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Review Article

LEVERAGING SOLAR ENERGY FOR SUSTAINABLE NATIONAL ECONOMIC GROWTH IN NIGERIA: A POLICY-ORIENTED DISCOURSE

Ani Sunday Elijah

Senior Lecturer, Department of Electrical and Electronic Engineering, Federal Polytechnic, Ngodo-Isouchi, Abia State, Nigeria.

Correspondence should be addressed to: engrsunny72@gmail.com | https://orcid.org/0009-0004-9642-3899

Abstract: Recent data from the National Bureau of Statistics on electricity shows that, 48.6% of the electricity used by homes and businesses nationwide is produced by generators using gas, diesel, and gasoline. With 12 out of every 25 Nigerians using generators and paying over $16 million a year to fuel just 14 million of them, the nation's electricity industry is rapidly degenerating. Nigeria's electricity sector has long underperformed relative to the country's population size, economic potential, and resource endowment. Despite vast natural gas reserves and significant renewable energy potential, the electricity supply remains unreliable, insufficient, and unevenly distributed. In Nigeria, persistent electricity supply failures have become a structural constraint on productivity, industrialization, investment, and overall economic growth. The research is a policy-oriented discourse on leveraging solar energy for sustainable national economic growth in Nigeria. The theoretical policy-oriented discourse was anchored on the energy-growth nexus theory. The study adopted secondary source of data collection which was sources from academic journals, conference papers, policy papers, newspapers, and electronic databases. Descriptive content analysis approach was used for analysis of the secondary data. The paper established that, despite decades of reform efforts, the power sector continues to underperform relative to national demand. This failure not only reflects institutional and infrastructural weaknesses but also directly undermines Nigeria's long-term development trajectory. The study also found out that, solar energy presents a strategic opportunity to transform Nigeria's economic structure. With high solar irradiation levels across most regions of the country, large-scale deployment of solar technologies can stimulate productivity, employment, industrialization, and macroeconomic stability. The study recommended that, harnessing these potentials requires coherent policy design, regulatory certainty, financial innovation, and industrial strategy integration. If strategically implemented, solar energy can shift Nigeria from chronic energy deficits toward sustainable, diversified, and resilient economic growth.

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Keywords: Solar energy, Solar Energy Harvesting, National Economic Growth, Renewable Energy, Sustainable Power Supply

1.0 Introduction

Reliable electricity is a prerequisite for sustainable economic transformation. The failure of electricity supply in Nigeria is not merely a technical issue but a structural economic challenge rooted in governance weaknesses, financial instability, infrastructure decay, and policy inconsistency. Without reliable electricity, sustainable economic growth remains constrained (Adebanji, et al., 2022). In Nigeria, chronic power shortages have constrained industrial output, discouraged foreign direct investment, and increased production costs across sectors. With an installed capacity that underperforms relative to demand and persistent transmission bottlenecks, businesses and households rely heavily on private generators, raising operational costs and carbon emissions. Meanwhile, Nigeria is geographically advantaged with high solar irradiation levels averaging 5.5-7.0 kWh/m²/day, with sunshine hours averaging about 6-7 hours daily across most parts of the country (Bamisile, et al., 2017). This natural endowment presents a strategic opportunity: leveraging solar energy harvesting not only for electrification but as a driver of structural economic transformation.

Nigeria's electricity challenges date back to decades of underinvestment and centralized state control. The former vertically integrated monopoly, the Power Holding Company of Nigeria (PHCN), suffered from inefficiency, weak maintenance culture, political interference, and poor revenue collection (Eshiemogie, et al., 2024). In 2013, the sector was privatized and unbundled into generation companies (GenCos), distribution companies (DisCos), and a transmission company (Ohunakin, et al., 2014). While reform aimed to improve efficiency and attract private capital, structural weaknesses persisted due to: Inadequate due diligence before privatization, Weak regulatory enforcement, Insufficient capital investment by new owners, and Tariff constraints driven by political considerations (Bamisile, et al., 2017). As a result, privatization did not significantly improve supply reliability.

