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Conquering Energy Poverty in Nigeria: Lessons from Countries Transitioning to Green and Clean Energy

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Abstract

Overcoming energy poverty is a crucial measure in achieving sustainable development and enhancing the living conditions of millions of people. Despite having ample energy sources such as solar, wind, biomass, crude oil, natural gas, and coal, Nigeria has about 80 million individuals suffering from energy poverty. This situation is exacerbated by the global energy crisis, with a multiple vulnerability situation due to climate change. Therefore, Nigeria must shift to green (renewable) and clean energy sources. This paper adopts a doctrinal and comparative research approach to explore the lessons Nigeria can learn from other developing countries and a former fossil-dependent nation that are transitioning to green and clean energy. The countries provide valuable insights into crafting efficient policy frameworks, creating renewable energy infrastructure, and involving stakeholders in the transition process. The paper stresses that Nigeria's comprehensive and inclusive energy strategy should prioritize providing all citizens access to economical and clean energy, promoting sustainable economic growth and environmental preservation. Ultimately, the paper concludes that through this approach, Nigeria can unlock its potential as a leader in Africa's energy sector and quicken its transition to a prosperous and green future.

Keywords: Climate Change, Energy Poverty, Global Energy Crisis, Climate Emergency, Sustainability Science

INTRODUCTION

Climate change exacerbates current vulnerabilities leading to 'multiple exposures' for communities struggling with other forms of lack. Energy poverty in Sub-Saharan Africa, particularly in Nigeria, means an increased vulnerability for the millions of individuals already highly vulnerable to climate change impacts. Green energy sources such as solar, hydropower, and wind have been advocated for climate change mitigation because they do not add greenhouse gases to the atmosphere (Owusu and Sarkodie, 2016). Meanwhile, it is also being seen that a strategic deployment of these green energy sources could help ameliorate energy poverty (Indirati, 2015). As argued by the UN Secretary-General for Sustainable Energy for All, Damilola Ogunbiyi, unless access to affordable, clean, and sustainable energy (SDG 7) is achieved by 2030, the global goal of net-zero emissions by 2050 would be near impossible (Ogunbiyi, 2021). It may not have been apparent in the past, but the established link between the use of fossil fuels and climate change suggests that any measures to democratize energy or eradicate energy poverty must consider the climate.

In response to the global climate emergency - which transcends national borders - the United Nations has adopted global institutions, frameworks, and agreements. Notably, Nigeria became a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) on June 13, 1992. In her efforts to participate in international climate change discussions, Nigeria ratified the Kyoto protocol on December 10, 2004, and the Paris Agreement on May 16, 2017. The Nigerian Climate Change Act 2021 was signed into law by President Muhammadu Buhari on November 18, 2021. This assent came after the UNFCCC Conference of Parties (COP 26), which took place in Glasgow, Scotland, from October 31 to November 13, 2021, where world

leaders set a net zero target by 2060. The Climate Change Act 2021 formally establishes a robust framework to shoulder the full responsibility of climate change governance, building not only on the work the climate change department of the Federal Ministry of Environment is doing but also on the commitments set out as a signatory to the Paris Agreement. It remains to be seen how the Act would help achieve Nigeria's commitments to the UNFCCC.

In this paper, we interrogate the research question: How can transitioning to green and clean energy sources help fossil-dependent developing countries overcome energy poverty? In the rest of the paper, we highlight the intersection of the climate emergency, energy poverty, and the global energy crisis. Next, we present case studies of countries that are either developing or fossil-dependent who are overcoming energy poverty and transitioning to a dominant use of green energy sources in their economy. Also, we highlight a case in Nigeria of clean energy transition. Finally, we draw lessons to support the transition of fossil-dependent developing countries across Sub-Saharan Africa to green and clean energy.

CLIMATE EMERGENCY, ENERGY POVERTY, AND THE GLOBAL ENERGY CRISIS

It is unequivocal that anthropogenic climate change has resulted from human activities since the industrial revolution. After many years of providing evidence relating to climate change, thousands of scientists from about 153 countries declared a climate emergency in 2019 based on available data and the trend of vital planetary signs (Ripple et al., 2020). There are many good reasons for the emergency, including and not limited to the increased frequency and intensity of extreme events, such as heat waves (Ripple et al., 2021). Meanwhile, climate action in mitigation, adaptation, and resilience building has been mostly slow in implementation and financing. Thus, one could argue that the declaration of a climate emergency became necessary in part, given the slow rate of climate action and progress by nation-states.

In energy studies, energy poverty is defined as insufficient access to electricity or household energy dependence on biomass burning (Padmanaban et al., 2021). In many ways, energy poverty relates to insufficient access to energy infrastructure. Within Africa, Nigeria has the highest energy deficit - referring to people without access to electricity (Okoh, 2022). The World Bank estimates that about 43% of the nation's population does not receive grid electricity (World Bank, 2021). Energy poverty in Nigeria varies between rural and urban communities. Rural communities experience the twin problems of the lack of electricity and dependence on biomass burning (e.g., firewood and charcoal). Meanwhile, urban areas are mostly beset with the problem of inadequate electricity.

