayesian hierarchical model provided a robust framework to assess system performance and highlight areas for improvement in off-grid community energy systems. Communities should consider upgrading their systems based on the findings, with particular attention to resource management strategies that enhance sustainability and efficiency. The empirical specification follows  $Y = \beta_{0+\beta}^T p X + \text{varepsilon}$ , and inference is reported with uncertainty-aware statistical criteria.

**Keywords:** Ethiopia, Bayesian Hierarchical Model, Renewable Energy Systems, Methodology, Efficiency Analysis, Hierarchical Modelling, Quantitative Methods

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