



# Microgrid Integration and Renewable Energy Access in Northern Ghanaian Villages: Economic and Environmental Performance Analysis

Sanga Mwakabika<sup>1</sup>, Kamanda Matunga<sup>2,3</sup>, Shumba Ndagire<sup>3,4</sup>

<sup>1</sup> Nelson Mandela African Institution of Science and Technology (NM-AIST), Arusha

<sup>2</sup> Department of Interdisciplinary Studies, State University of Zanzibar (SUZA)

<sup>3</sup> Department of Advanced Studies, Catholic University of Health and Allied Sciences (CUHAS)

<sup>4</sup> Department of Advanced Studies, Nelson Mandela African Institution of Science and Technology (NM-AIST), Arusha

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**Correspondence:** [smwakabika@gmail.com](mailto:smwakabika@gmail.com)

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## Author notes

*Sanga Mwakabika is affiliated with Nelson Mandela African Institution of Science and Technology (NM-AIST), Arusha and focuses on Energy research in Africa.*

*Kamanda Matunga is affiliated with Department of Interdisciplinary Studies, State University of Zanzibar (SUZA) and focuses on Energy research in Africa.*

*Shumba Ndagire is affiliated with Department of Advanced Studies, Nelson Mandela African Institution of Science and Technology (NM-AIST), Arusha and focuses on Energy research in Africa.*

## Abstract

Microgrids are emerging as a critical solution for enhancing renewable energy access in remote areas of sub-Saharan Africa, particularly in northern Ghanaian villages where traditional grid infrastructure is unreliable or inaccessible. A mixed-methods approach was employed, combining quantitative surveys with qualitative interviews to gather data from 100 randomly selected villages. Data were analysed using descriptive statistics and thematic analysis. Microgrids demonstrated an average cost reduction of 25% compared to diesel generators, which is statistically significant at the  $p < 0.05$  level (t-test). The findings suggest that microgrid integration can significantly improve energy access and reduce environmental impacts in northern Ghanaian villages. Policy makers are encouraged to consider subsidies for microgrid projects and promote further research on their long-term benefits. Microgrids, Renewable Energy Access, Northern Ghana, Cost-Effectiveness Analysis The empirical specification follows  $Y = \beta_{0+\beta} p X + \text{varepsilon}$ , and inference is reported with uncertainty-aware statistical criteria.

**Keywords:** Sub-Saharan, Africa, Microgrids, Renewable, Energy, Sustainability, Economic Impact

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