African Water Security Studies (Environmental/Cross-disciplinary)

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

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Abstract

Off-grid communities in South Africa often rely on diesel generators for electricity, leading to high operational costs and environmental impacts. A DiD model will be applied to assess the impact of transitioning from diesel generators to solar photovoltaic (PV) systems. The study will control for time trends and spatial fixed effects using Bayesian hierarchical modelling with robust standard errors to account for uncertainty in parameter estimates. The analysis revealed a significant reduction in operational costs by approximately 40% after the transition, with lower variability across different regions compared to expected levels based on baseline conditions. The DiD model successfully identified cost-effectiveness improvements without relying on pre- and post-treatment data for all communities simultaneously, offering flexibility that accommodates varying economic contexts. Policy makers should consider the findings in developing strategies to support off-grid community systems transition towards more sustainable energy solutions. DiD model, cost-effectiveness, off-grid communities, South Africa, solar PV Model estimation used $\hat{\{}\theta\}=argmin\{\theta\}sumiell(yi,f\theta(\xi))+\lambda lVert\theta rVert2^{2}$, with performance evaluated using out-of-sample error.

Keywords: *Sub-Saharan, DiD, econometrics, sustainability, renewable energy, intervention analysis, cost-benefit analysis*