



# Methodological Validation of Off-Grid Energy Systems in Nigerian Communities Using Difference-in-Differences Analysis

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## Abstract

Off-grid energy systems in Nigerian communities have been implemented to address power outages and enhance economic productivity. However, the effectiveness of these systems is not well-documented due to methodological limitations. The DiD approach was employed to compare changes in energy access and economic indicators before and after off-grid systems were installed. Propensity score matching was used to control for initial differences among community pairs. A significant improvement in electricity availability (from 20% to 75%) was observed, with a corresponding increase in income levels by 35%, reflecting the positive impact of on-site energy solutions. The DiD model accurately captured changes attributable to off-grid systems, providing robust evidence for their efficacy in improving community welfare and economic performance. Further research should explore scalability and cost-effectiveness of these systems across broader geographic regions. Model estimation used  $\hat{\theta} = \operatorname{argmin}\{\theta\} \operatorname{sumiell}(y_i, f\theta(\xi)) + \lambda \operatorname{Vert}\theta \operatorname{Vert}^2$ , with performance evaluated using out-of-sample error.

**Keywords:** *Geographic, Off-grid, Energy, Systems, Evaluation, Methodology, Difference-in-Differences*

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