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Hybrid Solar-Powered Irrigation Systems in Northern Nigeria's Semi-Arid Regions: Cost-Effectiveness Analysis Over Five Seasons

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Abstract

Hybrid solar-powered irrigation systems have shown promise in addressing water scarcity issues in semi-arid regions of northern Nigeria. The study employed a mixed-method approach combining economic modelling and field data collection to assess system performance and financial viability. During the study period, the average cost per hectare for irrigation was reduced by 25% when using hybrid solar systems compared to conventional diesel-powered systems, with an estimated range of ±3% due to varying climate conditions and operational inefficiencies. Hybrid solar-powered irrigation systems demonstrated significant cost savings over five seasons, providing a viable alternative for farmers in semi-arid regions. Investment strategies should prioritise the adoption of hybrid solar systems for sustainable agricultural development in northern Nigeria’s semi-arid zones. hybrid solar systems, irrigation, cost-effectiveness, semi-arid regions, economic modelling The empirical specification follows $Y = \beta_{0+\beta}^{\rightarrow} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *Semi-Arid Regions, Nigeria, Hybrid Systems, Renewable Energy, Cost-Benefit Analysis, Sustainability, Irrigation Technology*