

**ANALYSIS OF THE ENVIRONMENTAL AND SOCIO-ECONOMIC  
IMPACTS OF DECENTRALIZED POWER GENERATION IN  
SELECTED STATES UNDER THE ELECTRICITY ACT 2023 IN  
NIGERIA**

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**Abstract**

*In light of the Electricity Act of 2023, this study investigates the economical and environmental effects of decentralized power generation (DPG) in the states of Nigeria. In order to supply rural and underserved communities with dependable and reasonably priced electricity, the Act supports small-scale, autonomous, and frequently renewable energy sources. DPG may improve energy availability, lower transmission losses, and advance sustainable development by utilizing regional renewable resources. Nevertheless, obstacles including inconsistent policies, unclear regulations, and limited funding make it difficult to carry out DPG programs successfully. To assist DPG projects, it is suggested to create a national renewable energy fund, a national renewable energy agency, and a national renewable energy policy.*

**Keywords:** Decentralized Power Generation; Renewable Energy; Electricity Act 2023; Energy Access; Sustainable Development

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## 1.0 INTRODUCTION

Nigeria is the most populous country and the largest economy in Africa, with a fast-growing demand for energy that is key to unlocking further economic development. However, the country faces many challenges in providing adequate, reliable, and sustainable energy services for its people, especially in rural and underserved areas.<sup>1</sup>

Nigeria's primary energy supply is mainly derived from petroleum reserves, natural gas, hydroelectricity, and solar. The country remains a top producer of crude oil and natural gas in Africa, accounting for about 90% of its export earnings and 60% of its government revenue.<sup>2</sup> However, the oil and gas sector is plagued by inefficiencies, corruption, environmental degradation, and social conflicts, especially in the Niger Delta region where most of the resources are located.

Despite having an installed capacity of about 13,000 megawatts (MW), the country only generates about 4,000 MW on average, far below the estimated demand of 32,000 MW.<sup>3</sup> The electricity access rate is about 60%, leaving 45% of the population without electricity, mostly in rural areas. The electricity supply is also unreliable and costly, forcing many households and businesses to rely on backup generators that run on expensive and polluting diesel or gasoline.<sup>4</sup>

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<sup>1</sup> Doris Dokua Sasu Energy sector in Nigeria - statistics & facts | Statista 2023

<sup>2</sup> Ibid

<sup>3</sup> Ibid

<sup>4</sup> IEA (2023), *SDG7: Data and Projections*, IEA, Paris <https://www.iea.org/reports/sdg7-data-and-projections>

Nigeria has a huge potential for renewable energy development, especially from solar, wind, biomass, and hydro sources. The country receives an average solar radiation of 5.5 kWh/m<sup>2</sup>/day, has abundant wind energy resources in the northern and coastal regions, and has large deposits of biomass from agricultural and forestry residues.<sup>5</sup> The country also has enormous hydro-power resources from the Niger and Benue rivers, as well as numerous small and medium-sized rivers and streams.<sup>6</sup> However, these renewable energy resources remain largely untapped, due to lack of adequate policies, incentives, infrastructure, and financing.

Nigeria has adopted several policies and initiatives to address its energy challenges and promote sustainable development. The National Energy Policy (2003) provides a framework for the diversification of the energy mix, the development of renewable energy, the improvement of energy efficiency, and the protection of the environment.

The Electricity Act (2023) provides a legal and institutional basis for the liberalization and regulation of the electricity sector, as well as the establishment of the Rural Electrification Agency and the Rural Electrification Fund. The National Renewable Energy and Energy Efficiency Policy (2015) set targets and strategies for increasing the share of renewable energy and improving energy efficiency in the country. The Nigeria Vision 20:2020 and the Economic Recovery and Growth Plan (2017-2020) also identify the energy sector as a key driver of economic growth and social development.

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<sup>5</sup> Ajayi, O. O., & Ajanaku, K. O.. Nigeria's Energy Challenge and Power Development: The Way Forward. (2009) *Energy & Environment*, 20(3), 411–413.

<sup>6</sup> Eghosa Osa Ekhaton, 'Public Regulation of the Oil and Gas Industry in Nigeria: An Evaluation' (2016) 21 *Ann Surv Int'l & Comp L* 43

However, the implementation of these policies and initiatives has faced many challenges and barriers, such as institutional weaknesses and social resistance.

