

Electric Power Distribution Challenges and Renewable Energy Integration for Sustainable Development: Evidence from Kano Electricity Distribution Company (KEDCO)

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ABSTRACT

This paper examines the major challenges affecting electricity distribution within the service area of Kano Electricity Distribution Company (KEDCO) and explores how renewable energy solutions can contribute to sustainable development. Drawing on evidence from policy reports, operational records, and relevant literature, the study highlights persistent issues such as network instability, aging infrastructure, inadequate metering, energy losses, and financial limitations. The analysis further shows that renewable energy technologies, particularly solar mini-grids, hybrid systems, and smart-grid applications, can complement existing infrastructure and improve service delivery. Recent initiatives undertaken by KEDCO, including solar projects and the Safe Grid programme, demonstrate the growing relevance of decentralized energy systems in northern Nigeria. The study concludes that a combination of infrastructure modernization, regulatory support, and renewable energy deployment is necessary to improve reliability, increase energy access, and support long-term economic development.

KEYWORDS

Electric power distribution, Distribution challenges, Renewable energy integration, Sustainable Development

I. INTRODUCTION

Reliable electricity supply remains an essential requirement for economic growth, industrial productivity, and improved living standards. In Nigeria, however, electricity distribution continues to face numerous operational and structural constraints. KEDCO, which serves Kano, Katsina, and Jigawa States, operates within an environment characterized by increasing demand, rapid urban growth, and significant gaps in energy access. These realities place considerable pressure on distribution infrastructure and service delivery. At the same time, global and national efforts toward cleaner energy sources provide an opportunity to address some of these challenges through renewable energy integration. Consequently, understanding the relationship between distribution challenges and renewable energy adoption has become increasingly important.

II. THEORETICAL FRAMEWORK

This study draws from Sustainable Development Theory, Energy Transition Theory, and Systems Theory. Sustainable Development Theory emphasizes the need to balance economic advancement, social welfare, and environmental protection. Energy Transition Theory explains the gradual movement from conventional centralized energy systems toward cleaner and more decentralized alternatives. Systems Theory views the electricity sector as an interconnected structure in which technical, financial, institutional, and regulatory components influence one another. Together, these perspectives provide a useful basis for understanding the complex nature of electricity distribution and the role of renewable energy in addressing existing shortcomings.

III. METHODOLOGY

A mixed-methods approach was adopted to provide a comprehensive understanding of the issues under investigation. Quantitative information relating to electricity losses, billing performance, and power allocation was reviewed alongside qualitative evidence obtained from policy documents, stakeholder reports, and relevant studies. The combination of numerical and descriptive evidence enabled a broader assessment of operational realities within KEDCO's distribution network.

IV. KEY FINDINGS

The analysis revealed that inadequate power supply, deteriorating infrastructure, and high technical and commercial losses continue to affect service delivery. Energy theft, poor metering coverage, and revenue collection challenge further weaken operational performance. In addition, financial constraints and inconsistent policy implementation limit investment opportunities and slow infrastructure upgrades. Despite these difficulties, the region possesses considerable renewable energy potential, particularly in solar energy. Ongoing mini-grid and embedded generation projects indicate gradual progress toward diversifying energy sources and improving electricity access.

V. DISCUSSION

The findings suggest that conventional grid expansion alone may not adequately address the electricity challenges facing KEDCO. While improvements to existing infrastructure remain necessary, renewable energy technologies offer additional pathways for enhancing reliability and expanding access. Solar mini-grids, hybrid generation systems, and smart-grid technologies can help reduce dependence on the national grid while supporting underserved communities. Nevertheless, the success of these initiatives depends on effective regulation, sustained investment, technical expertise, and strong institutional support.

VI. CONCLUSION

KEDCO's electricity distribution challenges are multidimensional and require coordinated responses from policymakers, regulators, investors, and utility operators. Renewable energy integration presents a practical opportunity to complement existing infrastructure and improve overall system performance. A balanced strategy that combines grid modernization with decentralized renewable energy solutions is likely to contribute to greater energy security, economic growth, and sustainable development across the region.

RECOMMENDATIONS

- Modernize existing distribution infrastructure.
- Expand smart metering and grid management systems.
- Support investment in renewable energy projects.
- Strengthen regulatory oversight and policy consistency.
- Encourage public-private partnerships.
- Improve workforce capacity through training and development.
- Promote decentralized energy solutions for underserved communities.

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