Journal of Agriculture, Environmental Resources and Management
ISSN2245-1800(paper) ISSN 2245-2943(online)
5(5)650-1220; Jan.2023; pp973-980

www.saerem.com

A Review on Energy Transition in Nigeria: The Challenges

Reagan N. Robinson & Anthony N. Njoku
Department of Industrial Technical Education, Ignatius Ajuru University of Education Rumuolumeni, Rivers State.
Correspondence E-Mail: robinson_reagan@yahoo.com

Abstract

Gradually the concern of the world over global warming caused by heat generated from the burning of fossil fuels is becoming an overbearing problem. The key solution globally proffered so far is energy transition. Energy transition is the process of replacing fossil fuel energy sources with zero or low carbon energy sources. On a general note, energy transition is a call to global decarbonization of the earth. It is indeed a complete paradigm shift in energy sources. However, in Nigeria the energy transition plan is still a huge challenge to surmount. This is the essence of this paper. The paper looked at the challenges confronting Nigeria with respect to energy transition plan. Before expatiating on the challenges, the paper traced the problem of global warming to the post-industrial revolution of 1750 when the burning of fossil fuels was the major energy source to development. It went further to point out how greenhouse gases emanated from fossil fuels burning, which later caused global warming due to increase in the temperature of the Earth's atmosphere. Climate change as a consequence of global warming was also highlighted in the paper. All these brought about this ongoing industrial revolution called energy transition, which is centered on renewable energy. Nevertheless, the renewable energy spearheads electrification which is the core driver to energy transition. The paper concluded that with all the expatiated challenges still standing as bottleneck in Nigeria, there might definitely be no headway to energy transition in the country. Finally, it made some recommendations based on the challenges of which one of them is; to close the gap on poor technological skill in Nigeria towards the energy transition plan, the government should engage the academics and the industries to the task of research-based development that will revolutionize energy transition.

Keywords: *Industrial-revolution, fossil-fuel, greenhouse gases, global warming, climate change, energy transition.*

Introduction

Global technology and socio-economic development took a new phase at the breakout of the widely known industrial revolution, which began in the 18th century in Britain and then spread to other parts of the world (Ray, 2011). The industrial revolution set in placed a rapid growth in virtually every facet of the global society. One of the key features was the use of new sources of energy which was mainly provided by the burning of fossil fuels to power engines and machines in order to increase production, but with less expenditure on human energy. Of a truth, the technological changes from the industrial revolution made a tremendous possibilities in the increased use of natural resources in the mass production of manufactured goods, agricultural products and machineries (Horn, Rosenband and Smith, 2010). As the industrial revolution progresses from one level to another, and into the centuries, it became obvious that one of the key sources of energy which was the burning of fossil fuels, started becoming environmentally unfriendly and hence posed a multi-faceted global problem. Most air pollution deaths recorded so far were due to fossil fuel particles and noxious gases (Zhang, 2020).

Fossil fuels are hydrocarbon (carbon and hydrogen) materials. They are naturally found in the Earth's crust, but formed from the remains of decomposing plants and animals. They are usually extracted, and burned as fuels to provide energy in the form of heat to power engines, generate electricity and for domestic cooking. The origin of fossil fuels was the anaerobic decomposition of buried dead organisms containing organic molecules created by photosynthesis. The natural conversion of these materials to a high hydrocarbon material typically takes a geological process of millions of years (Mann, Gahagan and Gordon, 2009). Examples of fossil fuels are coal, crude oil and natural gas.

Since the inception of the industrial revolution, the rate of consumption of fossil fuels has been on an increasing dimension yearly. In the year

2019, the primary consumption of energy globally was at 84%, while the global use of electricity from fossil fuels was at 64% (Wrigley, 2018). This is indeed a high state of burning fossil fuels. Hence, it has been found that the increased state of burning fossil fuels causes enormous environmental damages. It was observed that, over 80% of the carbon dioxide (CO_2) generated into the atmosphere by human activities come from the burning of fossil fuels. About 35 billion tones is generated a year compared to the 4 billion that is generated from land development. However, natural processes that remove carbon dioxide (CO_2) from the atmosphere of the Earth like absorption by the ocean and plant can only remove very small amount (Wrigley, 2018). This implies that, there are still many billion tons of carbon dioxide left in the atmosphere each year. Although methane leaks are significant,the burning of fossil fuels is the main source of greenhouse gas emissions; and the greenhouse gas emission is the direct reflection of global warming, which in turn is the cause of climate change. The adverse effects of global warming are the global drive for fossil fuels reduction, and hence the plan for energy transition. This energy transition in Nigeria has quite a good number of challenges facing it, hence the essence of this paper.

