Carbon Emission Reduction and Strategies in Nigeria: A Sustainable Practice For Environmental Impact & Economic Development: A Review Paper

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ABSTRACT

This review paper, explores the critical need for effective carbon emission reduction strategies in Nigeria. It provides an overview of national carbon emissions, emphasizing the importance of mitigating emissions in the Nigerian context, given the country's vulnerability to climate change and its reliance on fossil fuels. The methodology involves a comprehensive analysis of existing literature, policies, and case studies related to carbon emission reduction, focusing on key sectors such as energy, transportation, and agriculture. The results highlight the effectiveness of various strategies, including policy and regulatory approaches, technological innovations, market-based mechanisms, and societal changes, in reducing emissions while supporting economic development. The study recommends a holistic approach that integrates these strategies, supported by consistent policies, increased investment in renewable energy and infrastructure, and public engagement, to achieve sustainable development and long-term environmental protection in Nigeria.

Keywords: Carbon Emission Reduction, Sustainable Development, Renewable Energy, Nigeria Climate Strategy, Environmental Policy

1.0 Introduction

Global carbon emissions, predominantly from the combustion of fossil fuels, industrial activities, and deforestation, are a leading cause of climate change. Since the onset of the Industrial Revolution, atmospheric carbon dioxide (CO_2) levels have surged, resulting in a global temperature increase of approximately 1.1°C above pre-industrial levels, with significant consequences for the planet's climate system (Jain[1], A., *et al* 2020). The effects of these emissions are far-reaching, contributing to more frequent and severe weather events, rising sea levels, and ecological disruptions. While developed nations have historically been the largest contributors to global carbon emissions, emerging economies like China and India have recently become major emitters due to rapid industrialization (Jiang, J., *et al* 2019).

Nigeria, Africa's most populous country and one of its largest economies, plays a significant role in the continent's carbon emissions profile. Nigeria's carbon footprint cannot be underestimated given that they make up about 0.37% of the world's CO_2 emissions in 2020 (Ibrahim, H. A., *et al* 2022). The country's emissions are primarily driven by the energy sector, particularly oil production and gas flaring, which are central to Nigeria's economy. Additionally, deforestation for agricultural expansion and illegal logging are major contributors to the nation's carbon footprint. With ongoing economic growth and urbanization, Nigeria's carbon emissions are expected to rise, presenting challenges for both the nation and the global community in achieving climate goals.

Reducing carbon emissions is of critical importance for Nigeria, both environmentally and economically. The country is highly vulnerable to the impacts of climate change, including desertification in the north, increased flooding in the south, and coastal erosion, all of which threaten food security, water resources, and infrastructure (Haider, H. 2019). Addressing carbon emissions is also vital for Nigeria's economic future. The nation's heavy reliance on oil exports makes it vulnerable to the global shift towards renewable energy and decarbonization, which could lead to reduced demand for fossil fuels and decreased revenues (Williams, E. A. *et al* 2019). By diversifying its economy through investments in renewable energy and sustainable practices, Nigeria can reduce its carbon footprint, enhance energy security, and create new economic opportunities.

Furthermore, reducing carbon emissions is essential for public health in Nigeria. Air pollution, largely from the burning of fossil fuels, is linked to respiratory diseases and premature deaths, affecting over 150,000 people annually (Valavanidis, A., 2023). As a signatory to the Paris Agreement, Nigeria has committed to reducing its greenhouse gas emissions, aiming for a 20% reduction unconditionally and up to 45% with international support by 2030 (Okoh, A. I., *et al* 2020). Achieving these targets is crucial not only for global climate efforts but also for Nigeria's long-term sustainability and development.

2.0 Overview of Carbon Emissions in Nigeria

Nigeria's carbon emissions are primarily driven by a combination of activities across key sectors namely: energy, transportation, agriculture, land use changes, and industrial activities. Understanding the sources of these emissions is crucial for developing effective strategies to reduce the nation's carbon footprint and promote sustainable economic development.