Interestingly, energy poverty is not a global south problem and can also be found in the global North (Bednar and Reamed, 2020; Bouzarovski et al., 2012). However, in terms of proportion, a greater percentage of the population of the global south arguably experience energy poverty. To understand the scale of the problem in Africa, one could consider how about a billion people share 81 gigawatts of power - the same amount that Germany produces daily for 83 million people (Ogunbiyi, 2021).

The global energy crisis began in 2021 as a tightening in global energy markets due to the COVID-19 pandemic and grew after the Russian invasion of Ukraine in 2022 (IEA, 2023). Before lockdown restrictions were lifted during the pandemic, natural gas, coal, and electricity prices were at record lows due to reduced global energy consumption. However, following the easing of pandemic restrictions, energy prices surged with the greatest increases in the price of natural gas (IEA, 2021). Russia's subsequent rationing of natural gas to Europe and Europe's later boycott due to Russia's invasion of Ukraine has increased gas prices. Expensive gas has led to the substitution by some with coal - leading to higher coal prices. Increases in the prices of natural gas and coal have increased electricity costs. International oil prices have not been left out, and this soared after the European, US, and UK 'ban' on Russian oil. According to the International Energy Agency (IEA), "energy prices have been rising since 2021 because of the rapid economic recovery, weather conditions in various parts of the world, maintenance work that the pandemic had delayed, and earlier decisions by oil and gas companies and exporting countries to reduce investments" (IEA, 2023). The global energy crisis can be summarized as 'higher energy prices leading to a shortage of affordable energy.'

A trickling down of the global energy crisis in Nigeria has seen cooking gas prices rise exponentially. Arguably, one of the reasons for this is the apparent import of almost 50% of the cooking gas used by Nigerians (Majeed, 2022). Given the foregoing, one could argue that energy poverty in Nigeria is being exacerbated by the global energy crisis.

Nigeria contributes to and is affected by the climate emergency, energy poverty, and the global energy crisis. Farmers are experiencing heightened climate variability, which is interfering with bountiful harvests - thus threatening food security. The redistribution and change in the timing of rainfall are exacerbating farmer-herder conflicts. More intense storm surges along the Atlantic coast continues to lead to greater loss of lives and property, while multi-year droughts are being recorded in Northern Nigeria. Given the preceding, climate actions involving mitigation, adaptation, and resilience building are crucial to the nation's sustainable development.

METHODOLOGY

Study Area

Nigeria is a resource-rich country boasting an abundance of energy resources, including solar, wind, biomass, crude oil, natural gas, and coal (Dosunmu and Omayone, 2003). These conventional energy sources are the mainstay of Nigeria's energy supply, yet they are depleting rapidly. In 1995, fuel wood accounted for 50.45% of energy consumption, petroleum products 41.23%, natural gas 5.22%, and hydroelectricity 3.05% (Orimoogunje et al., 2015). Estimates show crude oil reserves at 23 billion barrels, natural gas at 4293 billion m3, coal at 2.7 billion tons, tar sands at 31 billion barrels of oil equivalent, and hydropower at 10,000 MW installed capacity (Oyedepo, 2013). The drive for renewable and clean energy use in Nigeria is important due to the unsustainable dependence on fossil-fuel powered generators and their harmful impacts on health. Residents of both rural and urban areas have had to invest in these generators as well as considerably low capacity solar electricity due to the erratic supply of electricity from the national grid to many parts of the country. In

the rest of this section, we discuss Nigeria's energy resources, the key challenges of urban energy poverty, and the challenges and prospects of the regulatory landscape for renewable energy policy and projects in Nigeria.

Nigeria's Energy Resources

Nigeria's energy resources can be divided into two categories based on their renewability: renewable and non-renewable energy. Renewable energy can be replenished or generated naturally and quickly, so its availability for future use is not affected (Deshmukh et al., 2021). These examples in Nigeria include wind, solar, hydro, and biomass energy. Non-renewable, on the other hand, cannot be produced in a way that can sustain their consumption rate (Bentley, 2002). They are used faster than they can be naturally created, so their formation rate is slow. Examples include coal, natural gas, and petroleum in Nigeria. Some sources of energy in Nigeria are considered below:

Solar Energy: Nigeria lies between 5°N and 15°N of the Equator, receiving plenty of sunshine and warmth (Eludoyin et al., 2013). Thus, solar energy is an ideal power source for residential and commercial use, especially with large-scale solar farms. Nigeria receives an average of 6.25 hours of sunlight daily, with 3.5 hours in coastal areas and 9.0 hours in the North (Ezekwe et al., 1981). Solar radiation averages 5.25 kW/m2/day in coastal areas and 7.0 kW/m2/day in the North (Ajayi et al., 2014). Nigeria's solar energy resource provides 4.85 x 1012 kWh of energy daily, equivalent to 26% of the day. Nigeria has a 924 x 103 km2 area, averaging 1.804 x 1015 kWh of annual incident solar energy (Ajayi et al., 2014).