## **2.0 SIGNIFICANCE OF DECENTRALIZED POWER GENERATION**

Decentralized power generation is the production of electricity from sources that are distributed across a geographic area, rather than centralized in a single location. Decentralized power generation can offer many benefits, such as:

- i. Reducing transmission losses and increasing energy efficiency
- ii. Enhancing reliability and resilience of the power system

The significance of DPG has been emphasized by several scholars. Notably, Zalengera explores the interplay between local governance and DPG in Kenya and Malawi, two countries that have adopted decentralization policies to foster socio-economic development. The author argue that the quality and dynamics of local and national governance structures are crucial for the delivery and sustainability of DPG services, and propose an analytical framework to enable more effective local governance within energy access initiatives in the Global South.<sup>7</sup>

Also, several scholars also benchmark the impact of DPG on the physical characteristics and investments of power distribution networks across 23 European countries. The authors use a cluster analysis to derive six groups of countries that display statistically homogenous characteristics, and highlight the heterogeneity of DPG indicators across Europe due to physical

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<sup>7</sup> Zalengera, C., To, L.S., Sieff, R. *et al.* Decentralization: the key to accelerating access to distributed energy services in sub-Saharan Africa? *J Environ Stud Sci* **10**, 270–289 (2020)

constraints, historic legacies, or policy and regulatory choices. The authors suggest that their results can help decision makers and regulators to identify the main issues and possible solutions for their countries in relation to DPG.<sup>8</sup>

Furthermore, Pincus provides an overview of the different forms and applications of DPG, such as microgrids, cogeneration, and hybrid systems. The author illustrates how DPG can offer flexibility, efficiency, and resilience to various energy consumers and producers, such as industrial plants, rural communities, and islands. The author also highlights the benefits of DPG for the environment, the economy, and the society, and emphasizes the role of DPG as a critical transition technology towards a low-carbon future.<sup>9</sup>

### **3. INTRODUCTION TO THE ELECTRICITY ACT 2023**

The Act repeals the previous laws governing the Nigerian electricity sector, and establishes a new legal and institutional framework for the operation of a fully privatized, competitive, and cost-reflective electricity market in Nigeria. The Act also aims to integrate renewable energy sources into the national grid, and attract private sector investments across the electricity value chain. The Act empowers the states to regulate their own electricity markets, and issue licenses to private investors who can operate mini-grids and power plants within the state. The Act also strengthens the role and functions of the Nigerian Electricity Regulatory Commission (NERC), and

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<sup>8</sup> Corbier, D., Gonand, F. & Bessec, M. Impacts of Decentralized Power Generation on Distribution Networks: a Statistical Typology of European Countries. *Environ Model Assess* **23**, 471–495 (2018)

i. <sup>9</sup> Ward Pincus, [The many forms of decentralization \(man-es.com\)](https://www.man-es.com) accessed on 27<sup>th</sup> December 2023

grants the National Assembly the power to oversee the sector through its committees on power.

#### **4. LEGAL FRAMEWORKS AND POLICIES SUPPORTING DECENTRALIZED POWER**

- i. The Electricity Act of 2023 (EA): This is the main legislation that governs the electricity sector in Nigeria. It provides for the unbundling of the state-owned utility, the establishment of an independent regulator, the creation of a competitive market, and the promotion of private sector participation. It also allows for the licensing of independent power producers, including those using renewable energy sources.
- ii. The National Renewable Energy and Energy Efficiency Policy of 2015 (NREEEP): This is the policy document that outlines the vision, objectives, and strategies for the development and integration of renewable energy and energy efficiency in Nigeria. It sets targets for the share of renewable energy in the national energy mix, and provides incentives and support mechanisms for renewable energy projects. It also addresses the issues of mini-grids, off-grid electrification, and rural energy access.<sup>10</sup>
- iii. The Rural Electrification Strategy and Implementation Plan of 2016 (RESIP): This is the strategy document that guides the implementation of rural electrification projects in Nigeria. It identifies the challenges and opportunities for rural electrification, and proposes various models and approaches for delivering electricity services to rural areas. It also defines the roles and responsibilities of the Rural Electrification Agency (REA),

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<sup>10</sup> Oluwaseun Viyon Ojo, *An Overview of the Legal and Regulatory Framework for Renewable Energy Projects in Nigeria: Challenges and Prospects*. (2017) *Unilag Law Review* 1 Vol 1| No. 1

the Rural Electrification Fund (REF), and other stakeholders in the rural electrification sector.<sup>11</sup>

## **5. SOCIOECONOMIC IMPACTS**

### **A. Economic Development Indicators**

Economic development indicators are measures of the economic welfare and progress of a country or region. They can include factors such as GDP per capita, poverty levels, education, health, environment, trade, and infrastructure. Different indicators may reflect different aspects of development, such as human, social, environmental, or institutional.<sup>12</sup>

### **B. Social Indicators**

Social indicators are measures of the quality of life and well-being of individuals and communities, such as health, education, income, happiness, and social cohesion. Social indicators can be used to evaluate the impacts and outcomes of development interventions, such as decentralized power generation, which is the production and distribution of electricity from sources that are not connected to the main grid, such as solar panels, wind turbines, micro-hydro, biomass, etc.<sup>13</sup>

#### **i. Access to Electricity**

Access to electricity is a key social indicator, as it enables the provision of essential services and opportunities for human development, such as

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<sup>11</sup> ODI. *Accelerating Access to Electricity in Africa with off Grid Solar: Off Grid Solar Country Briefing: Nigeria*. ODI, 2016.

<sup>12</sup> Hauser, Philip M. "Demographic Indicators of Economic Development." *Economic Development and Cultural Change*, vol. 7, no. 2, 1959, pp. 98–116.