A. Sources of Carbon Emissions

i. Energy Sector (Oil and Gas Industry)

The energy sector, dominated by the oil and gas industry, is the largest source of carbon emissions in Nigeria. The country is one of the top oil producers in Africa, and its economy is heavily reliant on oil exports. However, this dependency comes with significant environmental costs. Gas flaring, the burning of natural gas associated with oil extraction, is a major contributor to Nigeria's carbon emissions. Despite regulations aimed at reducing flaring, Nigeria remains one of the highest flaring countries globally, emitting millions of tons of CO_2 annually. As an emerging economy dependent on oil and gas, Nigeria's continuing waste of natural gas through flaring alone accounts for 40 per cent of total greenhouse gas emissions from Sub-Saharan Africa (Eneyo, G. A. 2022).

ii. Transportation

The transportation sector is another significant source of carbon emissions in Nigeria. The country's road network is the primary mode of transport, and it relies heavily on fossil fuels, particularly diesel and gasoline. The widespread use of aging and inefficient vehicles, combined with poor infrastructure, exacerbates emissions. Urbanization and population growth have led to

increased vehicle ownership, contributing to rising emissions from this sector. In Lagos, Nigeria's largest city, transportation is a major source of air pollution and CO_2 emissions (Maduekwe, M., *et al* 2020).

iii. Agriculture and Land Use Changes

Agriculture and land use changes also play a critical role in Nigeria's carbon emissions Adesina, F. A., *et al* 1999). Deforestation, driven by the expansion of agricultural land, logging, and the use of wood as a primary energy source in rural areas, contributes significantly to the country's carbon footprint. The Food and Agriculture Organization (FAO) estimates that Nigeria loses approximately 350,000 to 400,000 hectares of forest annually, which not only reduces carbon sequestration but also releases significant amounts of CO_2 stored in trees and soil (Saka-rasaq, O. 2019). Additionally, agricultural practices, such as the use of fertilizers and the burning of crop residues, contribute to emissions of CO_2, methane, and nitrous oxide.

iv. Industrial Activities

Nigeria's industrial sector, though less developed compared to its energy sector, also contributes to carbon emissions. Key industries, including cement production, manufacturing, and mining, rely on fossil fuels and are significant sources of CO_2. Cement production, in particular, is a major industrial contributor to carbon emissions due to the energy-intensive process of calcination, where limestone is heated to produce clinker, releasing large amounts of CO_2 (Antunes, M., *et al* 2021). As Nigeria seeks to industrialize further, emissions from this sector are expected to increase unless cleaner technologies and energy sources are adopted.

