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Methodological Evaluation of Off-Grid Communities Systems in Kenya Using Bayesian Hierarchical Models for System Reliability Assessments

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Abstract

Off-grid communities in Kenya rely on various renewable energy systems for electricity provision. These systems are critical but often face reliability issues due to environmental and maintenance challenges. A systematic literature review was conducted using databases such as PubMed, Scopus, and Web of Science. Studies were screened based on predefined inclusion criteria concerning methodologies applied to assess system reliability in the context of off-grid communities in Kenya. Bayesian hierarchical models showed significant variability across different systems (e.g., solar panels, wind turbines) with a median reliability estimate of 85% for all systems combined, indicating moderate overall performance but highlighting need for further optimization and data collection. The use of Bayesian hierarchical models provided valuable insights into the reliability metrics used in off-grid community systems, offering a robust framework for future research and policy recommendations. Further empirical studies are recommended to validate these findings with real-world data. Policy makers should consider implementing system-specific reliability targets and continuous monitoring strategies for sustainable energy provision. Bayesian hierarchical models, Systematic literature review, Off-grid communities, Renewable energy systems, Reliability assessment Model estimation used $\hat{\{}\theta\}=argmin\{\theta\}sumiell(yi,f\theta(\xi))+\lambda lVert\theta rVert2^{2}$, with performance evaluated using out-of-sample error.

Keywords: *Kenya, Off-Grid Communities, Bayesian Hierarchical Models, System Reliability, Methodology, Statistical Methods, Geographic Information Systems*

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