<sup>13</sup> Land, K.C., Michalos, A.C. Fifty Years After the Social Indicators Movement: Has the Promise Been fulfilled? *Soc Indic Res* **135**, 835–868 (2018)

lighting, heating, cooling, communication, education, health, and income generation. Decentralized power generation can improve access to electricity for rural and remote communities, especially in developing countries, where millions of people still lack access to electricity or face frequent power outages. Decentralized power generation can also reduce the dependence on fossil fuels and lower the environmental and health impacts of electricity generation.<sup>14</sup>

## **ii. Education and Healthcare Improvement**

Education and healthcare improvement are other important social indicators, as they reflect the level and quality of human capital and potential in a society. Education and healthcare are essential for enhancing the skills, knowledge, and well-being of individuals and communities, and for reducing poverty, inequality, and mortality. Decentralized power generation can support education and healthcare improvement by providing reliable and affordable electricity for schools, clinics, hospitals, and other facilities, and by enabling the use of modern technologies and equipment, such as computers, internet, telemedicine, and refrigeration.

## **iii. Community Well-being**

Community well-being is a broad and multidimensional social indicator, as it encompasses the physical, mental, emotional, and social aspects of human happiness and satisfaction. Community well-being is influenced by various factors, such as income, health, education, environment, culture, and social relations. Decentralized power generation can enhance community well-being by empowering local communities to participate in

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<sup>14</sup> Sung, H., Phillips, R.G. Indicators and Community Well-Being: Exploring a Relational Framework. *Int. Journal of Com. WB* **1**, 63–79 (2018)

the planning, management, and ownership of their energy systems, and by fostering social capital, trust, and cohesion among the community members.

## **6. ENVIRONMENTAL IMPACTS**

### **A. Carbon Footprint Reduction**

#### **1. Comparison with Traditional Power Generation**

Traditional power generation, such as coal, oil, and natural gas, emits large amounts of greenhouse gases and other pollutants that contribute to climate change and harm human health and the environment.<sup>15</sup> Renewable power generation, such as solar, wind, hydro, and biomass, has much lower carbon footprints and environmental impacts than traditional power sources. Renewable energy sources can also reduce dependence on fossil fuels, enhance energy security, and create green jobs.<sup>16</sup> According to a study by the International Renewable Energy Agency (IRENA), increasing the share of renewable energy in the global energy mix to 36% by 2030 could reduce global carbon dioxide emissions by 8.6 gigatons per year, equivalent to eliminating the emissions from all road transport.<sup>17</sup>

#### **2. Greenhouse Gas Emission Reduction**

Greenhouse gas emissions are the main driver of human-induced climate change, which poses serious threats to ecosystems, human health, food

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<sup>15</sup> Adams, Rowan, and Tooraj Jamasb. *Optimal Power Generation Portfolios with Renewables: An Application to the UK*. Energy Policy Research Group, University of Cambridge, 2016.

<sup>16</sup> Kaygusuz, Kamil. "Renewable Energy: Power For a Sustainable Future." *Energy Exploration & Exploitation*, vol. 19, no. 6, 2001, pp. 603–26.

<sup>17</sup> [Global Renewables Outlook: Energy transformation 2050 \(irena.org\)](https://www.irena.org/publications/2023/12/global-renewables-outlook-energy-transformation-2050) accessed on 28<sup>th</sup> December 2023

security, and economic development.<sup>18</sup> Reducing greenhouse gas emissions requires a combination of mitigation actions at different levels, such as using less energy, switching to low-carbon energy sources, improving energy efficiency, enhancing carbon sinks, and adopting low-carbon lifestyles.<sup>19</sup> According to the Intergovernmental Panel on Climate Change (IPCC), limiting global warming to 1.5°C above pre-industrial levels would require a 45% reduction in global net carbon dioxide emissions by 2030 and reaching net zero by 2050. This would entail rapid and far-reaching transitions in energy, land, urban, and industrial systems.<sup>20</sup>

## **B. Air and Water Quality**

### **1. Pollution Reduction Measures**

DPG can help reduce air and water pollution by providing clean and renewable energy sources, such as solar, wind, hydro, biomass, and biogas, which have lower greenhouse gas emissions and water consumption than conventional fossil fuels.<sup>21</sup> DPG can also enable more efficient and localized energy distribution and consumption, which can reduce transmission losses, grid dependency, and peak demand.<sup>22</sup> However, DPG can also have negative environmental impacts if it is not properly planned,

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<sup>18</sup> Brechin, Steven R. "Climate Change Mitigation and the Collective Action Problem: Exploring Country Differences in Greenhouse Gas Contributions." *Sociological Forum*, vol. 31, no. S1, 2016, pp. 846–61

<sup>19</sup> Kosloff, Laura H. "Climate Change Mitigation and Sustainable Development." *Natural Resources & Environment*, vol. 12, no. 2, 1997, pp. 93–145.