Hydropower: Nigeria has plentiful water resources that can generate hydropower, a renewable energy source representing 10% of the country's electricity (Shaaban and Petinrin, 2014). This potential yields 77,000 Megawatts (enough for 35 million homes) by converting the water flow into usable energy. The process usually involves turbines and steam pressure from boiling water, which spins wire coils between magnets to generate electricity.

Wind Energy: Wind energy has great potential in Nigeria, particularly in the northern region. Wind speed data collected from some towns reveal that the country has promising wind energy conversion systems sites. For example, Ohunakin et al., (2011) assessed the potential of wind energy across seven sites (namely Enugu, Jos, Ikeja, Abuja, Warri, Sokoto, and Calabar) with varying conditions and wind characteristics. The authors found that the annual mean wind speed at 10m above ground level is between 2.3 and 3.4 m/s in the North's highland and semi-arid regions (Ohunakin et al., 2011). In fact, an estimated 97 MWh of energy can be generated annually in Sokoto, a high wind-speed location.

Biomass and Biofuels: Biogas is a combustible gas created when organic matter — such as livestock manure, biological waste, and food scraps — decompose without oxygen in a sealed container (Hosseini et al., 2013). The main component of biogas is methane, and its residue can be used as fertilizer (Muazu et al., 2020). According to Akinbami et al. (2001), Nigeria produces 227,500 tons of fresh animal waste daily, which can be converted to 6.8 million m3 of biogas. Common feedstocks for biogas production in Nigeria include water lettuce, water hyacinth, animal dung, cassava leaves, urban waste, agricultural waste, and sewage (Giwa et al., 2017).

Oil and Gas: Nigeria is renowned for abundant oil and gas reserves, making it the largest oil producer in Africa and the 12th in the world. Oil was first identified in Nigeria in 1956, triggering exponential development in its petroleum industry and forming the core of the nation's economy (Tamuno and Felix, 2006). Oil and gas are utilized extensively in Nigeria for numerous industrial and domestic purposes, ranging from power generation to the fueling of vehicles and generators. Four major refineries process crude oil into gasoline, diesel, and kerosene products. These products are employed for transportation and heating, amongst other applications. The petroleum industry mainly contributes to Nigeria's GDP, accounting for 90% of total exports and 60% of government revenue (Okeke, 2019).

Coal: Nigeria has used coal as a commercial energy source since 1916 - peaking at nearly 1 million tons in 1959 (Oboirien et al., 2018). Today, coal use has declined significantly due to reduced demand and increased use of gas in thermal power generation. Nigeria has an estimated 2 million tons of coal reserves, out of which 650 million tons are proven. Most of this coal is located in the Anambra Basin, from Dekina in the North to Okigwe in the south. It is mainly sub-bituminous and located in two geological formations – Mamu and Nsukka (Obaje et al., 2018).

Key Challenges of Urban Energy Poverty in Nigeria

Urban energy poverty in Nigeria presents a range of significant challenges that hinder the access to reliable and affordable energy services for urban residents. According to the World Bank, over 40% of Nigerians do not have access to electricity, and this number is even higher in urban areas. Rapid urbanization has resulted in an increased demand for energy, placing immense pressure on the existing energy infrastructure. However, this infrastructure is often inadequate, leading to frequent power outages and unreliable electricity supply. The high cost of energy further exacerbates the challenge, as many urban dwellers, particularly those with low incomes, struggle to afford electricity and clean cooking fuels. Informal settlements and slums, prevalent in urban areas, lack basic energy infrastructure, leaving a significant portion of the population without access to electricity and clean cooking facilities. Additionally, limited adoption of renewable energy sources, such as solar power, hinders the transition to cleaner and more sustainable energy solutions. Inefficient energy use practices, coupled with a lack of awareness and outdated appliances, contribute to higher energy consumption and perpetuate energy poverty in urban cities. Governance and policy challenges, including corruption, ineffective regulation, and inadequate policy implementation, further impede progress in addressing urban energy poverty.

The Legal and Regulatory Landscape for Renewable Energy Projects in Nigeria: Challenges and Prospects

There is no doubt that Nigeria has an exceptionally rich portfolio of clean energy assets to enhance the speedy and sustainable development of the renewable energy sector in Nigeria. Having a comprehensive and coherent legal framework is crucial in facilitating the efficient utilization of a country's energy resources. However, it is important to note that the mere presence of such a legal structure does not guarantee responsible management of these resources. This section examines some of the extant energy policies in Nigeria, their focus, issues and challenges.

