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INNOVATIVE ENTREPRENEURSHIP AS A CATALYST FOR SUSTAINABLE RENEWABLE ENERGY DEVELOPMENT AND CAPACITY BUILDING IN NIGERIA'S EMERGING ECONOMIES

Ovundah, Azubuike[1] Allison Sidney Sunju[2]
Correspondence email address: *ovundahazubuike1@gmail.com*
Department of Electrical/Electronic Technology, Federal College of Education (Technical), Ekiadolor, Edo State
Department of Industrial Technical Education, Ignatius Ajuru University of Education

Abstract: *Nigeria continues to face substantial electricity-access and reliability challenges, creating a need for decentralized and sustainable energy solutions. This paper examines the role of innovative entrepreneurship in advancing renewable energy development and capacity building in Nigeria. The paper adopts a critical narrative review approach, drawing on relevant policy documents, development reports and scholarly literature on decentralized renewable energy, entrepreneurship, skills development and energy access. The review indicates that entrepreneurial activity can contribute to renewable energy development through innovative business models, localized technological adaptation, productive-use applications, private sector led mini grid deployment and enterprise based skills development. Evidence from Nigeria's electrification programmes also shows the practical importance of private-sector participation in the deployment of solar mini-grids and standalone solar systems. However, the expansion of renewable energy enterprises remains constrained by financing requirements, regulatory and institutional challenges, infrastructure limitations, affordability and shortages of appropriately skilled personnel. The paper argues that entrepreneurship should be considered alongside technology, finance, regulation and human-capital development in Nigeria's energy transition strategy. It recommends improved access to patient and risk sharing finance, coherent regulation, support for local renewable energy supply chains, stronger partnerships between renewable energy enterprises and technical and vocational institutions, and consumer oriented financing and awareness programmes. These measures can strengthen the capacity of enterprises to expand clean energy access while contributing to employment, technical skills development and inclusive economic development.*
Keywords: *Innovative Entrepreneurship; Renewable Energy; Energy Access; Capacity Building and Mini-Grids*

Introduction

Reliable and affordable electricity is essential for enhancing economic productivity, supporting educational activities, improving healthcare delivery, and promoting the growth of small and medium-sized enterprises. Despite its importance, Nigeria continues to face a significant electricity access deficit, coupled with unreliable power supply among many connected consumers. The World Bank reported that over 85 million Nigerians lacked access to electricity as of 2021, while petrol and diesel powered generators remained important alternatives for meeting electricity needs. More recently, the World Bank identified distributed renewable energy solutions, particularly solar mini-grids and standalone solar systems, as important strategies for extending electricity access to underserved communities (World Bank, 2024). The issue extends beyond merely increasing power generation; it encompasses the financing, delivery, maintenance, and contextual adaptation of electricity services for underserved communities. The Nigeria Electrification Project was designed around private-sector-led solar hybrid mini-grids and standalone solar systems, demonstrating an institutional shift toward decentralized approaches and entrepreneurial participation in electricity provision (World Bank, 2018). The subsequent Distributed Access through Renewable Energy Scale-up programme further emphasizes distributed renewable-energy solutions and innovative financing mechanisms (World Bank, 2023).

Nigeria has substantial renewable energy resources, while national policy documents recognize the importance of renewable energy and energy efficiency in the country's energy development pathway (Energy Commission of Nigeria, 2015; Federal Republic of Nigeria, 2022). Studies of Nigeria's future energy system have also identified solar photovoltaics and storage as important components of pathways

toward a more sustainable electricity system (Oyewo et al., 2018). These opportunities, however, require more than technological availability. They require enterprises and workers with the capacity to design, install, operate, maintain, finance and commercially manage renewable energy systems. Innovative entrepreneurship provides a useful lens for examining this interaction between technology, markets and human capacity. Schumpeter (1934) associated entrepreneurship with the creation of new combinations and economic change. In renewable energy, this perspective can be applied to new business models, decentralized service delivery, technology adaptation, productive use applications, financing arrangements and enterprise led skills development. The relevance of entrepreneurship is particularly apparent where conventional infrastructure approaches do not adequately reach dispersed or underserved consumers.

