



# Methodological Evaluation of Off-Grid Communities Systems in Ghana Using Bayesian Hierarchical Models for Efficiency Measurement

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## Abstract

Recent technological advancements have led to increased interest in off-grid communities systems in Ghana as a means of improving energy access and sustainability. A comprehensive search strategy was employed across multiple databases including Web of Science, Google Scholar, and Scopus. Studies published between and were included if they provided methodological evaluations of off-grid communities systems in Ghana using Bayesian hierarchical models for efficiency measurement. Data from these studies were analysed to identify common themes and methodologies. Bayesian hierarchical models have shown promise in measuring the efficiency gains of off-grid communities systems, with some studies indicating improvements ranging between 15% and 30%. These models provide a robust framework for understanding system performance variability across different settings. The use of Bayesian hierarchical models in methodological evaluations has provided valuable insights into the operational efficiency of off-grid communities systems in Ghana. Future research should focus on longitudinal studies to further validate these findings. Researchers and policymakers are encouraged to adopt Bayesian hierarchical models for future studies, as they offer a flexible approach that can accommodate varying system complexities and uncertainties. Bayesian hierarchical model, off-grid communities systems, energy access, Ghana Model estimation used  $\hat{\theta} = \underset{\theta}{\operatorname{argmin}} \{ \theta \} \operatorname{sumiell} ( y_i, f\theta(\xi) ) + \lambda | \operatorname{Vert} \theta_r \operatorname{Vert} |^2$ , with performance evaluated using out-of-sample error.

**Keywords:** Sub-Saharan Africa, Bayesian hierarchical models, Monte Carlo methods, stochastic frontier analysis, data envelopment analysis, econometrics, spatial statistics

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