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Sustainable Strategies for Low Carbon Development in Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author NVE designed the study, wrote the protocol and wrote the first draft of the manuscript. Author CCE managed the literature searches and author ASAE managed the revision process. All authors read and approved the final manuscript.

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ABSTRACT

This study investigated the possibility of achieving a low carbon development in Nigeria through the application of some sustainable strategies. The investigation was through a review of some low carbon policies applied in some country's cases. The strategies were then explored to ascertain the possibilities of replication in the Nigerian context. It was necessary due to the increase in climate change activities experienced in Nigeria. The strategies were based on some successful country case in a bid to improve their transition towards a low carbon economy. These strategies applied by other nations were investigated and explored for replication possibilities in the Nigerian context. They include; thinking and adopting the green growth ideology, energy policy reforms, long-term energy planning and target, energy regulations and standards, environmental tax reforms, urban planning, efficient building design, the efficiency of the energy system, efficiency of passenger transport system, and renewable energy options. The

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low carbon strategies presented in this study can contribute to the achievement of a low-carbon economy in Nigeria and create sustainable development.

Keywords: Low carbon development; sustainable strategies; Nigeria; case study; green growth.

1. INTRODUCTION

Climate change is recognized as one of the most significant, complex, and multi-faceted threats facing the world today. In response to this, the international community in 1992 established the United Nations Framework on Climate Change Convention (UNFCCC) to address the problem [1]. The UNFCCC is objective is to stabilize greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with climate change [2]. The principle of the convention is guided by the common, but differentiated responsibilities, and the actual response to the climate change is determined by the ability of individual countries to adapt to the changing environment and contributing to the reduction of the global GHG emission [3].

The UNFCC effort to simultaneously address climate change and advance its development may be regarded as one of the key challenges of the 21st century. Low-carbon development is a development paradigm that contributes to addressing these twin challenges. It seeks to promote economic growth and sustainable development while keeping greenhouse gas emissions low, or lower than without interventions [4]. The transition to a low carbon economy appears exciting but has its socio-economic challenges along with the transformation process [5]. Attaining a low-carbon society requires the formulation and implementation of strategic policies that are sustainable in the long term[1]. Usually, a low carbon development is followed by the move towards a green growth which results to a green society [6].

Climate change has been confirmed to affect several countries and regions, following the release of the 4th IPCC Assessment report [7]. In the study, Africa will be worst hit by the effects of climate change which Nigeria is part of it, and this makes Nigeria vulnerable to the effects of climate change [7]. Available evidence show that climate change will be global, likewise its impacts, but the severe effects will be felt more by the developing countries, especially those in Africa due to their low level of coping capabilities [8-9]. The impacts of climate change are being felt by both developed and developing countries. In a developing country such as Nigeria, green growth can be a kind of economic strategy cushion the effect of climate change and ensure sustainability in the presence of resource constraint and climate change [10]. Although the global average carbon dioxide (CO_2) emission stands at 5.0 metric tons per capita[2], Nigeria emits about 0.5 metric tons per capita[3]. Although this may seem little as compared with countries such as China with CO_2 emission per capita of about 7.6, Nigeria needs to make good strive to ensure CO_2 emission stay minimal. This study intends to explore the strategies that can provide a low carbon development in Nigeria with a view to attaining green growth[4]. This study was based on successful country cases, and a means to adopt it in the Nigerian context.

The rest of this paper is arranged as follows. Section 2 presents a discussion on the sustainable strategies that are based on the country cases. The paper is then concluded in section 3.

2. SUSTAINABLE STRATEGIES

In view of attaining a low carbon economy, some country cases that were successful needs to be investigated and explore the possibility of replication into the Nigerian context. The strategies includes; thinking and adopting the green growth ideology, energy policy reforms, long term energy planning and target, energy regulations and standards, environmental tax reforms, urban planning, efficient building design,

[1] *http://www.greengrowthknowledge.org/sites/default/files/kggp_knowledge%20note%20-series_01.pdf*

[2] *"CO2 time series 1990-2014 per capita for world countries". Netherlands Environmental Assessment Agency.*

[3] *http://databank.worldbank.org/data/reports.aspx?source=2&country=NGA&series=&period=*

[4] *According to the World Bank, green growth is the growth that is efficient in its use of natural resources, clean in that it minimizes pollution and environmental impacts, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters. The Organization for Economic Co-operation and Development (OECD) define green growth as fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies.*

efficiency of the energy system, efficiency of passenger transport system, and renewable energy options. These strategies are discussed as follows.