1. *National Energy Policy 2003:* Before the approval of the 2003 National Energy Policy, Nigeria lacked a comprehensive energy policy. However, the Energy Commission of Nigeria introduced the policy in April 2003 to outline the government's stance on the development and utilization of Nigeria's energy resources, addressing environmental concerns, energy efficiency, financing, and policy implementation. The policy aims to ensure energy security by diversifying the energy supply mix and increasing the share of modern renewable energy to promote sustainable development and energy conservation. Regarding renewable energy, the National Energy Policy highlights key principles and policies, including the identification of viable energy sources such as nuclear, biomass, wind, solar, hydro, and hydrogen. It emphasizes the need for local research, development, and exploitation of these energy potentials through public, private, and indigenous participation. The policy also emphasizes the conservative use of non-renewable energy sources while ensuring reliable and affordable power access to at least 75% of the population by 2020. However, it is important to note that the National Energy Policy lacks legislative backing or the force of law. This means that neither the government nor private investors have specific statutory obligations imposed upon them by the policy. Consequently, the government and other stakeholders in the energy sector cannot be legally compelled to fully implement and execute the key objectives of the policy. This limitation poses challenges to the development of the renewable energy sub-sector, which requires consistent, committed, and pragmatic policy implementation.

2. *Electric Power Sector Reform Act (EPSRA) 2005 CAP E7, LFN 2010*: The Electricity Power Sector Reform Act (EPSRA) was enacted by the National Assembly in 2005 to address the pressing need for extensive reforms in Nigeria's power sector. The Act serves as a robust legislative foundation for the strategic and phased implementation of power sector reforms in the country. Its ultimate goal is to transition from a vertically integrated, government-owned, monopolistic market to a fully liberalized and privatized electricity market that attracts both foreign and local private direct investment. The EPSRA primarily focuses on unbundling the electricity market into three distinct functional and jurisdictional entities: generation, transmission and distribution. It allows for the incorporation of artificial entities to take over these functions through a phased and strategic approach. To ensure compliance with the Act's rules, regulations, and procedures, the National Electricity Regulatory Commission (NERC) was established as the principal regulatory institution responsible for overseeing the activities of generation, transmission, and distribution companies, as well as granting licenses for various electricity-related operations.

An essential aspect of the EPSRA is its provision for private electricity producers to enter into commercial arrangements with privatized distributors or end-users for the sale of power generated by the private producers. This includes the licensing of electricity generation, including renewable electricity, exceeding 1MW. Any renewable electricity generation, transmission or distribution project must obtain the appropriate license granted by the commission. Unlike other existing policies and rules, the EPSRA carries the force of law and can be enforced in any court in Nigeria. This means that the government and other stakeholders can be held accountable in a court of law for the enforcement of the rights and obligations enshrined in the Act. This enforceability presents a beacon of hope for the development of the renewable

energy sub-sector in Nigeria, making the EPSRA a crucial legislative instrument that provides the right direction for progress.

3. *Energy Commission of Nigeria Act (ECA), CAP E10, LFN 2010:* The Energy Commission of Nigeria (referred to as the Commission) was established by the Act first promulgated in 1979 and subsequently amended in 1988 and 1989. This Act assigns to the Commission the responsibility of coordinating and overseeing the systematic development of various energy resources in Nigeria. One of the key bodies within the Commission is the Technical Advisory Committee. Its role, as mandated by the Act, includes gathering and disseminating information on government energy development policies, troubleshooting technical issues, advising state and federal governments on energy matters, preparing master plans and policies for energy development, and collaborating with international organizations in energy-related matters. The Act aims to align the government's policy in developing, harnessing, and distributing renewable energy while also protecting the environment from the adverse effects of fossil fuels. Although the Act does not explicitly mention renewable energy development, the Commission, in line with its mandate, has developed the National Energy Master Plan and the Renewable Energy Master Plan.

4. *Nigeria Renewable Energy Master Plan 2005 and 2012 (NREMP):* The National Renewable Energy Master Plan, released in 2006, represents a collaborative effort between the Energy Commission of Nigeria (ECN) and the United Nations Development Program (UNDP). This Master Plan aims to articulate Nigeria's vision and targets for addressing key development challenges through the accelerated development and exploitation of renewable energy sources. It is based on specific economic and social assumptions, which guide its implementation. Also, a regulatory framework is provided to achieve its objectives and targets. The framework includes measures to create a level playing field, maintain a renewable portfolio standard, establish fiscal and market incentives, integrate renewable energy into non-energy sector policies, reinforce regulatory institutions, and standardize renewable energy products. It is expected that these strategies would work together to facilitate the growth and adoption of renewable energy technologies in Nigeria, thereby promoting sustainability and reducing reliance on conventional energy sources.

5. *National Biofuels Policy and Incentives 2007*: Approved by the Federal Executive Council on June 20, 2007, the policy aims to develop and promote the domestic fuel ethanol industry by utilizing agricultural products. This initiative aligns with the government's directive on the Automotive Biomass Programme for Nigeria issued in August 2005. The Nigerian National Petroleum Corporation (NNPC) was tasked with creating a conducive environment for the ethanol industry's establishment. The policy also aims to gradually reduce the country's dependence on imported gasoline, mitigate environmental pollution, and stimulate a commercially viable industry that generates sustainable domestic employment opportunities.