The purpose of this paper is therefore to examine how innovative entrepreneurship can contribute to sustainable renewable energy development and capacity building in Nigeria. The paper focuses on four interconnected areas: innovative business models; technological and service adaptation; private-sector and institutional participation; and human-capital development. It also examines barriers that can restrict entrepreneurial activity and proposes policy pathways for strengthening the contribution of renewable-energy enterprises.

Methodology

The study adopted a critical narrative review design. The approach involved examination and synthesis of scholarly literature, Nigerian policy documents and reports from recognized development and energy institutions relating to renewable energy development, electricity access, decentralized energy systems, entrepreneurship, private-sector participation and capacity building. Particular attention was given to evidence directly concerning Nigeria and to authoritative sources describing Nigerian electricity access programmes and renewable-energy policy. The literature was examined thematically rather than statistically. Evidence was organized around the following themes: innovative entrepreneurship and renewable energy business models; decentralized renewable energy deployment; productive uses of renewable electricity; capacity building and skills development; financing and regulatory barriers; and policy measures for enterprise development. The purpose of the review was not to estimate an effect size but to develop an integrated explanation of how entrepreneurship can interact with renewable energy technology, institutions, finance and human capital in Nigeria.

Innovative Entrepreneurship and Renewable Energy Development

Innovative entrepreneurship extends beyond the establishment of a business to include the identification of unmet needs and the development of new combinations of technologies, resources, services and markets. Schumpeter's (1934) conception of entrepreneurship is useful because renewable energy enterprises often create value by combining existing technologies with new methods of financing, distribution and service delivery. One important entrepreneurial pathway is business-model innovation. Distributed energy systems can reduce the need for large centralized infrastructure by bringing electricity services closer to underserved consumers. Pay-as-you-go arrangements, lease-to-own models, service contracts and other flexible payment mechanisms can address the problem of high initial costs for households and small businesses. The Nigerian Electrification Project explicitly incorporated private sector participation in solar hybrid mini-grids and standalone solar systems, demonstrating how decentralized energy provision can be organized through market oriented delivery mechanisms (World Bank, 2018).

A second pathway is technological and service adaptation. Renewable energy systems must be designed and maintained in ways that reflect local environmental, technical and consumer conditions. Entrepreneurs can provide value by adapting system sizes, maintenance arrangements, customer support, monitoring systems and productive-use applications to local demand. The importance of decentralized solutions is reflected in the World Bank's account of Nigeria's electrification programmes,

which identifies solar mini-grids and standalone systems as mechanisms for reaching underserved consumers (World Bank, 2023, 2024).

A third pathway concerns productive use. Electricity becomes more economically meaningful when it supports activities such as small-scale processing, refrigeration, irrigation, communications, retail services and other income-generating activities. The design of Nigeria's electrification programme recognized the importance of productive uses in mini-grid development (World Bank, 2018). Entrepreneurs can therefore connect energy provision with local economic activity, creating a business relationship in which electricity is not merely a household service but an input into production.

A fourth pathway is financial innovation. Renewable energy enterprises commonly require significant initial investment while serving consumers whose ability to pay may be limited or irregular. Public finance, concessional finance, guarantees, results-based financing and private investment can therefore interact with entrepreneurial delivery models. The African Development Bank's Nigeria Country Focus Report emphasizes the need for increased private sector participation in financing climate and green growth activities (African Development Bank, 2023).

Renewable Energy Development in Nigeria: From Potential to Practice

Nigeria's renewable energy transition is supported by national policy and by evidence that decentralized renewable systems can expand electricity access. The approved National Renewable Energy and Energy Efficiency Policy provide a policy framework for expanding renewable energy and energy efficiency in Nigeria (Energy Commission of Nigeria, 2015). The revised National Energy Policy also emphasizes renewable energy development as part of the country's sustainable socio-economic development pathway (Federal Republic of Nigeria, 2022).