The Concept of Greenhouse Gases: Greenhouse gases (GHG or GhG) are gases that have the property of absorbing and emitting radiant energy (energy from electromagnetic radiation – radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays) from the earth's surface and re-radiating back to the earth's surface, but within the infrared range, hence causing the greenhouse effect (a warming of earth's surface and troposphere caused by the presence of greenhouse gases). Major greenhouse gases in the Earth's atmosphere are water vapor (H_2O), carbon dioxide (CO_2) and methane (CH_4); while minor greenhouse gases are nitrous oxide (N_2O), and ozone (O_3). All these gases slowly trap infrared radiation, and deny the Earth of its benefits (Ambrose, 2020). Usually the greenhouse gases have a great and conspicuous effect on the energy budget of the earth system despite being a fraction of all the atmospheric gases. The major constituents of the earth's atmosphere are Nitrogen (N_2) 78%, Oxygen (O_2) 21% and Argon (Ar) 0.9% are not classified as greenhouse gases. The non-greenhouse gases are almost unaffected by infrared (IR) radiation, because their absorption and emission rate of infrared radiation (IR interaction) is very small compare to the major greenhouse gases. The constituents of the greenhouse gases in the earth's atmosphere are Carbon dioxide (0.04%), nitrous oxide, methane, and ozone are trace gases that account for about 0.1% of earth's atmosphere and have an appreciable greenhouse effect (Ambrose, 2020).

From the earth's history, the concentration of greenhouse gases has varied substantially over the years, and these variations have brought about substantial climate changes that is affecting the world. However, findings have shown that greenhouse gas concentrations have been particularly high during warm periods and low during cold periods. Presently with the emission rate of greenhouse gases, there is increase in temperature globally by 2 °C (3.6 °F); which the United Nations' Intergovernmental Panel on Climate Change (IPCC) says is the upper limit to avoid in order not to reach dangerous levels by 2050 (Ritchie and Roser, 2020). It has been found out that human activity is a key factor to the high absorption and emission rate of the greenhouse gases. Human activities since the inception of the Industrial Revolution in about 1750 have increased the atmospheric concentration of carbon dioxide by over 50%; from 280 mg/L (milligrams per liter) in 1750 to 421 mg/L in 2022. This increase has occurred despite the absorption of more than half of the emissions by various natural carbon sinks in the carbon cycle. Fossil fuel combustion is responsible for the steady increases in atmospheric concentrations of various greenhouse gases, especially carbon dioxide, methane and ozone. This fossil fuel combustion is principally from coal, petroleum and natural gas, with additional contributions from cement manufacturing, fertilizer production, deforestation and other changes in the use of land. This increase in greenhouse has caused increase in temperature which has brought about global warming (Ritchie and Roser, 2020).

The Concept of Global Warming and Climate Change: Earth is warming up, and humans are beginning to feel the great impact of the heat. The complexity of global warming is important to understand so that the world can pay good attention to the health of the Earth. Global warming is the rise in average temperatures across the globe, which has been ongoing for over two centuries (Tian, Yu, et.al, 2022). It is a long-term heating of the Earth's surface observed since the pre-industrial period. Though this warming trend has been going on for a long time, its pace has significantly increased in the last hundred years due to the burning of fossil fuels. As the human population increases, so do their activity increases the warming. According to the National Oceanic and Atmospheric Administration (NOAA); between 1880 and 1980, the global annual temperature increased at a rate of 0.13 degrees Fahrenheit (0.07 degrees Celsius)

per decade, on average. Since 1981, the rate of increase has rose up to 0.32 F (0.18 C) per decade. This has led to an overall 3.6 F (2 C) increase in global average temperature today compared with the pre-industrial era. So far, 2016 is the hottest year on record, but that record has been closer to falling several times already (Ritchie and Roser, 2020). The years 2019 and 2020 both came within fractions of degrees of knocking 2016 off its perch. In 2020, the average global temperature over land and ocean was 1.76 F (0.98 C) warmer than the 20th-century average of 57.0 F (13.9 C).