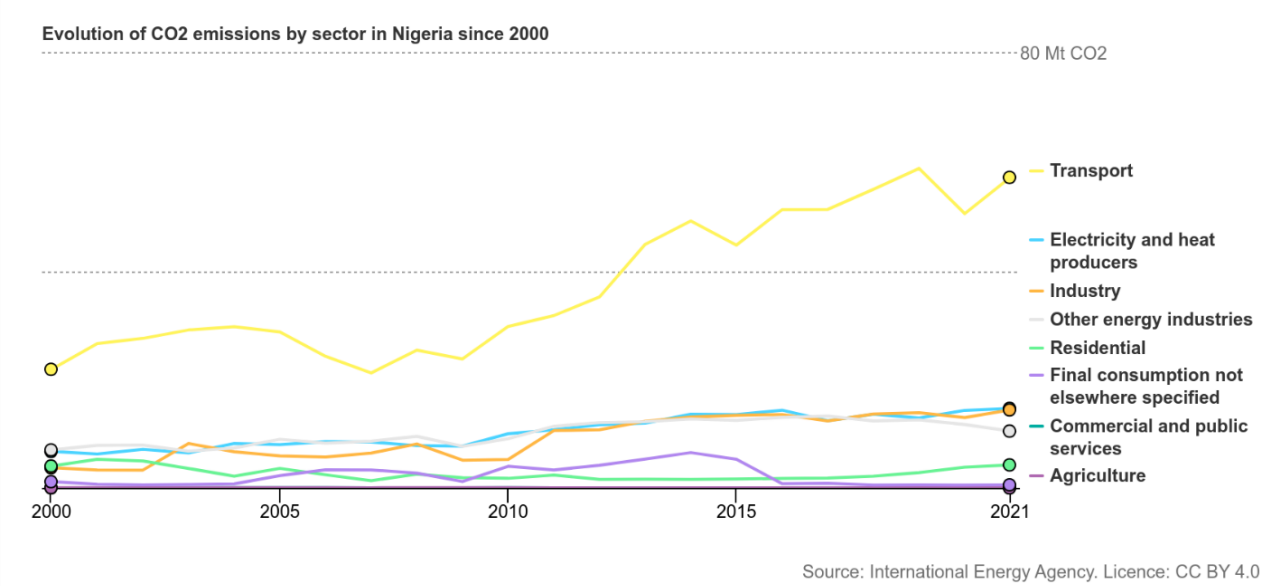

Figure 1: Graph of $C0_2$ Emissions in Nigeria (Mt) against Years (Yr).

3.0 Carbon Emission Reduction Strategies

Addressing carbon emissions in Nigeria requires a multifaceted approach that combines policy and regulatory frameworks, technological innovations, market-based mechanisms, and societal changes. These strategies are essential for reducing greenhouse gas emissions while fostering sustainable economic development.

A. Policy and Regulatory Approaches

i. International Agreements (e.g., Paris Agreement)

Nigeria is a signatory to the Paris Agreement, which commits the country to reducing its greenhouse gas emissions as part of a global effort to limit temperature rise to below 2°C above pre-industrial levels. Under its Nationally Determined Contributions (NDCs), Nigeria has pledged to cut its emissions by 20% unconditionally and up to 45% with international support by 2030 (Okoh, A. I., *et al* 2020). This international commitment forms the backbone of Nigeria's carbon emission reduction strategy, providing a framework for aligning national policies with global climate goals.

ii. National Policies and Regulations

At the national level, Nigeria has implemented several policies aimed at reducing carbon emissions. The National Renewable Energy and Energy Efficiency Policy (NREEEP) promotes

the use of renewable energy sources and energy-efficient practices. Additionally, the Nigeria Climate Change Policy Response and Strategy outlines the country's approach to mitigating and adapting to climate change, emphasizing the reduction of emissions across key sectors, including energy, transportation, and agriculture (Malley, C. S., *et al* 2021). These policies are supported by regulatory measures, such as the Gas Flare Commercialization Programme, which aims to reduce gas flaring by encouraging the capture and utilization of flared gas.

iii. Carbon Pricing Mechanisms

Carbon pricing mechanisms, such as carbon taxes and cap-and-trade systems, are essential tools for incentivizing emission reductions. While Nigeria has not yet fully implemented a comprehensive carbon pricing system, discussions are ongoing regarding the introduction of such mechanisms to encourage industries to reduce their carbon footprints (Dioha, M. O., *et al* 2020). Implementing a carbon tax or a cap-and-trade system could provide a market-based solution to limit emissions, making it more costly to emit carbon while generating revenue that could be reinvested in sustainable projects (Klein, M. 2009).