At the implementation level, the Nigeria Electrification Project illustrates the practical role of private sector participation. The World Bank project documentation identifies solar hybrid mini-grids for rural economic development and standalone solar systems for homes and enterprises among its components. The project design also emphasized private sector investment, affordable tariffs and the integration of productive uses into mini-grid development (World Bank, 2018).

The experience of the Nigeria Electrification Project provides an important example of entrepreneurship operating within a public policy framework. The World Bank subsequently reported that the project had supported 125 hybrid mini-grids and more than one million solar home systems, providing electricity access to more than five million people and creating more than 5,000 green jobs. The same programme informed the development of the Distributed Access through Renewable Energy Scale-up initiative, which seeks to expand distributed renewable energy access further (World Bank, 2023).

These developments suggest that the relationship between entrepreneurship and renewable energy development is not necessarily a choice between public and private provision. Rather, public institutions can establish policy, financing and regulatory frameworks while private enterprises contribute investment, innovation, construction, operation, maintenance and customer oriented service delivery. This interaction is particularly relevant for communities where conventional grid expansion may be difficult or slow.

Capacity Building through Renewable Energy Entrepreneurship

Renewable energy development depends on human capacity as well as physical infrastructure. Solar photovoltaic systems, battery storage, mini-grids, control equipment and associated electrical installations require personnel capable of planning, installation, testing, commissioning, troubleshooting and maintenance. Capacity building is therefore an essential component of sustainable deployment. Entrepreneurial firms can contribute to capacity building through apprenticeships, workplace learning, installation teams, after-sales services and partnerships with technical and vocational education institutions. Such arrangements can expose learners and entry-level technicians to current equipment,

installation procedures, customer requirements and maintenance practices. They can also create opportunities for graduates to move from training into employment or self-employment.

The employment dimension is also relevant to Nigeria's green transition agenda. The African Development Bank's 2023 Nigeria Country Focus Report identifies private-sector participation as important to climate and green-growth financing and emphasizes the country's need for investment that supports sustainable economic transformation (African Development Bank, 2023). In addition, Nigeria's distributed renewable energy programmes have already incorporated employment and productive use objectives (World Bank, 2023). The implication for technical and vocational education is that curriculum development should remain connected to the competencies demanded by renewable energy enterprises. Training can emphasize system design, photovoltaic installation, battery and inverter systems, electrical safety, testing, fault diagnosis, preventive maintenance, customer service and basic entrepreneurship. Partnerships with enterprises can complement classroom instruction by providing practical exposure and opportunities for supervised workplace learning.

Barriers to Renewable Energy Entrepreneurship

Despite the opportunities presented by decentralized renewable energy, several constraints can limit entrepreneurial growth. The first is finance. Renewable-energy enterprises may require substantial capital for equipment, inventory, installation teams and customer acquisition before revenue becomes predictable. The African Development Bank has emphasized the importance of mobilizing private sector financing for climate and green growth in Nigeria (African Development Bank, 2023).

The second barrier is regulatory and institutional coordination. Entrepreneurs operate within electricity market, licensing, technical, environmental and consumer protection frameworks. Predictable rules and clear institutional responsibilities can reduce uncertainty and transaction costs. Nigeria's electricity reforms and decentralized energy programmes have increasingly created a framework for private participation, but effective implementation remains important to enterprise confidence and investment.

The third barrier is infrastructure and supply chains. Renewable energy enterprises require transportation, communications, storage facilities, spare parts and reliable access to equipment. Exchange rate pressures and dependence on imported components can affect project costs and delivery schedules. Local manufacturing, assembly, servicing and distribution can therefore strengthen the resilience of the renewable-energy entrepreneurial ecosystem.

The fourth barrier is technical capacity. Inadequate numbers of appropriately trained technicians can increase installation and maintenance costs and reduce system reliability. Enterprise-led training and stronger collaboration between renewable-energy firms and technical and vocational institutions can help address this constraint.