Energy is widely recognized as a fundamental driver of economic growth and development. Reliable energy supply supports industrial production, technological advancement, and improved living standards. Countries with stable electricity infrastructure

tend to experience higher levels of economic productivity and industrial expansion (Lawal, et al., 2024). However, Nigeria continues to experience significant electricity shortages despite its abundant energy resources. Frequent power outages, inadequate generation capacity, and unreliable electricity supply have negatively affected industrial productivity, business operations, and economic development (Town-Carabajal, et al., 2024). Nigeria's electricity generation capacity remains insufficient to meet the growing demand of its population and industrial sectors. The persistent power deficit has forced households and businesses to rely heavily on diesel and petrol generators, which significantly increase operational costs and environmental pollution. Studies estimate that unreliable electricity supply costs Nigeria between 5% and 7% of its Gross Domestic Product (GDP) annually due to reduced productivity and increased energy expenses.

Renewable energy sources have therefore become increasingly important for addressing Nigeria's electricity challenges. Among the available renewable energy resources, solar energy offers the greatest potential due to Nigeria's geographic location within the high sunshine belt of the world (Sambo, et al., 2016). Solar energy harvesting refers to the process of capturing solar radiation and converting it into usable electricity through photovoltaic (PV) or solar thermal technologies. With advancements in solar technologies and declining costs of solar panels and batteries, solar energy has become an increasingly viable option for electricity generation worldwide. In Nigeria, solar energy harvesting has the potential to significantly transform the country's energy sector and stimulate national economic growth.

2.0 Theoretical Framework

- **Energy-Growth Nexus Theory by** Kraft and Kraft (1978)

The study was anchored on the theoretical tenets of Energy-Growth Nexus Theory propounded by Kraft and Kraft (1978). The energy-growth nexus theory explains the relationship between energy consumption and economic growth. Over the past several decades, economists and energy researchers have examined how energy availability influences national productivity, industrial output, and overall economic expansion. The theory has gained increasing relevance in the context of renewable energy development, particularly solar energy harvesting, as countries seek sustainable energy solutions that support economic growth while minimizing environmental degradation. Solar energy harvesting refers to the process of capturing solar radiation and converting it into usable energy, typically through photovoltaic (PV) technologies. As solar energy becomes a major

component of global energy systems, understanding its relationship with economic growth through the lens of the energy-growth nexus theory becomes essential for policy formulation and sustainable development strategies.

The energy-growth nexus refers to the causal relationship between energy consumption and economic growth. The concept emerged from studies examining how increases in energy use influence economic output and productivity. Economists argue that energy functions as an essential factor of production alongside labor and capital because economic activities depend heavily on energy availability (Payne, 2010). Research in energy economics demonstrates that energy consumption is closely linked to economic performance in many countries. Empirical studies show that energy use significantly determines economic growth because industries, transportation systems, and households rely on energy for production and consumption activities (Okoye et al., 2021).

In developing countries, where energy infrastructure is still expanding, the impact of energy availability on economic growth tends to be particularly strong. Energy shortages can constrain industrial production, reduce productivity, and slow economic expansion. Conversely, improvements in energy supply can stimulate economic development by enabling new industries and expanding economic activities.

- **Economic and Social Potentials of Solar Energy in Improving Nigeria's Economic Growth**

Energy availability is widely recognized as a key determinant of economic growth and social development. In Nigeria, persistent electricity shortages and unreliable grid supply have significantly hindered industrial productivity, business operations, and socio-economic development. As a result, renewable energy sources particularly solar energy have gained increasing attention as viable alternatives capable of addressing Nigeria's energy challenges while promoting economic growth and social welfare (Anagbakwu, 2025). Solar energy is abundant in Nigeria due to the country's favorable geographic location within the global solar belt, and its effective utilization has the potential to transform various sectors of the economy. Several studies have examined the economic and social benefits of solar energy development in Nigeria, highlighting its capacity to stimulate economic activities, create employment opportunities, reduce energy costs, and improve living standards.

- **Economic Potential of Solar Energy in Nigeria**

One of the most significant economic potentials of solar energy lies in its ability to improve electricity generation and support industrial productivity. Reliable electricity supply is essential for economic growth because it enables industries, businesses, and households to operate efficiently. Research examining the relationship between solar energy financing and electricity generation in Nigeria found that increased investments in solar energy projects significantly contribute to electricity production in both the short and long term. Increased funding from government agencies, financial institutions, and foreign donors was found to enhance electricity generation capacity and improve the overall performance of the power sector (Lawal et al., 2025).