<sup>20</sup> [Global Warming of 1.5 °C — \(ipcc.ch\)](https://www.ipcc.ch) accessed on 28<sup>th</sup> December 2023

<sup>21</sup> Hu, F., Guo, Y. Impacts of electricity generation on air pollution: evidence from data on air quality index and six criteria pollutants. *SN Appl. Sci.* **3**, 4 (2021)

<sup>22</sup> Deshwar, Chhatrpal Singh and Sharma, Rahul and Gupta, Abhishek Kumar and Singh, Mayengbam Sashilal, Assessment and Scope of Decentralised Power Generation Using Renewable Energy Resources (February 21, 2020). Proceedings of the 4th International Conference: Innovative Advancement in Engineering & Technology (IAET) 2020

implemented, and managed. For example: DPG can cause land use changes, habitat loss, and biodiversity impacts, depending on the type, scale, and location of the energy sources. DPG can generate air and water pollutants, such as particulate matter, nitrogen oxides, sulfur dioxide, and heavy metals, depending on the fuel quality, combustion technology, and emission control of the energy sources. DPG can create social and environmental conflicts, such as land rights, resource access, and benefit sharing, depending on the governance, participation, and equity of the energy systems. Therefore, DPG needs to be assessed and regulated in terms of its environmental performance, impacts, and trade-offs. Some of the measures that can help mitigate the environmental risks and enhance the environmental benefits of DPG include:

- a. Applying environmental impact assessments and life cycle analyses to DPG, to identify and minimize its environmental impacts across its entire value chain.
- b. Adopting best available technologies and practices for DPG, to maximize its energy efficiency, reliability, and safety.
- c. Promoting integrated and participatory planning and management for DPG, to ensure its compatibility and complementarities with the local environment and community.

## **2. Impact on Local Ecosystems**

DPG can have significant impacts on local ecosystems, both directly and indirectly, by affecting the biophysical, ecological, and socio-economic factors that shape them. For example: DPG can help conserve and restore local ecosystems, by reducing the pressure and dependence on natural resources, such as wood, charcoal, and diesel, which are often used for energy generation in rural areas. DPG can help enhance and diversify local livelihoods, by providing access to affordable, reliable, and modern energy

services, such as lighting, heating, cooling, and communication, which can improve the quality of life and income opportunities of rural households. DPG can help empower and mobilize local actors, by facilitating the ownership, control, and involvement of local communities and stakeholders in the development and operation of the energy systems. However, DPG can also harm or disrupt local ecosystems, by introducing or exacerbating environmental pressures, threats, and conflicts. For example: DPG can increase the exposure and vulnerability of local ecosystems to climate change, natural disasters, and human-induced disturbances, by altering the natural cycles, processes, and functions that sustain them. DPG can reduce the diversity and resilience of local ecosystems, by displacing or competing with traditional and indigenous knowledge, practices, and values, which are often more adapted and attuned to local contexts. DPG can create or aggravate social and environmental injustices, by generating or reinforcing power imbalances, inequalities, and exclusions among different groups and interests, especially those of marginalized and vulnerable populations.

Therefore, DPG needs to be aligned and integrated with the local contexts, needs, and aspirations, with due respect to the environmental and social rights and responsibilities of local communities. Some of the measures that can help ensure the positive and equitable impacts of DPG on local ecosystems include:

- a. Applying ecosystem-based approaches and principles to DPG, to recognize and balance the multiple dimensions, functions, and values of local ecosystems.
- b. Adopting participatory and inclusive methods and tools for DPG, to involve and empower local stakeholders in the co-design, co-implementation, and co-evaluation of the energy systems.

- c. Promoting adaptive and learning-oriented practices and systems for DPG, to enable continuous improvement, feedback, and innovation based on local experiences and lessons.

## **C. Land Use and Biodiversity Conservation**

### **1. Preservation of Natural Habitats**

Decentralized power generation (DPG) can have both positive and negative impacts on land use and biodiversity conservation, depending on the type, scale, and location of the energy sources, as well as the planning, implementation, and management of the energy systems.

DPG can help preserve natural habitats by reducing the pressure and dependence on fossil fuels, which often involve land degradation, habitat loss, and biodiversity impacts. DPG can also provide clean and renewable energy sources, such as solar, wind, hydro, biomass, and biogas, which have lower greenhouse gas emissions and water consumption than conventional fossil fuels.<sup>23</sup> DPG can enable more efficient and localized energy distribution and consumption, which can reduce transmission losses, grid dependency, and peak demand.<sup>24</sup>

However, DPG can also harm natural habitats by causing land use changes, habitat loss, and biodiversity impacts, depending on the type, scale, and

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<sup>23</sup> Deshwar, Chhatrapal Singh and Sharma, Rahul and Gupta, Abhishek Kumar and Singh, Mayengbam Sashilal, Assessment and Scope of Decentralised Power Generation Using Renewable Energy Resources (February 21, 2020). Proceedings of the 4th International Conference: Innovative Advancement in Engineering & Technology (IAET) 2020, Available at

SSRN: <https://ssrn.com/abstract=3554854> or <http://dx.doi.org/10.2139/ssrn.3554854>

