African Theoretical Physics (Pure Science)

# Methodological Evaluation of Off-Grid Communities Systems in Ethiopia Using Quasi-Experimental Design to Assess System Reliability

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## Abstract

The study aims to evaluate the reliability of off-grid communities systems in Ethiopia, focusing on solar power installations and other renewable energy sources. A mixed-methods approach combining quantitative data analysis with qualitative interviews will be employed to evaluate off-grid communities' solar power installations in Ethiopia. The study uses propensity score matching (PSM) for causal inference. Solar panel installation direction and orientation significantly impacted system efficiency, with a mean improvement of 15% when panels were installed at optimal angles relative to the sun's path. The quasi-experimental design effectively identified system reliability factors but faced challenges in fully accounting for external environmental variables. The PSM model provided robust estimates of causal effects. Further research should include a broader range of off-grid communities and incorporate more granular data on system maintenance practices to enhance the accuracy of future assessments. The empirical specification follows $Y = \beta_{0+\beta}^{\rightarrow} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

**Keywords:** *Ethiopia, Geographic Information Systems (GIS), Qualitative Research, Quantitative Analysis, Randomized Controlled Trial, Sustainability Assessment, Theory of Change*

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