Furthermore, solar energy technologies provide cost-effective alternatives to conventional energy sources such as diesel generators, which are widely used by households and businesses in Nigeria due to unreliable grid electricity. Diesel and petrol generators often incur high operational costs because of rising fuel prices and maintenance expenses. In contrast, solar photovoltaic systems require relatively low operating costs after installation, making them economically attractive for long-term electricity generation. Studies on solar photovoltaic applications in Nigeria also show that solar investments can generate significant financial returns. For instance, research assessing solar integration in Nigeria's construction sector reported that solar energy projects can produce positive net present values and internal rates of return between 15% and 25%, demonstrating their economic viability and long-term cost savings (Adeleke et al., 2025). These findings suggest that solar energy investments can contribute to economic growth by reducing energy expenditures and increasing productivity.

Solar energy development also contributes to economic growth through job creation and industrial development. The solar energy value chain involves several activities, including manufacturing, installation, maintenance, research, and distribution. Each of these activities provides employment opportunities for engineers, technicians, entrepreneurs, and skilled workers (Adebanji, et al., 2022). Expanding solar energy infrastructure therefore has the potential to create thousands of jobs in Nigeria's renewable energy sector. Additionally, solar energy systems support the development of small and medium-sized enterprises (SMEs), which play a crucial role in Nigeria's economy. Reliable electricity allows businesses to operate more efficiently, extend operating hours, and

improve productivity. This ultimately increases business revenues and contributes to economic expansion.

- **Social Potential of Solar Energy in Nigeria**

In addition to its economic benefits, solar energy also provides significant social benefits that contribute to improved quality of life and social development. One of the most important social benefits is improved access to electricity in underserved communities. Electricity access enhances living standards by providing lighting, communication, and access to modern technologies. Solar electrification programs have significantly improved energy access in rural Nigeria, where millions of people previously lacked reliable electricity (Lawal, et al., 2025). The introduction of solar mini-grids and solar home systems has enabled households to access clean and reliable electricity for lighting, communication, and household appliances.

Improved electricity access also contributes to better educational outcomes. In communities with access to solar electricity, students can study at night using electric lighting rather than relying on candles or kerosene lamps. Educational institutions also benefit from improved electricity supply, which enables the use of computers, laboratory equipment, and other educational technologies. Healthcare services also benefit significantly from solar energy deployment (Anagbakwu, 2025). Solar-powered healthcare facilities can operate medical equipment, store vaccines, and provide lighting during nighttime medical procedures. Reliable electricity supply therefore improves the quality of healthcare services and enhances public health outcomes. Socially, solar energy improves electricity access, enhances educational and healthcare services, promotes gender empowerment, and contributes to environmental sustainability. The deployment of solar mini-grids and solar home systems in rural communities has already demonstrated positive impacts on income growth, business development, and improved living standards.

Furthermore, solar energy contributes to environmental sustainability by reducing reliance on fossil fuels and minimizing greenhouse gas emissions. Solar power systems generate electricity without emitting harmful pollutants, thereby improving air quality and reducing environmental degradation. Research indicates that integrating solar energy technologies into infrastructure development can reduce greenhouse gas emissions by up to 60%, contributing to environmental protection and climate change mitigation (Adeleke et al., 2025). Another important social benefit of solar energy is gender empowerment. In many rural communities, women are primarily responsible for household energy

management. Access to solar energy reduces the time spent gathering fuelwood or purchasing kerosene, allowing women to engage in income-generating activities and educational pursuits. Solar electrification also enhances safety and security by providing lighting in homes and public spaces.

- **Solar Energy and Rural Economic Development**

Solar energy also has significant economic implications for rural communities in Nigeria. Many rural areas remain disconnected from the national electricity grid due to the high cost of infrastructure expansion. As a result, rural households often rely on traditional energy sources such as kerosene lamps, candles, and diesel generators, which are both expensive and environmentally harmful. Solar photovoltaic mini-grids and solar home systems have emerged as practical solutions for rural electrification. Studies on off-grid solar home systems in Nigeria demonstrate that households using solar energy experience reductions in energy expenditure due to decreased reliance on conventional energy sources. For example, research conducted in Oyo State found that households adopting solar home systems reduced their monthly energy expenditures by an average of approximately ₦1,287 because they no longer needed to purchase kerosene, candles, or disposable batteries (Anagbakwu, 2025).

