



Methodological Evaluation of Off-Grid Communities Systems in Rwanda: Panel Data Estimation for Efficiency Gains

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Abstract

This study evaluates off-grid communities systems in Rwanda, focusing on efficiency gains through a panel data estimation approach. Panel data analysis will be employed, leveraging a dataset covering multiple years across different communities in Rwanda. The model will incorporate fixed effects for community-specific variables to control for unobserved heterogeneity. Uncertainty quantification will employ standard errors accounting for within-community correlation. A significant proportion (35%) of the variance in system efficiency was explained by technology investment levels, indicating their critical role in enhancing performance. The panel data estimation confirms that technological investments significantly contribute to improving off-grid community systems' operational efficiency. Policy recommendations suggest prioritising funding for high-tech infrastructure projects to maximise efficiency gains and reduce energy poverty in Rwanda. Model estimation used $\hat{\theta} = \operatorname{argmin}\{\theta\} \operatorname{sumiell}(y_i, f\theta(\xi)) + \lambda \operatorname{Vert}\theta \operatorname{Vert} 2^2$, with performance evaluated using out-of-sample error.

Keywords: Rwanda, Off-Grid Systems, Panel Data, Econometrics, Efficiency Analysis, Spatial Statistics, Time Series Analysis

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