B. Technological Innovations

i. Renewable Energy Technologies

The deployment of renewable energy technologies, such as solar, wind, and hydroelectric power, is critical for reducing Nigeria's reliance on fossil fuels. Solar energy, in particular, holds significant potential given Nigeria's high solar irradiance (Ozoegwu, C. G., et al 2017). The government has initiated several projects, including the Nigeria Electrification Project, to increase access to renewable energy, particularly in rural areas. Expanding the use of renewables can significantly lower carbon emissions from the energy sector while improving energy security (Hache, E. 2018).

ii. Energy Efficiency Improvements

Improving energy efficiency is another key strategy for reducing emissions. This involves adopting technologies and practices that reduce energy consumption in industries, buildings, and transportation. For instance, the promotion of energy-efficient appliances and lighting, as well as the retrofitting of existing infrastructure, can lead to significant reductions in energy demand and

associated emissions. Energy efficiency is a cost-effective way to reduce emissions while lowering energy costs for consumers and businesses (Gillingham, K., *et al* 2006).

iii. Carbon Capture and Storage (CCS)

Carbon Capture and Storage (CCS) technology offers a promising solution for mitigating emissions from large industrial sources. CCS involves capturing CO_2 emissions from power plants and industrial facilities and storing them underground to prevent their release into the atmosphere (Shahbazi, A., *et al* 2016). While still in the early stages of development in Nigeria, CCS could play a vital role in reducing emissions from the country's oil and gas sector, especially as it seeks to balance economic growth with environmental sustainability.

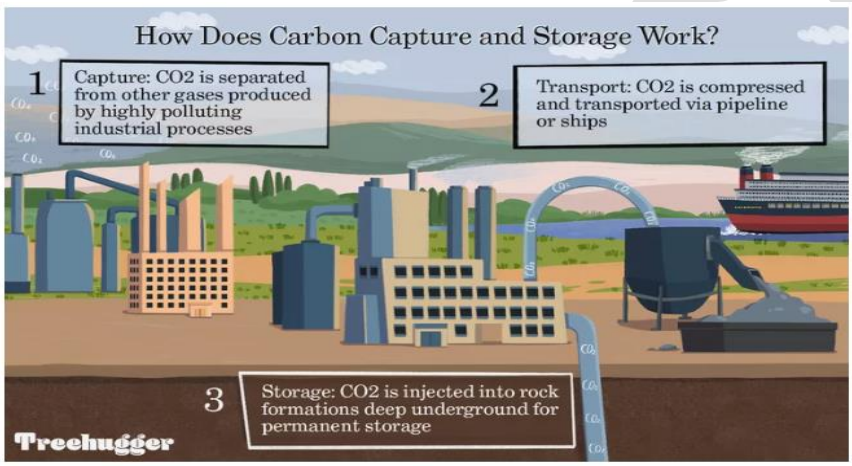

Figure 2: The basic principle for Carbon Capture and Storage (CCS).
Source: https://www.treehugger.com/carbon-capture-and-storage-5119849

C. Market-Based Approaches

i. Carbon Offsetting and Trading

Carbon offsetting and trading mechanisms allow companies and individuals to compensate for their emissions by investing in projects that reduce or sequester carbon, such as reforestation or renewable energy projects (Van der Gaast, W., *et al* 2018). Developing a robust carbon market in Nigeria could provide incentives for emission reductions across various sectors while also attracting international investment in low-carbon projects.

ii. Green Financing and Investment Strategies

Green financing involves the allocation of capital to projects that contribute to environmental sustainability, such as renewable energy and energy efficiency initiatives. The Nigerian

government, along with financial institutions, is increasingly promoting green bonds and other financial instruments to support sustainable projects (Oguntuase, O. J., *et al* 2021). These investments are crucial for scaling up the deployment of low-carbon technologies and infrastructure, which are essential for meeting emission reduction targets.

D. Behavioral and Societal Changes

i. Public Awareness and Education

Raising public awareness about the impacts of carbon emissions and the importance of sustainable practices is essential for driving behavioral change (Cordero, E. C., *et al* 2020). Education campaigns that inform citizens about energy conservation, sustainable transportation, and waste reduction can empower individuals and communities to reduce their carbon footprints.

ii. Sustainable Consumption and Lifestyle Changes

Encouraging sustainable consumption and lifestyle changes is critical for reducing demand for carbon-intensive products and services. This includes promoting the use of public transportation, reducing meat consumption, and supporting local, sustainable products. By adopting more sustainable lifestyles, individuals can contribute to broader efforts to reduce emissions and mitigate climate change (Shwom, R., et al 2012).

iii. Corporate Social Responsibility (CSR) Initiatives

Corporate Social Responsibility (CSR) initiatives are increasingly being adopted by businesses in Nigeria to address environmental challenges, including carbon emissions. Companies are investing in sustainable practices, such as energy-efficient operations and supply chain management, to reduce their environmental impact (Centobelli, P., *et al* 2018). These initiatives not only help companies meet regulatory requirements but also enhance their reputation and competitiveness in the global market.

