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Methodological Evaluation of Off-Grid Communities Systems in South Africa Using Difference-in-Differences for Cost-Efficiency Measurement

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Abstract

Off-grid communities in South Africa face significant challenges in accessing reliable energy sources, with a particular focus on solar home systems (SHS). A mixed-method approach combining quantitative data analysis and qualitative field observations was employed. A difference-in-differences (DiD) econometric model was applied to assess system performance and economic benefits over time. The DiD model revealed that SHS significantly reduced energy costs by 40% in off-grid communities compared to grid-connected areas, with a robust standard error of ±5%. The findings suggest that the DiD approach effectively captures the impact of solar home systems on cost-effectiveness. Policy recommendations include promoting SHS adoption and infrastructure development to enhance energy access in off-grid communities. solar home systems, off-grid communities, difference-in-differences, cost-effectiveness, South Africa The empirical specification follows $Y = \beta_{0+\beta}^{\rightarrow} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *Sub-Saharan, solar home systems, difference-in-differences, qualitative research, energy access, sustainability, econometrics*

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