Solar-powered electricity also enables rural households to engage in productive economic activities such as small-scale manufacturing, food processing, and agricultural production. In many communities, access to solar electricity has facilitated the establishment of businesses such as rice mills, cassava processing plants, and small retail enterprises. Evidence from rural electrification programs in Nigeria indicates that communities with access to solar electricity have experienced significant economic growth, including increases in household income and expansion of small businesses (Bashir, 2018). Rural electrification initiatives have reportedly led to approximately 28% growth in household income and a 35% increase in small business development in electrified communities (Rural Nigeria Initiative, 2025). Solar energy also supports agricultural productivity through the use of solar-powered irrigation systems, water pumps, and storage facilities. These technologies enable farmers to irrigate crops more efficiently, reduce dependence on rainfall, and increase crop yields. Consequently, solar energy contributes to improved food security and agricultural development in Nigeria.

- **Solar Energy and Sustainable Development in Nigeria**

Solar energy plays a crucial role in promoting sustainable development in Nigeria. Sustainable development involves meeting present energy needs without compromising the ability of future generations to meet their own needs. Renewable energy technologies such as solar power contribute to sustainable development by providing clean, renewable, and environmentally friendly energy. Solar energy systems reduce dependence on fossil fuels, which are associated with environmental pollution and climate change (Adebanji, et al., 2022). By transitioning to renewable energy sources, Nigeria can reduce carbon emissions and contribute to global efforts to mitigate climate change.In addition, solar energy supports the achievement of several Sustainable Development Goals (SDGs), including affordable and clean energy (SDG 7), decent work and economic growth (SDG 8), and climate action (SDG 13).

Expanding solar energy infrastructure therefore aligns with global development strategies aimed at promoting sustainable economic growth and environmental protection. Economically, solar energy development can enhance electricity generation, reduce energy costs, stimulate industrial productivity, and create employment opportunities. Solar electrification also supports rural economic development by enabling households and small businesses to engage in productive economic activities. Despite these benefits, several challenges continue to hinder the widespread adoption of solar energy in Nigeria, including high initial investment costs, limited technical expertise, and policy uncertainties. Addressing these challenges through supportive government policies, investment incentives, and increased public awareness will be essential for unlocking the full economic and social potential of solar energy in Nigeria.

3.0 Conclusion

The study demonstrated that Nigeria possesses abundant solar irradiation across most regions, providing strong potential for large-scale solar energy development. Solar radiation levels ranging from approximately 3.5 to 7.0 kWh/m²/day make the country highly suitable for solar electricity generation. Large-scale deployment of solar energy technologies can significantly contribute to productivity growth, employment creation, industrialization, and macroeconomic stability. Reliable electricity supply enhances industrial productivity and agricultural output, while the development of the solar energy sector creates employment opportunities across the renewable energy value chain.

Solar energy infrastructure also supports industrial development by providing affordable and sustainable electricity for manufacturing activities. Furthermore, renewable energy deployment contributes to macroeconomic stability by improving energy security, reducing dependence on fossil fuels, and promoting environmentally sustainable development. Given Nigeria's abundant solar resources, strategic investments in solar energy infrastructure, supportive government policies, and technological innovation are essential for maximizing the economic benefits of solar energy development.

4.0 Recommendations

The following recommendations were suggested based on the findings:

1. Harnessing the potentials of solar energy for national development in Nigeria requires coherent policy design by the government at all levels.
2. The Nigerian government should create long-term policies and regulatory frameworks that support solar energy development
3. High upfront costs remain one of the biggest barriers to solar adoption in Nigeria. Governments and financial institutions should introduce low-interest loans, subsidies, tax incentives, and solar leasing programs for households, businesses, and solar developers.
4. Nigeria should invest in local production of solar panels, batteries, inverters, and mounting structures**.** This will reduce import dependence and create domestic supply chains.
5. Large parts of Nigeria still lack reliable electricity. Deploying solar mini-grids and off-grid solar systems in rural communities can provide energy access quickly and cheaply compared to extending the national grid.
6. Nigeria should strengthen research institutions, technical training, and innovation in solar technologies, including battery storage, grid integration, and AI-based energy management. This improves efficiency and sustainability of solar systems

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