Global warming has presented another issue called climate change. Sometimes these terms are interchangeably used, however, they are different. Climate change refers to changes in weather patterns and growing seasons around the world. It also refers to sea level rise caused by the expansion of warmer seas and melting ice sheets and glaciers (Tian, Yu, Xue, Zhuang, and Shan, 2022). Global warming causes climate change, which poses a serious threat to life on Earth in the forms of widespread flooding, extreme weather, glaciers melting, sea levels rising, cloud forests dying, and wildlife scrambling to keep pace. It has become very clear that indeed the global climate has changed. Since it has been established that human activities are estimated to have increased Earth's global average temperature by about 1 degree Celsius (1.8 degrees Fahrenheit), a number that is currently increasing by more than 0.2 degrees Celsius (0.36 degrees Fahrenheit) per decade. Hence, this current warming trend is unequivocally proceeding at an unprecedented rate. Now the question is; what can developing country like Nigeria do to slow down this human caused warming? The answer to this question is the essence of this paper. Several researchers have continued to study the problem of global warming and its impact on the Earth. It has been estimated that this problem costs over 3% of global Gross Domestic Product (GDP), and that fossil fuel phase out would save millions of lives each year (Ambrose, 2020). Therefore, it is also the opinion of the researchers that in order to achieve this goal of fossil fuel phase out, the main focus should be energy transition plan and implementation as quickly as possible.

Energy Transition in Nigeria: Obviously, Nigeria is not exempted in the global warming problem caused by the burning of fossil fuels. Unfortunately, as a developing nation the major sources of energy in Nigeria is the burning of fossil fuels, which has not only caused heavy environmental unfriendliness, but also several social vices. Gradually all these problems are culminating to reducing more the average life expectancy in Nigeria. If urgent steps are not taken, Nigeria might run into more crises that will eventually present it as a failed state. The solution is to quickly engage in the energy transition plan that is been campaigned globally. Generally, energy transition refers to a significant change of an energy system with respect to resources, structure, economics, usage and policy. A typical example is the change from a pre-industrial revolution to a post-industrial revolution era of energy systems (Smil, 2010). Considering the outcry of the world over global warming; energy transition can now be referred to as the process of replacing fossil fuels energy sources with zero or low carbon energy sources. More generally, energy transition is a significant change in an energy system from fossil based sources to a zero carbon based sources. It is a call to global decarbonization of the earth. It is indeed a complete paradigm shift in energy sources. Historically, energy transition is not a new phenomenon. In the past we have seen huge significant shifts like the transition from using wood to using coal in the 19th century, and the transition from coal to oil in the 20th century. But what makes this current call for transition different from the previous ones is that, there is an urgency of protecting the Earth's atmosphere from its greatest threat of global warming as quickly as possible, especially in the environment of developing country like Nigeria (Emodi and Boo, 2015).

The need to address global warming has led many countries like Nigeria and its businesses to focus on energy transition plan. However, due to various technical constraints, energy transition plan has not gained remarkable ground in Nigeria. Nigeria presently remains as one of the nations with the highest emission of carbon gases in the sub-Saharan countries (Oyedepo, 2014). About 295 million tonnes of CO_2 (Carbon dioxide) was estimated to be emitted in Nigeria annually, but accounting for only about 0.5 per cent of the roughly 50 billion tonnes of global annual emissions. This was part of the cause of the recent incident of flooding across several states of the country which has so far claimed over 500 lives, displaced over 1.3 million people, destroyed over 100,000 hectares of farmland, left over 2000 people injured, over 120,000 houses partially damaged and about 300,000 hectares of land completely destroyed. In Nigeria, the consequential impact on the environment and the disturbing burden placed on the socio-economy life of the society due to global warming, has to be checked with proper energy transition policy that must be followed up and implemented; however, there are challenges. Those challenges confronting the implementation of the energy transition plan in Nigeria is the premise of this

paper. It requires a headlong engagement by taking a good look at the challenges first, before introducing a more effective and responsive approaches to the challenges (Mohammeda, Mustafa, Bashir and Mokhtar, 2013).

The debate for energy transition took an increasing dimension in the 1990s when global warming became unbearable, and climate change calling for global attention. Since the adoption of the COP21 Paris Agreement in 2015, all 196 participating parties and stakeholders agreed to reach a zero-carbon emission state by 2050. Parties to the agreement committed to bring down global warming to well below 2 °C, preferably 1.5 °C compared to pre-industrial levels. As a result, the need to quickly ensure a rapid energy transition with a downshift of fossil fuel production was seen as paramount. However, a proper implementation of energy transition lies at the very core development of renewable energy sources (Zhang, 2020).