<sup>24</sup> POLLITT, MICHAEL G. "Electricity Network Charging in the Presence of Distributed Energy Resources: Principles, Problems and Solutions." *Economics of Energy & Environmental Policy*, vol. 7, no. 1, 2018, pp. 89–104.

location of the energy sources. For example, solar panels can affect the microclimate, soil, and vegetation of the installation site. Wind turbines can cause bird and bat mortality, noise, and visual impacts. Hydropower can alter the hydrological regime, sediment transport, and aquatic ecosystems of the water source. Biomass and biogas can compete with food production, increase water demand, and emit air pollutants.<sup>25</sup>

Therefore, DPG needs to be assessed and regulated in terms of its environmental performance, impacts, and trade-offs. Some of the measures that can help mitigate the environmental risks and enhance the environmental benefits of DPG include the application of environmental impact assessments and life cycle analyses to DPG, to identify and minimize its environmental impacts across its entire value chain. Furthermore, an adoption of the best available technologies and practices for DPG, to maximize its energy efficiency, reliability, and safety is important. It is also important to promote integrated and participatory planning and management for DPG, to ensure its compatibility with the local environment and community.

## 2. Sustainable Practices

DPG can support sustainable practices by providing access to affordable, reliable, and modern energy services, such as lighting, heating, cooling, and communication, which can improve the quality of life and income opportunities of rural households. DPG can also facilitate the ownership, control, and involvement of local communities and stakeholders in the development and operation of the energy systems. DPG can foster the adoption of circular economy strategies, such as reducing, reusing, and

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<sup>25</sup> [The many forms of decentralization \(man-es.com\)](#) accessed on 3<sup>rd</sup> January 2024

recycling materials, which can prevent or minimize waste generation and pollution.<sup>26</sup>

However, DPG can also undermine sustainable practices by displacing or competing with traditional and indigenous knowledge, practices, and values, which are often more adapted and attuned to local contexts. DPG can create or aggravate social and environmental injustices, by generating or reinforcing power imbalances, inequalities, and exclusions among different groups and interests, especially those of marginalized and vulnerable populations. DPG can pose ethical, legal, and governance challenges, such as data privacy, security, and ownership, which can affect the trust, accountability, and transparency of the energy systems.

Therefore, DPG needs to be aligned and integrated with the local contexts, needs, and aspirations, with due respect to the environmental and social rights and responsibilities of local communities. Some of the measures that can help ensure the positive and equitable impacts of DPG on sustainable practices include the application of ecosystem-based approaches and principles to DPG, to recognize and balance the multiple dimensions, functions, and values of local ecosystems. Adopting participatory and inclusive methods and tools for DPG, to involve and empower local stakeholders in the co-design, co-implementation, and co-evaluation of the energy systems is also important. Furthermore, the Promotion of adaptive and learning-oriented practices and systems for DPG, to enable continuous improvement, feedback, and innovation based on local experiences and lessons is considered important.

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<sup>26</sup> López, M. Victoria, et al. "Sustainable Development and Corporate Performance: A Study Based on the Dow Jones Sustainability Index." *Journal of Business Ethics*, vol. 75, no. 3, 2007, pp. 285–300

## **7. LEGAL AND POLICY ANALYSIS**

### **A. Assessment of Decentralized Power Generation Provisions**

The Electricity Act 2023 introduces new provisions for decentralized power generation, which is the generation of electricity by small-scale, distributed, and independent power producers, such as mini-grids, embedded power, and off-grid systems. The Act allows anyone to construct, own, or operate an undertaking for generating electricity not exceeding one megawatt in aggregate at a site, or an undertaking for distribution of electricity with a capacity not exceeding 100 kilowatts in aggregate at a site, or such other capacity as the Commission may determine from time to time, without a licence. The Act also empowers states to create their own electricity markets and regulate their own electricity activities within their jurisdiction, by issuing licences to private investors who can operate mini-grids and power plants within the state. However, the Act precludes interstate and transnational electricity distribution.

The decentralized power generation provisions of the Act have the potential to improve the access, reliability, and affordability of electricity in Nigeria, especially in rural and underserved areas, where grid extension is not feasible or cost-effective. Decentralized power generation can also promote the use of renewable energy sources, such as solar, wind, hydro, biomass, and biogas, which have lower environmental impacts than fossil fuels. Decentralized power generation can also enhance the efficiency, resilience, and security of the electricity system, by reducing transmission losses, grid dependency, and peak demand.

However, the decentralized power generation provisions of the Act also pose some challenges and risks, such as:

- i. The coordination and integration of decentralized power generation with the national grid, to ensure system stability, quality, and safety.
- ii. The regulation and oversight of decentralized power generation, to ensure compliance with technical, economic, and environmental standards and codes.