2.1 Thinking and Adopting the Green Growth Ideology

Over recent years, the concept of "green growth" has been making waves in the international policy scene [11]. The green growth approach adopted by the Fifth Ministerial Conference on Environmental and Development (MCED) [5] sought to harmonize economic growth with environmental sustainability, while improving the eco-efficiency of economic growth and enhancing the synergies between environment and economy. As with green economy, green growth attracted significant attention as a way out of today's economic doldrums in the aftermath of the 2008 financial crisis[6]. In 2008, the Korean Government adopted "low carbon green growth" as the country's new development vision in response to the global financial crisis [12].

The advancement to a low carbon economy and then green growth should start in the manner of thinking of not only the Nigerian government alone, but also the citizens in the country. It is not enough to say that Nigeria is the largest economy in Africa [13], while energy demand far exceeds supply. Nigeria needs to focus on shifting from quantity of economic growth to quality of economic growth. In adopting a green growth strategy, Nigeria will not only change the way its cities, industries and infrastructures are being built, but also open up opportunities for income generation. As observed in the GO scenario for the household sector, the provision of solar PV systems for household will enable electricity consumers to become electricity generators who can sell power back to the grid ("Prosumers"). This can be done through feed-in-tariff[7] (FIT) for potential household owners, while electricity generators can benefit from renewable portfolio standard[8] (RPS).

Ignoring the topic of low carbon-green growth leads to the increased cost of climate change and other natural disaster on economic growth. This has direct impact on a country's GDP as some natural disaster such as floods due to heavy rains and rising sea levels, heat waves, desert encroachment and deforestation alter economic activities[9]. Thinking green growth while implementing low carbon strategies will not only solve the energy poverty situation in Nigeria, it will also create job opportunities which will reduce the unemployment rate in Nigeria which still stands at 7.5% [14].

2.2 Energy Policy Reforms

The Nigerian Energy Policy which is also known as the National Energy Policy, was developed to ensure the optimal, adequate, reliable and secure supply of energy to, and its efficient utilization, while ensuring a sustainable development [17]. It's vital for policy reforms in the energy sector in order to keep abreast of the latest development going on in the field of energy technology. The introduction and deployment of the suggested low carbon technologies can only be actualized through energy policy reforms.

Energy policy reforms will provide a historic opportunity to identify and revitalize some ailing areas in the energy sector and bolster the overall economy. In countries such as Mexico (Romero and Castro, 2008), the United States of America [18], some European countries [19], South Korea [10] and other Asian countries [11], energy policy reforms have played important roles in low carbon-green growth. Although the Nigerian government has made some reforms in the energy sector [20], the reforms take considerable time in its implementation and the effect of most energy policies take more than 10 years to be felt. The solution to this challenges would be to reduce the lifetime of most policies and set up policy evaluation units, with the responsibility of evaluating the effectiveness of energy policies in the county.

2.3 Long-term Energy Planning and Target

According to Winston Churchill during the Second World War, "He who fails to plan is

[5] *This conference was held in March 2005 in Seoul, Republic of Korea.*

[6] *It is important to note that the concept of green growth has its origins in the Asia and Pacific Region].*

[7] *FIT is a policy mechanism designed to accelerate investment in renewable energy technologies through the offering of long-term contracts to renewable energy producers, typically based on the cost of generation of each technologies [15].*

[8] *RPS is a regulation that requires the increased production of energy from renewable energy sources, such as wind, solar, biomass, and geothermal [16].*

[9] *http://www.theguardian.com/environment/blog/2014/jul/14/8-charts-climate-change-world-more-dangerous*

[10] *https://www.iea.org/publications/freepublications/publication/Korea2012_free.pdf*

[11] *http://www.adb.org/sectors/energy/issues/sector-governance-reform*

planning to fail"[12]. A country that has no proper plans on energy for the future is bound to experience energy crisis[13]. Long-term energy planning can help mitigate not against shortage in energy supply, but also GHGs in the environment. Lack of proper planning can lead to pollution problems experienced in places such as Baoding in China[14] and some cities in India[15]. Long-term energy planning and target creates a vision and strategy which has the capacity to promote technological innovation and development in low carbon technologies [21].