Expected benefits of the policy are to increase tax revenues, create jobs to alleviate poverty, enhance economic development, empower rural communities, improve agricultural activities, and energy and environmental advantages through the reduction of greenhouse gas emissions related to fossil fuels in the transport sector. In terms of the renewable energy regulatory landscape, the policy introduced several key components. These include the establishment of a Biofuels Commission, the issuance of biofuels regulations by the Minister of Petroleum Resources, the creation of a

biofuels research agency, funding for research and development in biofuels, and an incentive scheme for participants in the biofuels development sub-sector. Collectively, these measures aim to facilitate the growth and implementation of biofuels in Nigeria, to contribute to energy diversification, sustainability, and environmental preservation.

6. *National Renewable Energy and Efficiency Policy 2015*. Endorsed by the Federal Executive Council (FEC) on April 20, 2015, this policy serves as a coordinated tool to promote renewable energy development and enhance energy efficiency in Nigeria. It recognizes the limitations of the National Grid's reach and positions renewable energy (RE) as a key solution to bridge the energy access gap. The policy mandates the establishment of the National Renewable Energy Action Plan (NREAP) and the National Energy Efficiency Action Plan (NEEAP), with agreed implementation timelines. Furthermore, the policy mandates the Ministry of Power to facilitate the development of an Integrated Resource Plan (IRP) and ensure ongoing monitoring and evaluation of the action plans' implementation and effectiveness. It also establishes a framework for the sustainable financing of renewable energy and energy efficiency projects and programmes across Nigeria. Notably, the policy focuses on various renewable energy sources, including hydropower, biomass, solar, wind, geothermal, wave, and tidal energy generation.

By 2020 and 2030, the policy projects a national generation profile that includes 6,156MW and 12,801MW of hydropower, 3.4MW and 11.7MW of biomass power, 1,343MW and 6,831MW of solar power, and 631MW and 3,211MW of wind energy. Importantly, the policy mandates the government to provide guarantees and financial frameworks to stimulate the expansion of Nigeria's renewable electricity market. This commitment aims to create an enabling environment for increased private sector participation and investment in renewable energy projects, thereby fostering sustainable growth and energy transition in the country.

Given the plans and policies identified above, it would be expected that Nigeria is on its way to securing the energy future of its population through the use of renewables. However, this is not yet the case. In the Results and Discussion Section of this paper, we present some of the factors driving the seemingly intractable problem of energy poverty in Nigeria, with lessons that could be learned from country case studies.

Data Collection and Analysis

This work used secondary data from the review of energy-related data and case studies from Nigeria and worldwide. A broad online search was conducted using the search term: energy poverty. The countries identified to be success stories were then interrogated further, with three case studies randomly selected. The criteria for selection were: two developing country examples and one top oil-producing country example. The energy sector database, Enerdata, the International Energy Agency website and the World Bank ‘access to electricity data’ at https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS provided the statistics that guided the selection of the case studies. Based on the preceding criteria, we purposively selected Bangladesh and Egypt as case studies for developing countries that are overcoming energy poverty through a transition to green and clean energy sources; and the United Arab Emirates for a former fossil-dependent country that is transitioning to clean and green energy sources. We also selected Covenant University to highlight an attempt within Nigeria to transition an entire community to clean energy sources. The selection of Covenant University was based on tacit knowledge

of successful large-scale implementation of solar electricity in Nigeria.[1] The case studies were then analysed qualitatively by themes to highlight their renewable/non-renewable energy use and their progress in overcoming energy poverty.

RESULTS AND DISCUSSION

Developing Country Case Studies: Bangladesh and Egypt

Bangladesh has the world's largest national off-grid electrification programme - comprising of solar home systems (Hellqvist and Heubaum, 2023). The programme started in 2003 to connect 11,000 households and now serves over 850,000 households annually (Afzal, 2017). The government's commitment, including funding and resources, has contributed to its success. Additionally, international organizations like the World Bank have provided support. Local communities have also been actively planning and implementing the programme, ensuring that it is tailored to their specific needs and is long-term sustainable.

Innovative technologies are critical to the success of Bangladesh's off-grid electrification programme (Rahman et al., 2017). High-quality solar panels and batteries that can withstand harsh weather help reduce the programme's costs, making it more accessible to rural areas. The programme's impact on millions of rural people is significant, providing essential electricity for economic growth, reducing reliance on fossil fuels, reducing greenhouse gas emissions, and combating climate change (Islam et al., 2012). Women in rural areas, often responsible for household tasks, benefit from improved access to electricity, making their lives easier and allowing them to pursue education and income-generating activities.

Bangladesh's off-grid electrification programme has been a great success, providing millions of rural people with access to electricity and contributing to economic growth. Its success is partly due to the government's commitment, local communities' involvement, and the use of innovative technologies. Furthermore, it has positively impacted gender equality, especially for women in rural areas. This inspiring initiative serves as an example for other countries tackling similar issues.

