



Renewable Energy Integration and Smallholder Farmer Livelihoods in Rural Rwanda: A Five-Year Sustainability Analysis

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Abstract

Rural Rwanda faces significant energy challenges due to limited access to modern energy sources, particularly for smallholder farmers who rely on traditional biomass fuels for cooking and lighting. Renewable energy integration could offer a viable solution to improve energy security and livelihoods. Qualitative case studies were conducted on selected RE projects; data collection included farmer surveys, focus group discussions, and stakeholder interviews. Project performance metrics such as energy production capacity, cost-effectiveness, and social impact were analysed. Renewable energy integration led to a significant increase in household energy access by 85% among participating smallholder farmers, though initial costs were substantial at an average of \$100 per household. Long-term sustainability was compromised by limited government support and high maintenance costs. While renewable energy projects provided immediate benefits, long-term viability requires robust policy frameworks supporting infrastructure development and financial incentives for rural communities. Government should prioritise funding for RE integration in rural areas, establish clear guidelines for project implementation, and implement policies to ensure equitable access to technology and resources. Partnerships with NGOs and private sector entities can help bridge the financing gap.

Keywords: *Rwanda, Smallholder Agriculture, Renewable Energy, Sustainability Analysis, Livelihoods Enhancement, Development Economics, Case Study Methodology*

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