



# Methodological Evaluation of Off-Grid Communities Systems in Ethiopia Using Difference-in-Differences for Efficiency Gains Analysis

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### Abstract

Off-grid communities in Ethiopia face significant challenges in accessing reliable electricity, necessitating the deployment of off-grid renewable energy systems (ORES). These systems are often designed and implemented without comprehensive evaluations of their efficiency. A difference-in-differences approach was employed to assess the impact of ORES on energy access and usage within targeted Ethiopian off-grid communities. Data from pre- and post-ORES implementation periods were analysed using statistical software to estimate model parameters. The DiD analysis revealed a statistically significant increase in electricity consumption ( $p < 0.05$ ) among the intervention group compared to control areas, indicating potential improvements in efficiency gains. This study provides empirical evidence supporting the efficacy of ORES in enhancing energy access and usage within Ethiopian off-grid communities. The findings suggest that ongoing monitoring and periodic upgrades are essential for sustaining these systems' optimal performance. Off-Grid Communities, Difference-in-Differences, Energy Efficiency, Renewable Energy Systems Model estimation used  $\hat{\theta} = \underset{\theta}{\operatorname{argmin}} \{ \theta \} \operatorname{sumiell} ( y_i, f\theta(\xi) ) + \lambda \operatorname{Vert}\theta \operatorname{rVert}^2$ , with performance evaluated using out-of-sample error.

**Keywords:** Ethiopia, Off-grid, Renewable Energy Systems, Methodology, Difference-in-Differences, Efficiency Gains, Sub-Saharan Africa

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