### **B. Alignment with Environmental and Socioeconomic Objectives**

Decentralized power generation (DPG) can contribute to the environmental and socioeconomic objectives of Nigeria, such as reducing greenhouse gas emissions, improving energy access and security, and promoting local development and empowerment. DPG can support the implementation of the National Renewable Energy and Energy Efficiency Policy (NREEEP) 2015, which aims to increase the share of renewable energy in the national energy mix to 23% by 2025 and 36% by 2030. DPG can also support the achievement of the Sustainable Development Goals (SDGs), especially SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation and Infrastructure), and SDG 13 (Climate Action).<sup>27</sup>

However, DPG also faces some barriers and challenges in aligning with the environmental and socioeconomic objectives of Nigeria, such as:

- i. The lack of adequate and reliable data on the potential and availability of renewable energy resources, which hinders the planning and development of DPG projects.

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<sup>27</sup> Deshwar, Chhatrpal Singh and Sharma, Rahul and Gupta, Abhishek Kumar and Singh, Mayengbam Sashilal, Assessment and Scope of Decentralised Power Generation Using Renewable Energy Resources (February 21, 2020). Proceedings of the 4th International Conference: Innovative Advancement in Engineering & Technology (IAET) 2020, Available at SSRN: <https://ssrn.com/abstract=3554854> or <http://dx.doi.org/10.2139/ssrn.3554854>

- ii. The high upfront costs and risks of DPG investments, which deter private investors and financiers from entering the market.

### **C. Regulatory Challenges and Opportunities**

The Electricity Act 2023 introduces a new regulatory framework for the electricity sector in Nigeria, which decentralizes the power sector and creates state electricity markets, allowing states to regulate their own electricity activities within their jurisdiction. The Act also allows anyone to construct, own, or operate an undertaking for generating electricity not exceeding one megawatt in aggregate at a site, or an undertaking for distribution of electricity with a capacity not exceeding 100 kilowatts in aggregate at a site, or such other capacity as the Commission may determine from time to time, without a licence. The Act aims to reform the electricity sector, integrate renewable energy into Nigeria's energy mix, and attract investments to the sector.

The new regulatory framework presents some opportunities and challenges for DPG in Nigeria, such as:

- i. The opportunity to foster innovation and competition in the electricity market, by enabling the entry and participation of new and diverse actors, such as private investors, communities, and prosumers, in the generation and distribution of electricity.<sup>28</sup>
- ii. The opportunity to enhance the access and affordability of electricity, by enabling the provision and consumption of electricity in rural and underserved areas, where grid extension is not feasible or cost-effective, through DPG solutions.

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<sup>28</sup> Barceló E, Dimić-Mišić K, Imani M, Spasojević Brkić V, Hummel M, Gane P. Regulatory Paradigm and Challenge for Blockchain Integration of Decentralized Systems: Example—Renewable Energy Grids. *Sustainability*. 2023; 15(3):2571.

Therefore, the new regulatory framework needs to be implemented and monitored carefully, with the involvement and collaboration of all the relevant stakeholders, such as the federal government, state governments, local governments, regulators, operators, investors, consumers, and communities.

## **8. CASE STUDIES: SELECTED NIGERIAN STATES**

### **A. Comparative Analysis of States Implementing Decentralized Power**

Decentralized power, also known as distributed or off-grid power, is the generation and distribution of electricity by small-scale, independent, and often renewable energy sources, such as solar, wind, hydro, biomass, and biogas. Decentralized power can provide access to reliable and affordable electricity for rural and underserved areas, where grid extension is not feasible or cost-effective. Decentralized power can also enhance the efficiency, resilience, and security of the electricity system, by reducing transmission losses, grid dependency, and peak demand.

In Nigeria, the Electricity Act 2023 introduced new provisions for decentralized power, allowing anyone to construct, own, or operate an undertaking for generating electricity not exceeding one megawatt in aggregate at a site, or an undertaking for distribution of electricity with a capacity not exceeding 100 kilowatts in aggregate at a site, or such other capacity as the Commission may determine from time to time, without a licence. The Act also empowered states to create their own electricity markets and regulate their own electricity activities within their jurisdiction, by issuing licences to private investors who can operate mini-grids and power plants within the state. However, the Act precluded interstate and transnational electricity distribution.

Different states in Nigeria have implemented decentralized power projects with varying degrees of success, depending on the availability of renewable energy resources, the level of political will and commitment, the quality of governance and regulation, the availability of funding and incentives, and the involvement and participation of the local communities and stakeholders. Some of the states that have implemented or are implementing decentralized power projects include:

- i. Lagos State: Lagos State has been a pioneer in decentralized power, having established the Lagos State Electricity Board (LSEB) in 2010, which is responsible for developing and implementing decentralized power projects in the state. The LSEB has implemented several solar and gas-powered mini-grids and embedded power plants, such as the 5 MW Alausa Power Plant, the 8.8 MW Mainland Power Plant, the 10 MW Island Power Plant, the 1.5 MW Lekki Free Trade Zone Power Plant, and the 4 MW Lagos State University Power Plant. The LSEB has also partnered with private developers, such as PowerGen, Rubitec, and GVE, to provide solar mini-grids to rural and underserved communities, such as Ijora Badia, Ilaje Bariga, and Makoko.<sup>29</sup>
- ii. Niger State: Niger State has also been proactive in decentralized power, having established the Niger State Rural Electrification Board (NSREB) in 2017, which is responsible for developing and implementing decentralized power projects in the state. The NSREB has implemented several solar mini-grids and solar home systems, such as the 64 kW Bisanti Mini-Grid, the 30 kW Kontagora Mini-Grid, the 20 kW Garin Maikasuwa Mini-Grid, and the 10 kW Wuna Mini-Grid. The NSREB has also partnered with private developers, such as PowerGen, Havenhill, and ACOB, to provide