The fifth barrier is consumer affordability and awareness. Although decentralized renewable systems can reduce dependence on generators, consumers still face initial and recurring costs. Flexible financing, transparent pricing, quality standards, warranties and consumer education can help build confidence and expand the market.

Conclusion

Innovative entrepreneurship has an important potential role in Nigeria's renewable-energy transition because enterprises can combine technology with financing, market development, service delivery and human capital development. Evidence from Nigeria's electrification programmes demonstrates that private-sector-led solar mini-grids and standalone solar systems can form part of a broader strategy for extending electricity access to underserved consumers. The contribution of entrepreneurship should nevertheless be understood within a wider institutional system. Renewable-energy enterprises require enabling regulation, finance, infrastructure, technical skills and consumer confidence. Likewise, renewable-energy deployment requires a workforce capable of installing, operating, maintaining and

improving the technologies being introduced. Consequently, sustainable energy development and capacity building should be treated as interconnected elements of Nigeria's energy strategy.

The paper concludes that strengthening the entrepreneurial ecosystem around renewable energy can support multiple development objectives, including electricity access, productive economic activity, technical skills development and employment. Future research should complement the literature reviewed here with empirical studies of renewable-energy enterprises, technicians, consumers and training institutions in different regions of Nigeria. Such studies would provide stronger evidence on the specific entrepreneurial models and capacity-building practices that produce sustainable outcomes.

Policy suggestions and Pathways Forward

1. Expand access to patient and risk-sharing finance: Government and development-finance institutions should strengthen guarantees, concessional finance and results-based financing mechanisms that reduce the initial risk of decentralized renewable-energy projects. Financing arrangements should be designed to attract private capital while maintaining affordability for underserved consumers.

2. Strengthen regulatory coherence: Relevant federal and state institutions should provide clear, predictable and coordinated requirements for mini-grid development, distributed generation, tariffs, technical standards and consumer protection. Consistent implementation can reduce uncertainty for renewable-energy entrepreneurs.

3. Support local renewable-energy supply chains: Policies should encourage domestic assembly, servicing and, where economically feasible, manufacturing of renewable-energy components. Local supply chains can reduce dependence on imported equipment and create additional technical and entrepreneurial opportunities.

4. Institutionalize enterprise-based capacity building: Technical and vocational institutions should establish structured partnerships with renewable-energy firms for curriculum co-development, supervised industrial training, apprenticeships, certification and continuing professional development. Such partnerships can improve the alignment between training outcomes and workplace requirements.

5. Promote productive-use applications and consumer awareness: Renewable-energy programmes should support applications that enable households and small enterprises to generate income from electricity access. Consumer education should also address system quality, warranties, maintenance, financing options and realistic performance expectations.

6. Strengthen monitoring and evidence generation: Renewable-energy programmes should systematically document deployment, reliability, employment, training outcomes, productive-use impacts and consumer experience. Better evidence would help policymakers and entrepreneurs identify which business and financing models are scalable in different Nigerian contexts.

References

African Development Bank. (2023). Country focus report 2023: Nigeria Mobilizing private sector financing for climate and green growth. African Development Bank.

Energy Commission of Nigeria. (2015). National renewable energy and energy efficiency policy. Federal Republic of Nigeria.

Federal Republic of Nigeria. (2022). Revised national energy policy. Federal Republic of Nigeria.

Oyewo, A. S., Aghahosseini, A., Bogdanov, D., & Breyer, C. (2018). Pathways to a fully sustainable electricity supply for Nigeria in the mid-term future. Energy Conversion and Management, 178, 44–64. https://doi.org/10.1016/j.enconman.2018.10.036

Schumpeter, J. A. (1934). The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle. Harvard University Press.

World Bank. (2018). Nigeria electrification project. World Bank.

World Bank. (2023, December 15). Nigeria to expand access to clean energy for 17.5 million people. World Bank.

World Bank. (2024). Tracking SDG 7: The energy progress report 2024. World Bank. https://doi.org/10.1596/978-92-3-100183-0