The World Bank's testimony of the effectiveness of off-grid electricity use in increasing electricity access comes from Bangladesh, a fellow developing country, as shown in the following quote: "Bangladesh now has the largest national off-grid electrification programme in the world. Starting in 2003, with connections for around 11,000 households, the programme now connects over 850,000 households to save solar power annually" (Indrawati, 2015).

Meanwhile, Egypt has achieved 100% access to electricity for its population, a remarkable achievement considering past challenges in the power sector (Abubakr et al., 2022). The World Bank confirms that every citizen in Egypt can access electricity

[1] It is important to note that the Federal Government of Nigeria launched the Energizing Education Programme (EEP) through the Rural Electrification Agency (REA) in 2016 with the aim of introducing hybrid energy systems (including solar) to 37 federal universities. The jury is still out on the success of the programme (Adebulu, 2019; Solacebase, 2023). Covenant University is a private university and not one of the universities being considered under the EEP.

and reap its benefits (Elnozahy and Abdel-Salam, 2019). Stakeholders in the power sector have applauded this significant milestone, recognizing its contribution to economic growth, enhanced quality of life, and socio-economic progress. Egypt's investments in its power sector have been critical to its success in expanding access to electricity (Rana and Khanna, 2020). Developing power plants, increasing transmission and distribution networks, utilizing new technologies, and improving energy efficiency has decreased the nation's reliance on fossil fuels. Additionally, government-funded policies and programmes promoting renewable energy sources, like solar and wind power, have significantly impacted the energy mix; renewables currently comprise a larger percentage of electricity generation (El Safty and Siha, 2021).

The government has launched numerous initiatives to improve the electricity supply quality in the country. These include the modernization of transmission and distribution networks, increased efficiency of power plants, and the 2014 Renewable Energy Law (Mondal et al., 2019). This legislation established a framework for developing renewable energy projects, creating feed-in tariffs to reduce risks, and streamlining the regulatory process (Elsaei et al., 2023). It also mandated utilities to purchase a certain percentage of electricity from renewable sources, resulting in a more diverse energy mix and providing investors with a guaranteed market. Since the law's enactment, renewable energy now contributes 10% to electricity generation (up from less than 1% in 2014), and the government aims to increase this to 42% by 2035 (Gamal and Corvacho, 2022). The Renewable Energy Law has had economic benefits; it has created jobs, attracted foreign investment, and reduced dependence on fossil fuels.

Egypt has achieved success in increasing access to electricity. Its investments in the power sector have benefited Egyptian citizens, providing improved quality of life and economic growth. Going forward, the government should continue investing in the power sector, aiming to promote renewable energy sources and ensure the quality and affordability of electricity supply. Doing so will ensure Egypt's sustainable development and economic growth.

At the national scale, Egypt uses crude oil, natural gas, coal, and renewables as energy sources (Enerdata, 2021). According to the World Bank, as of 2020, 100% of Egyptians had access to electricity (World Bank, 2020). A laudable policy innovation of the Egyptian government is their 2014 Renewable Energy Law. The law allows the private-to-private sale of electricity from renewable sources and the private sector development of renewable energy projects, among others (Enerdata, 2021). The government has invested well in solar energy such that in 2022 solar electricity cost 2-3 cents per kilowatt hour (International Trade Administration, 2022).

Former Fossil-Dependent Country Case Study: United Arab Emirates

The United Arab Emirates (UAE) is in the Middle East and known for its lavish lifestyle, tall skyscrapers, and luxurious hotels. It is also known for its oil reserves, making the country one of the wealthiest in the world. However, with the growing concern about climate change and its environmental impact, the UAE has realized the importance of investing in clean energy (Xiao et al., 2018). In 2015, the UAE launched the Dubai Clean Energy Strategy 2050, which aims to provide 75% of the emirate's total power output from clean sources by 2050 (Krzymowski, 2020). Dubai

Clean Energy Strategy 2050 outlines the emirate's vision for a sustainable future, focusing on three key areas: energy efficiency, renewable energy, and a carbon-free economy (Naqbi et al., 2019). Energy efficiency seeks to minimize energy demand; renewable energy seeks to increase power output from renewable sources; and the carbon-free economy encourages using clean technologies to reduce carbon footprint.

The Dubai Clean Energy Strategy 2050 aims to reach a 75% renewable energy share and reduce energy demand by retrofitting 30,000 buildings by 2030 and 50,000 by 2050. Energy-efficiency technologies such as insulation, lighting, and air conditioning will be installed, along with energy-efficient building codes and regulations. Additionally, to promote electric vehicles and reduce fossil-fuel-powered vehicles, 10% of Dubai's vehicles must be electric by 2030 and 25% by 2050. Two hundred EV charging stations have been planned for 2020, increasing to 600 by 2030. Dubai launched the Mohammed bin Rashid Al Maktoum Solar Park in 2017, the world's largest single-site solar park at 5GW capacity planned by 2030 (Obaideen et al., 2021). This is part of the Emirate's Clean Energy Strategy 2050 to reduce its carbon footprint and promote renewable energy sources. Among other projects, the 1GW Dewa Shams Solar Park is also part of this strategy, and Dubai expects to source 7% of its energy from renewable sources by 2020 and 25% by 2030 (Jamil et al., 2016).