The research, development and deployment (RD&D) of low carbon technologies require considerable time for both research and development (R&D), commercialization and funding. Therefore, the Nigerian government should not only plan and set targets for energy development, but also set up important sustainable infrastructure development. This will stimulate investment and improve on innovative ideas between the government and private investors. An example is cited in the South Korea where the government implemented the Five Year Green Growth Plan to stimulate the needed investment and innovations in low carbon technologies [22-24].

2.4 Energy Regulations and Standards

In moving towards a low carbon-green growth society, the Nigerian government should improve on its energy regulations and standards. This includes technical regulations and voluntary standards as being handled by the Standard Organization of Nigeria (SON)[16]. However, renewable energy standards have not been adequately developed in Nigeria and this is vital in ensuring the acceptance of renewables in Nigeria [25]. The improvement on energy regulations and standards will provide an enabling environment and incentives, increase renewable energy consumers and business owner's confidence in deployment, and encourage innovation and commercialization of low carbon-green technologies [26-29]. The realization of a low carbon society will require a stronger commitment by the Nigerian government in improving energy regulations and standards. This includes a range of standards such as; emissions, energy efficiency, fuel efficiency, energy efficiency building in both residential, commercial and industrial buildings. The effect of this policies were observed in the scenario analysis.

An example of a standards that can be enforced as a Law is the National Appliance Efficiency Standards Law. This law would ensure that every electrical appliance, either imported or manufactured in the country, would meet the minimum efficiency standards for energy consumption. The standards would cover all major household appliances (home entertainment appliances, refrigerators, freezers, washing and drying machines, electric cookers, and air conditioners), lighting products (lamps and fluorescent lighting ballasts), and other appliances used in the industrial, commercial, and service sectors of the economy [30].

2.5 Environmental Tax Reforms

Environmental tax reform is defined as the reform of the national tax system where there is a shift of the burden of taxes, for example from labor to environmentally damaging activities such as unsustainable resource use or pollution [31]. This actually means shifting the tax base to resource consumption while maintaining revenue equality which will ensure the non-increase of the overall burden of tax. This has great potential in boosting economic growth and providing employment by reducing labor cost. This is done by increasing the prices of energy resource use (for electricity, transport, household etc.) and pollution (industries, transport etc.) by their accompanying tax. The tax revenues will be used to complement those tax realized from the productive sectors of the economy [32].

This will ensure the effectiveness of policies proposed in the alternative scenarios such as fuel switching and economy in the transport sector, conversion to electric arc blast furnace in industries, and the diversification of electricity generation source such as renewables. Some countries have introduce environmental tax, they include; India [33], Iran [34], China [35], Canada [36], Indonesia [37] and the some European countries [38]. This countries recorded some considerable amount of success in their environmental tax reforms, and this can be replicated in the Nigerian case if properly implemented.

[12] *http://www.in.gov/dnr/water/files/wa-IEAP.pdf*
[13] *http://www.thehindubusinessline.com/opinion/we-lack-a-clear-view-on-energy-planning/article6875164.ece*
[14] *http://www.theguardian.com/cities/2015/may/22/baoding-china-most-polluted-city-air-pollution-beijing-hebei*
[15] *http://gizmodo.com/indias-air-pollution-is-so-bad-its-causing-lung-damage-1707775668*
[16] *http://services.gov.ng/son*

2.6 Urban Planning

The increase in urbanization rate calls for proper urban planning in cities and urban areas. This increase will also lead to increase in car ownership by the population. Most cities and urban areas in Nigeria lacks proper strategic planning [39]. The proper planning of cities with a variety of mass transit options[17] and mixed use can reduce energy demand and GHGs emission in the transport sector. The design of urban centers should emulate compact city[18] in order to reduce the need for mobility through transport. This is done by concentrating and mixing offices, commercial and residential areas, and ensuring a walkable way is provided in streets which are well connected [40].

For discouraging private vehicle use, the Nigerian government should set up a parking management authorities in urban areas [41]. An example is cited in Abu Dhabi which was struggling with its congested traffic system and increased pollution due to large number of private car use by their owners. The government through the Abu Dhabi Urban Planning Council initiated the Abu Dhabi Urban Street Design Manual which sort of guide designers in creating walkable streets to encourage people to walk instead of driving [42].