4.0 Challenges and Barriers to Carbon Emission Reduction

Reducing carbon emissions in Nigeria faces significant economic challenges, primarily related to the high costs of implementing emission reduction strategies and their potential impact on economic growth (Elum, Z. A., *et al* 2020). Transitioning to low-carbon technologies, such as

renewable energy and energy-efficient infrastructure, requires substantial financial investment, which can strain the country's limited resources. Additionally, balancing the need for economic growth with the imperative to reduce emissions presents a complex challenge. Nigeria's economy is heavily reliant on fossil fuels, particularly oil and gas, which are major sources of revenue and employment. Shifting away from these sectors could lead to economic disruptions, job losses, and reduced government income, making it difficult to achieve emission reduction goals without harming economic development.

Technological and infrastructure barriers further complicate Nigeria's efforts to reduce carbon emissions. The current limitations of renewable energy technologies, such as intermittent supply and high costs, hinder their widespread adoption. Additionally, the country's existing infrastructure is not adequately equipped to support the large-scale deployment of renewable energy sources. For example, Nigeria's electricity grid is outdated and suffers from frequent outages, making it challenging to integrate renewable energy (Oyedepo, S. O. 2014). Furthermore, the lack of infrastructure for carbon capture and storage (CCS) technologies and the limited availability of electric vehicles and public transportation options also poses significant barriers (Lau, H. C., *et al* 2021). Addressing these issues requires not only technological innovation but also substantial investment in upgrading and expanding infrastructure to support a low-carbon transition.

Political and social challenges also play a critical role in the difficulties associated with carbon emission reduction in Nigeria. Policy inconsistencies, coupled with a lack of political will, often result in weak enforcement of environmental regulations and slow progress on climate initiatives (Howes, M., *et al* 2017). Moreover, public resistance to change, driven by a lack of awareness and social acceptance, can impede the adoption of sustainable practices. For example, the transition to renewable energy and energy-efficient technologies may be met with skepticism or resistance from communities that depend on traditional energy sources. Building public support and ensuring social acceptance of emission reduction strategies are therefore essential to overcoming these challenges and achieving sustainable development in Nigeria.

5.0 Conclusion & Recommendations

This review highlights the critical importance of implementing effective carbon emission reduction strategies in Nigeria, focusing on policy and regulatory approaches, technological innovations, market-based mechanisms, and behavioral changes. Key findings emphasize that while initiatives

such as the adoption of renewable energy, energy efficiency improvements, and participation in international agreements like the Paris Agreement are essential, significant challenges remain. These include economic constraints, technological limitations, and the need for greater political will and public engagement. The effectiveness of these strategies depends on overcoming these barriers and ensuring a balanced approach that promotes both environmental sustainability and economic growth.

For policymakers and stakeholders, it is imperative to develop and enforce consistent, long-term policies that align with global climate goals while addressing Nigeria's unique economic and social context. This includes enhancing investment in renewable energy infrastructure, implementing carbon pricing mechanisms, and fostering public awareness campaigns to drive societal change. Furthermore, a collaborative approach involving government, industry, and civil society is crucial to ensuring the successful adoption of sustainable practices. Moving forward, the urgency of addressing climate change in Nigeria cannot be overstated. Continued research and innovation are essential to refining strategies and adapting to emerging challenges, ultimately paving the way for a sustainable and resilient future.

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