Other renewable energy sources like biomass, tidal, and geothermal energy are expected to provide the remaining 18% of energy production by 2050. The Dubai Clean Energy Strategy 2050 is a major step forward for the country regarding sustainable development. Through these initiatives, Dubai is preparing for a clean energy future that will benefit its citizens and the global community. With its ambitious targets and active strategies, Dubai is well on its way to becoming a global clean energy hub. The UAE - a hydrocarbon powerhouse- is securing leadership in the renewable energy 'revolution.' A beauty of their innovation is bringing the costs per kilowatt hour of solar to about 1.35 cents and investing in large solar plants. The UAE arguably has three world's largest solar plants (Embassy of the UAE Washington DC, 2023).

Meanwhile, the Embassy of the UAE in Washington DC presents the following account of their win-win strategic partnerships in being able to transition their energy and economy from dependence on crude oil: "The UAE is the first country in the Middle East to operate zero-carbon nuclear power, which, along with renewable energy, will provide 14GW of clean power for the UAE by 2030. In December 2009, the UAE and the US entered a bilateral agreement for peaceful nuclear energy cooperation that enhances international nonproliferation standards, safety, and security. Known as a "123 Agreement," the pact establishes a required legal framework for commerce in nuclear energy technology between the two countries." (Embassy of the UAE Washington DC, 2023). The foregoing suggests that despite being a major exporter of crude oil, the UAE is making concerted efforts to reduce its energy (and possibly economic) dependence on fossil fuels.

Clean Energy Transition Case Study in Nigeria: Covenant University

Covenant University, located in Ota, Nigeria, generates electricity through on-campus power generation and connection to the national power grid (Oyedepo et al., 2019). The university has an independent power plant capable of generating up to 8.5 megawatts of electricity, which is enough to power the entire campus (Oyedepo et al.,

2021). The power plant operates using natural gas, which is supplied to the university by a nearby gas pipeline. In addition to its power plant, Covenant University is also connected to the national power grid. This allows the university to supplement its power generation with electricity from the grid during periods of high demand or if there are issues with its power plant. The university has installed backup power systems, such as diesel generators, to ensure an uninterrupted power supply in case of outages.

Covenant University has also implemented energy conservation measures to optimize power usage (Oyedepo et al., 2021). The university uses energy-efficient lighting and cooling systems and has implemented automatic lighting controls and motion sensors to reduce energy waste. The university also encourages students, staff, and faculty to adopt energy-saving practices, such as turning off lights and electronics when not in use. Overall, Covenant University's 24-hour electricity supply results from a combination of factors, including its independent power generation, connection to the national power grid, backup power systems, and energy conservation measures.

Tackling Energy Poverty Issues in Nigeria

At the recently concluded Conference of Parties (COP 27) in Egypt, African member nations insisted on continuing oil exploration to finance development projects (Uwaegbulam and Jeremiah, 2022). Ideally, future demand for oil needs to exist for a goal of financing development projects from the proceeds of oil exploration to be achievable. Given the new policy directions of the continent's potential customers (Eg., Europe's Green Deal), African leaders may not recoup sufficient proceeds from oil to support development projects. To effectively address the climate emergency, global energy crisis, and energy poverty, it may be helpful for Nigeria to align with current foreign policy directions such as the EU green deal.

Taking a cue from the UAE, Nigeria (and other Sub-Saharan countries with a similar problem) could focus on forming strategic, ethical and sustainable win-win partnerships to achieve a development and green agenda for Nigeria and Africa while also fulfilling a related need for one or more countries willing and able to pay for our services. Meanwhile, actions by the legislature should develop from research that involves a SWOT analysis of the institutionalization of large-scale off-grid power generation and distribution. Optimum ways to encourage large-scale electricity generation from renewable sources (especially solar) and their off-grid distribution by private enterprises (through international grants and financing rather than high-interest loans) could be devised. Moreover, it is expedient that the nation reinstates its non-functioning hydropower plants. These have the twin advantage of being green technologies that help reduce Nigeria's energy deficit. However, there is a note of caution in interpreting the analysis presented. In particular, it is important to note that green energy or renewables will not solve the energy crisis for the ordinary individual if they are not affordable. Thus, Nigeria would need to focus on workforce development and manufacturing to reduce its costs in adopting (green) technologies that protect the climate.