2.7 Efficient Building Design

The reduction in energy consumption in residential, commercial and industrial buildings can effectively reduce the total demand for energy and reduce GHG emission in Nigeria. Great potential exist in buildings if effective energy efficiency policies are rigorously followed. Already existing buildings in Nigeria will have to improve on energy efficiency, while new building designs should be based on low carbon building standards. According to studies by [43-46], buildings consume about 40 percent of the global energy, 12 percent of freshwater use and contributes 40 percent of the total GHG emission in the world. This is by far, a high demand for energy as compared to the alternative scenarios. This shows the need for the development of efficient buildings so as to reduce demands for energy.

Some challenges that may arise in the development of efficient building designs includes; lack of public awareness, access to financial resources and the unavailability of new efficient technologies which may be costly to the users. The introduction of energy labelling program presents its potentials for not only efficient appliance use, but also save utility bills to the consumers. The Nigerian government can use regulatory measures such as building certificate and audit programs, building codes, and appliance standards for high efficiency to aid in improving energy efficiency in buildings. Other means that can be used by the government are through fiscal incentives, which can come in forms of grants, subsidies and tax exceptions which are awarded to residential, commercial and industrial buildings employing energy efficiency measures. This will be useful in encouraging industries in acquiring electric arc blast furnace.

2.8 Efficiency of the Energy System

In order to advance to a low carbon-green economy, the efficiency of the Nigerian energy system needs to be improved. This will facilitate the production and consumption of low GHG emission and energy savings. As developed in the GO scenario, the shifting from fossil fuels to renewable energy options is vital in ensuring sustainability of power supply. In connection to improved urban planning and efficient building design, the demand-side management systems and energy efficiency will contribute to the realization of a low carbon-green economy in Nigeria.

Investing in low carbon and green technology are usually expensive. The good news to this effect are the reduction in cost of investment overtime. According to the International Energy Agency [47], for every US$1 of investment in low carbon energy technology not invested before 2020, an additional cost of US$4.3 will be required to off-set the GHG emissions. This means that if the Nigerian government refuse to take actions now in investing in low carbon, energy efficiency and green technologies, the government will spend a lot out of its budget on climate disaster on the medium and long term.

Other areas of the energy system that requires efficiency improvement includes T&D as described in the alternative scenarios. The diversifications to renewables should not only be at the supply side only, but also at the demand side, especially in the household sector.

[17] *This includes the increased access to mass transit use and the discouragement of private car use the transport sector.*

[18] *Measures includes; the promotion of vertical and cluster development, encourage cellular development, and set urban growth boundaries to limit urban and suburban sprawl.*

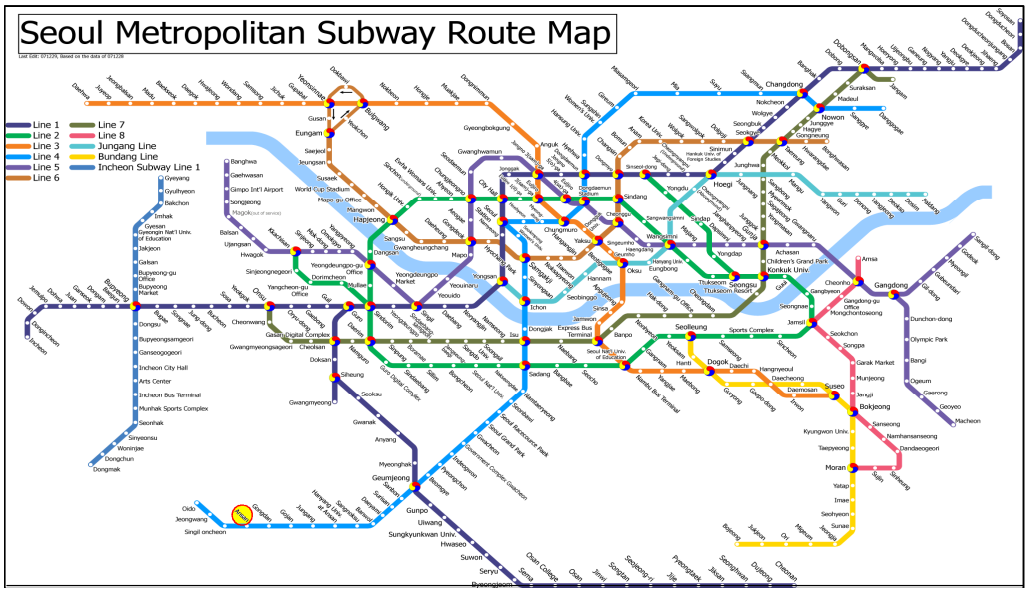

Fig. 1. Seoul metropolitan subway map
Source: Ref. [48]

In energy system should also incorporate the utilization of urban waste for energy generation as this will reduce pollution (urban waste) and contribute to electricity generation (through biomass power plants).