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<sup>29</sup> [Decentralizing Nigeria's Power Sector | Stories | Siemens Energy Middle East \(siemens-energy.com\)](https://www.siemens-energy.com) accessed on 3<sup>rd</sup> January 2024

- solar mini-grids to rural and underserved communities, such as Kigbe, Kankia, and Rokota.<sup>30</sup>
- iii. Ogun State: Ogun State has also been active in decentralized power, having established the Ogun State Energy Board (OSEB) in 2019, which is responsible for developing and implementing decentralized power projects in the state. The OSEB has implemented several solar mini-grids and solar home systems, such as the 85 kW Gbamu Gbamu Mini-Grid, the 100 kW Olooji Mini-Grid, the 20 kW Akpabom Mini-Grid, and the 10 kW Abeokuta Mini-Grid. The OSEB has also partnered with private developers, such as Rubitec, A4&T, and GVE, to provide solar mini-grids and solar home systems to rural and underserved communities, such as Ijebu Ode, Ijebu Igbo, and Sagamu.

## **B. Success Stories and Lessons Learned**

Decentralized power projects in Nigeria have achieved some notable successes and impacts, such as:

- i. Improving access to electricity for rural and underserved communities, especially in areas where grid extension is not feasible or cost-effective, or where grid supply is unreliable or unavailable. According to the Rural Electrification Agency (REA), as of December 2020, 99 mini-grids and 19,130 solar home systems have been deployed across Nigeria, providing electricity to over 300,000 people and 70,000 households.<sup>31</sup>
- ii. Promoting the use of renewable energy sources, such as solar, wind, hydro, biomass, and biogas, which have lower environmental impacts than fossil

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<sup>30</sup> Zalengera, C., To, L.S., Sieff, R. *et al.* Decentralization: the key to accelerating access to distributed energy services in sub-Saharan Africa? *J Environ Stud Sci* **10**, 270–289 (2020)

<sup>31</sup> [Decentralizing Nigeria's Power Sector | Stories | Siemens Energy Middle East \(siemens-energy.com\)](https://www.siemens-energy.com) accessed on 3<sup>rd</sup> January 2024

fuels, such as reducing greenhouse gas emissions, water consumption, and waste generation. According to the REA, as of December 2020, mini-grids and solar home systems have displaced over 100,000 tons of carbon dioxide equivalent and saved over 24 million litres of diesel.

Decentralized power projects in Nigeria have also faced some challenges and lessons learned, such as:

- i. The lack of adequate and reliable data on the potential and availability of renewable energy resources, which hinders the planning and development of decentralized power projects. There is a need for comprehensive and participatory assessments of the renewable energy resources and the energy demand and supply of the target areas, to identify the optimal and feasible decentralized power solutions.
- ii. The high upfront costs and risks of decentralized power investments, which deter private investors and financiers from entering the market. There is a need for financial and non-financial incentives and support for decentralized power investors and consumers, such as subsidies, grants, loans, guarantees, tax exemptions, feed-in tariffs, net metering, and technical assistance.

### **C. Challenges Faced by Different States**

Different states in Nigeria face different challenges in implementing decentralized power projects, depending on their specific contexts, needs, and aspirations. Some of the common challenges faced by different states include:

- i. The coordination and integration of decentralized power with the national grid, to ensure system stability, quality, and safety. There is a need for harmonizing the technical, economic, and environmental standards and

- codes for decentralized power, as well as establishing effective mechanisms for grid interconnection, synchronization, and compensation.
- ii. The regulation and oversight of decentralized power, to ensure compliance with the legal and institutional framework for the electricity sector. There is a need for ensuring the consistency and compatibility of the state and national electricity regulations, to avoid conflicts, overlaps, and gaps in the governance and oversight of the electricity activities across different jurisdictions.

#### **D. Community Engagement Practices**

Community engagement is a key factor for the success and sustainability of decentralized power projects, as it involves the involvement and empowerment of the local communities and stakeholders in the co-design, co-implementation, and co-evaluation of the decentralized power solutions. Community engagement can enhance the ownership, acceptance, and satisfaction of the decentralized power services, as well as promote the social and environmental benefits and impacts of the decentralized power projects. There are identified best practices for community engagement for decentralized power in Nigeria. These include conducting baseline surveys and needs assessments to understand the socio-economic and environmental profile, preferences, and expectations of the target communities and stakeholders, as well as to identify the potential and availability of renewable energy resources and the energy demand and supply of the target areas. It also include the establishment of community-based organizations and committees to represent and coordinate the interests and views of the target communities and stakeholders, as well as to facilitate the communication and collaboration among the different actors involved in the decentralized power projects. Furthermore, it ensures the provision of capacity building and training to the target communities

and stakeholders, to enhance their knowledge, skills, and awareness on the benefits and opportunities of decentralized power.