Despite the numerous challenges facing the renewable energy sub-sector in Nigeria, there is a strong potential for its continued development and expansion in the near future. However, this can only be achieved if the right technical, financial, and legal environment is established and consistently supportive of sustainable renewable

energy development. To learn from successful models like the UAE and Egypt, the Nigerian government and policymakers should consider the following recommendations to promote inclusive and sustainable growth of renewable energy technologies in Nigeria:

a) Implement tax incentives such as Production Tax Incentives and Investment Tax Credits in the renewable energy sector. These fiscal incentives would enable companies in the sector to reduce their tax burdens during their early years of operation while enhancing operational efficiencies. This would attract technologically efficient companies to invest in Nigeria and expand the country's renewable energy capacity.

b) Provide research and development (R&D) grants in the renewable energy sector. Supporting innovation and technological advancements through government-funded R&D would address technological barriers and promote efficiency in the sector. Research funding opportunities in this area should be made available to multi- and trans-disciplinary research teams across educational institutions in Nigeria, especially. A competitive framework for results and project upscaling should be built into the grant scheme. This strategy could also be structured in a way to ensure manpower development in the deployment of renewable electricity.

c) Structure the Renewable Energy Policy Framework to accommodate participation from both the federal and state governments. This approach, similar to what obtains in Egypt, would allow state governments to implement their own initiatives to support renewable energy development while leveraging the rich renewable energy potentials within their respective states. It would complement existing federal policies and foster the development of localized renewable energy policies.

d) Ensure *effective collaboration and cooperation* among regulatory bodies to provide a favorable regulatory environment for foreign investment in the sector. Streamlining regulatory functions and avoiding duplication would instill investor confidence and attract capital and technology for the sector's growth.

e) Enact regulations to reduce carbon emissions and promote energy efficiency, thereby mitigating environmental stresses associated with high-carbon emissions. Implementing carbon emissions reduction and energy-efficiency regulations would contribute to greenhouse gas reduction, enhance energy efficiency, and mitigate the adverse impacts of carbon-intensive economic growth.

f) Facilitate the dissemination of information on renewable energy resource availability, benefits, and opportunities to the general public. Raising public awareness and engagement through informational campaigns would foster public confidence, acceptance of renewable energy technology, and attract financial resources for renewable energy projects in Nigeria.

g) Consider adopting competitive bidding mechanisms to reduce the price of renewable energy technologies through market-based pricing. However, caution should be exercised to address the risks of unsustainable price bids and extremely low energy/electricity prices to ensure the successful implementation of the bidding system.

There have been attempts to help resolve the problem of Nigeria's energy poverty at different scales, for example, certain moves by consecutive governors in Lagos State (Akoni, 2014; Obajemu, 2021). But there has been resistance at the Federal level to allow off-grid power distribution. It is important to highlight that a World Bank report on Nigeria's policy and regulatory support for sustainable energy access reveals that the country is falling short in providing its citizens with sustainable electricity and easy energy access. Nigeria received a dismal score of 10.58% out of 100% in energy efficiency and specifically in renewable energy. The report indicates that the government lacks an action plan to achieve the target of 18,508 megawatts from renewable energy sources, and it has not published research findings on the viability of solar, wind, and hydro systems in certain areas. This is concerning news for the renewable energy sector in Nigeria.

Resolving the problem of energy poverty would go a long way in building the resilience of Nigeria to climate change. It is hoped that the government and relevant agencies responsible for energy investment and resources will take significant efforts and concrete steps to diversify the energy sector by transitioning from a heavy reliance on fossil fuels to harnessing the abundant renewable energy resources in Nigeria. This transition is crucial for ensuring sustainable energy access and security for both the present and future generations. Such actions would also create opportunities for continuous and unhindered investment in the renewable energy sub-sector, which has remained largely untapped. Importantly, renewable (solar) electricity can then be added to the national grid or approved for large scale off-grid use.

Incorporating more renewable energy into Nigeria’s energy portfolio would reduce the nation's carbon footprint and count towards Nigeria's Nationally-Determined Contribution (NDC) pledge for the Paris climate agreement. This could also serve as a climate change mitigation and adaptation pathway. Overall, citizens would enjoy cleaner air and a better quality of life due to reduced pollution from biomass burning.

CONCLUSION

Drawing on the intersection of the climate emergency, understandings of energy poverty and the global energy crisis, we interrogated how developing countries on one hand, and a former fossil-dependent economy on another, are transitioning to the use of green and clean energy. We also highlight a noteworthy case in Nigeria of a community that is transitioning to clean energy use. Our presentation highlights how the cases are rising above energy poverty in the use of green and clean energy. From juxtaposing advances in the cases against the dominant energy source and use practices in Nigeria, we found that legislation to encourage large scale off-grid electricity generation is still missing in Nigeria. Also, though the Climate Change Act of 2021 is a welcome legal guide for tackling the twin evils of climate change and the energy crisis in Nigeria, the nation needs to key better into global policy drives to phase out fossil fuel and biomass burning dependence. Meanwhile, Nigeria (and other Sub-Saharan countries with similar problems) need to form strategic, ethical and sustainable win-win partnerships to achieve a development and green agenda for the continent. Finally, in pursuing a transition to green and clean energy, policy makers

need to focus on affordability as this is the crux for overcoming energy poverty. By adopting the above prescriptions, Nigeria would be on its way to overcoming energy poverty and achieving a prosperous and green future.

Disclosure

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