2.9 Efficiency of Passenger Transport System

Improve the efficiency of the passenger transport system in Nigeria. The transportation sector is one of the main sources of energy consumption and atmospheric pollution in Nigeria. A more sustainable transport system could be achieved if there were proper coordination of urban and transport planning to reduce light vehicle and fuel use. Policy options for a sustainable transport system include the stimulation of public transportation through the introduction of an intermodal passenger and freight transport system that will better integrate and improve the lives of Nigerians. A specific example is the Seoul Metro System in Seoul[19], South Korea, as shown in Fig. 1.

This subway system can reduce energy use in cars and buses for urban movement. For the Nigerian government to facilitate and implement this option, some strategies should be explored. These strategies include the promotion of subway use, expansion of the public transport infrastructure, use of urban tolls, increase in the cost of automobile parking spaces in congested urban areas [20], restrictions on the use of automobiles to reduce congestion and air pollution in major cities, and improvements in telecommuting policies in Nigeria.

2.10 Renewable Energy Options

Ensuring a low carbon economy is never complete without the introduction and integration of renewable energy technology into a country's energy system. Renewable energy plays a vital role in meeting the needs of both rural and urban areas of a country regarding of sustainable development [51]. The Nigerian government should take up the development of renewable energy technologies as its top priority especially now that the issue of climate change and global warming is among the most critical issues discussed by the various government of the world. Nigeria is blessed with an abundance

[19] *The Seoul Metropolitan Subway is known as the world's longest multi-operator metro system by route length, and consists of 18 lines that serve the Seoul Metropolitan Area. The subway system is packed with advanced technology such as 4G LTE, WiFi, DMB, and WiBro services. Most of the trains are equipped with digital TV screens; all the trains are air conditioned, and include climate-controlled seats that operate automatically during the winter. All the subway lines use the T-money smart payment system using RFID and NFC technology for automatic payment by T-money smartphones or credit cards, and one can transfer to any of the lines within the subway system for free.*

[20] *These could be through a parking management policy as discussed in Johansson and Nakićenović [49], and Jaccard et al. [50].*

amount of renewable energy resources that must be fully harnessed, developed, and appropriately utilized [52].

The Nigerian government needs to develop effective policies that will attract Foreign Direct Investment (FDI) into the country. The FDI will aid in the investment of renewable energy technology and knowledge transfer to Nigerians [53]. It is also possible if the government develops favorable investment climate for both foreign and indigenous investors in the field of renewable energy [54]. The government should also develop an effect policy for the rapid expansion of biofuels. It will aid in the growth of the ethanol industry by direct investment [55].

The government should establish a National Innovation System with a special focus on renewable energy development [56]. This system has been adopted by the Brazilian government in the 1970s to address its energy situation in a sustainable manner [57]. Other renewable energy options include the inclusion of Renewable Portfolio Standards (RPS), Net Metering Policy and Tendering (or auctioning), and Biofuels Obligation Policy [58]. These options should be effectively adopted to fit the Nigerian context.

3. CONCLUSION

The aim of this study was to review some sustainable strategies for achieving a low carbon development in Nigeria. It's necessary due to the increase in climate change activities experienced in Nigeria. The strategies were based on some successful country cases in a bid to improve their transition towards a low carbon economy. These strategies taken by other countries were investigated and explored for replication possibilities in the Nigerian context. They include; thinking and adopting the green growth ideology, energy policy reforms, long-term energy planning and target, energy regulations and standards, environmental tax reforms, urban planning, efficient building design, the efficiency of the energy system, efficiency of passenger transport system, and renewable energy options. In achieving a low carbon economy, some challenges will occur along the way, but the continuous commitment by the government will see to the advancement of Nigeria to a low carbon society intending to attain green growth in the future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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