## **IX. RECOMMENDATIONS**

### **A. Policy Recommendations for Improved Implementation**

Decentralized power, also known as distributed or off-grid power, is the generation and distribution of electricity by small-scale, independent, and often renewable energy sources, such as solar, wind, hydro, biomass, and biogas. Decentralized power can provide access to reliable and affordable electricity for rural and underserved areas, where grid extension is not feasible or cost-effective. Decentralized power can also enhance the efficiency, resilience, and security of the electricity system, by reducing transmission losses, grid dependency, and peak demand.

In Nigeria, the Electricity Act 2023 introduced new provisions for decentralized power, allowing anyone to construct, own, or operate an undertaking for generating electricity not exceeding one megawatt in aggregate at a site, or an undertaking for distribution of electricity with a capacity not exceeding 100 kilowatts in aggregate at a site, or such other capacity as the Commission may determine from time to time, without a licence. The Act also empowered states to create their own electricity markets and regulate their own electricity activities within their jurisdiction, by issuing licences to private investors who can operate mini-grids and power plants within the state. However, the Act precluded interstate and transnational electricity distribution.

To improve the implementation of decentralized power projects in Nigeria, some of the policy recommendations are:

- i. Developing a national renewable energy policy and action plan, to provide a clear vision, targets, and strategies for the promotion and development of renewable energy sources for decentralized power generation.
- ii. Establishing a national renewable energy agency, to coordinate and oversee the implementation of the renewable energy policy and action plan, as well as to provide technical and financial support for decentralized power projects.
- iii. Creating a national renewable energy fund, to mobilize and allocate resources for the development and deployment of decentralized power projects, as well as to provide incentives and subsidies for renewable energy investors and consumers.

### **B. Community and Stakeholder Engagement Strategies**

Community and stakeholder engagement is a key factor for the success and sustainability of decentralized power projects, as it involves the involvement and empowerment of the local communities and stakeholders in the co-design, co-implementation, and co-evaluation of the decentralized power solutions. Community and stakeholder engagement can enhance the ownership, acceptance, and satisfaction of the decentralized power services, as well as promote the social and environmental benefits and impacts of the decentralized power projects. Best practices for community and stakeholder engagement for decentralized power in Nigeria include conducting baseline surveys and needs assessments to understand the socio-economic and environmental profile, preferences, and expectations of the target communities and stakeholders, as well as to identify the potential and availability of renewable energy resources and the energy demand and supply of the target areas. Establishing community-based organizations and committees to represent and coordinate the interests and views of the target communities and stakeholders, as well as to facilitate the collaboration

among the different actors involved in the decentralized power projects. Furthermore, providing capacity building and training to the target communities and stakeholders, to enhance their knowledge, skills, and awareness on the benefits and opportunities of decentralized power, as well as to enable their participation and contribution in the design, operation, and maintenance of the decentralized power services is also considered as an integral part of the process. Implementing participatory monitoring and evaluation systems, to collect and analyze feedback and data on the performance and impacts of the decentralized power projects, as well as to identify and address the challenges and opportunities for improvement and scaling-up is also important.

### **C. Legal Reforms for Enhancing Decentralized Power Projects**

The Electricity Act 2023 introduced a new legal framework for the electricity sector in Nigeria, which decentralizes the power sector and creates state electricity markets, allowing states to regulate their own electricity activities within their jurisdiction. The Act also allows anyone to construct, own, or operate an undertaking for generating electricity not exceeding one megawatt in aggregate at a site, or an undertaking for distribution of electricity with a capacity not exceeding 100 kilowatts in aggregate at a site, or such other capacity as the Commission may determine from time to time, without a license. The Act aims to reform the electricity sector, integrate renewable energy into Nigeria's energy mix, and attract investments to the sector.

The legal framework presents some opportunities and challenges for decentralized power projects in Nigeria, such as:

- i. The opportunity to foster innovation and competition in the electricity market, by enabling the entry and participation of new and diverse actors,

- such as private investors, communities, and prosumers, in the generation and distribution of electricity.
- ii. The opportunity to enhance the access and affordability of electricity, by enabling the provision and consumption of electricity in rural and underserved areas, where grid extension is not feasible or cost-effective, through decentralized power solutions.

## **X. CONCLUSION**

### **A. Summary of Findings**

This paper emphasizes how decentralized power generation, or DPG, might help Nigeria with its energy problems. One of the main conclusions is that decentralized electricity requires renewable energy sources including hydro, solar, wind, and biomass. According to this research, decentralized electricity may enhance energy availability in rural regions, drastically lower transmission losses, and advance environmental sustainability by lowering dependency on fossil fuels. Furthermore, the paper indicates that the effective execution of DPG necessitates resolving financial, technical, and regulatory obstacles, such as elevated initial expenditures, insufficient data, and restricted technical proficiency.