African Forest Ecology (Environmental Science)

Methodological Evaluation of Off-Grid Communities Systems in Senegal Using Panel Data for Efficiency Measurement

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Abstract

Off-grid communities in Senegal are increasingly relying on renewable energy systems to meet their electricity needs. These systems often operate outside of national grid networks and require efficient management to ensure sustainable use. The study employs a Data Envelopment Analysis (DEA) framework to assess the operational efficiency of these systems. A stochastic frontier analysis (SFA) is also utilised to incorporate technical inefficiencies into the model, providing insights into cost-saving measures. Panel data reveals that off-grid system efficiencies vary significantly across different communities in Senegal, with some showing a potential for improvement by up to 30% through targeted capacity building and policy adjustments. The findings suggest that tailored interventions could enhance the efficiency of off-grid systems, thereby reducing costs and improving sustainability. Policy makers are encouraged to develop and implement strategies aimed at increasing the operational efficiency of off-grid energy systems in Senegal. This includes providing training programmes for community members and implementing supportive policies. The empirical specification follows $Y = \beta_{0+\beta}^{\rightarrow} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *Sub-Saharan, Africa, Polytomous-FASE, Panel-Data, Empirical-Methods, Resource-Mapping, Energy-Efficiency*

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