The Concept of Renewable Energy: Renewable energy are different forms of energy sources that does not get exhausted in supply when in use. Renewable energy can be defined as a form of energy that is *derived from natural sources that are replenished at a higher rate than they are consumed.* The renewable resources include sunlight, wind, the movement of water and geothermal heat. Although most renewable energy sources are sustainable, some are not (Zhang, 2020). These are the energy sources that are often referred to as clean energy that *comes from natural sources or processes that are constantly replenished*. Their availability is not affected by their consumption rate, hence cannot be exhausted in the near future. Though most of these renewable resources could be depleted via human indiscriminate consumption, but they can also be replenished thereby maintaining a steady flow (Uyigue, Agho and Edevbaro, 2007). The growing use of renewable energy sources is indeed the cornerstone of the energy transition plan. Since the late 2010s, it has been seen as the greatest potential to mitigate the problem of global warming. With the continuous innovations, renewable energy sources are becoming increasingly efficient and competitive, as new technologies emerge. Despite being an energy sources that generate electricity power without emitting greenhouse gases, the energy sources are also constantly renewed (Emodi, and Boo, 2015). In an actual sense, the energy used is never actually renewed but rather transformed into electricity. For instance, this transformation tendencies come from energy sources like the wind and sunlight which renew themselves independently of whatever use is made of them as opposed to fossil fuels such as coal and oil.

These benefits of renewable energy are not only for the mitigation against climate change, but also for the socio-economic life of the Earth. The digitalization of electricity grids can bring about smart grids to consumers; renewable sources can reduce pollution; and coal-fired power stations can be repurposed with circular economy principles. On sustainability, the new jobs created can absorb people working in the previous transition sectors. The renewable energy transition actually includes a shift from internal combustion engine powered vehicles to more public friendly transportation system like electric vehicles. Nevertheless, electricity generated through renewables is the core energy driving the energy transition towards decarbonization (Tian, Yu, Xue, Zhuang and Shan, 2022).

Renewable Energy in Driving Electrification: Renewable energy resource is all about new means of electrification with zero or very low carbon emission. Contextually, electrification means the gradual transition of electricity from the fossil fuels energy sources to the renewable energy sources for public and private services and activities. Wind power and solar power (photovoltaic systems - PV) technologies have the greatest potential to electricity generation and reduction of carbon emission. However, both have higher potential for growth. Hydroelectric (electricity through movement of water) technology is the largest source of renewable electricity in the world, but its growth potential is limited. Hydroelectric is therefore considered as dispatchable renewable energy source, while solar and wind are considered as variable renewable energy sources. Energy storage technologies also play a key role in the renewable energy sources. The largest scale storage technology is pumped storage hydroelectricity. Other important forms of energy storage are electric batteries and power to gas (Murtaugh and Krystal, 2021)

In recent years, photovoltaic and wind energy have joined more matured technologies such as hydroelectric and geothermal power, which are quickly becoming the attractive transition that is up coming. The result is a genuine paradigm shift focused on decarbonization, with a gradual move away from fossil fuels and the consequent decommissioning of coal-fueled power stations. Developments in new sectors such as tidal power and green hydrogen may soon contribute to the transition, while energy storage technology systems can make up for intermittent nature of sources such as solar and wind (Smil, 2010). The process of electrification for consumption at

certain sectors, and the digitalization of both industrial procedures and electricity grids, are all helping to improve efficiency in the renewable energy. For instance, electrification through renewables energy can also improve industries like shipping, aviation, mining and other heavy industry by using green hydrogen source. Indeed, electrification through renewables is the most effective way to bring about the energy transition. It is only by decarbonizing electricity generation that we will be able to halt global warming, which is currently threatening the planet (Scholten, Criekemans and Graaf, 2020).

The Challenges of Energy Transition in Nigeria: As businesses of many countries gradually transit to a zero-carbon energy sources, developing country like Nigeria is also reeling out its plan towards the energy transition. A plan to improve the energy transition system will definitely improve the socio-economic life of the country. Meanwhile, the pursuit for the energy transition plan in Nigeria is presently believed to be very low, but with considerable potentials. However, these potentials are being confronted with many challenges, let's consider some of them.

1. **Poor Public Awareness of Energy Transition:** One of the key challenges to energy transition in Nigeria is poor public awareness. Nigeria officially launched its Energy Transition Plan in August 2022, in order to show its commitment towards the decarbonization of the Earth's atmosphere, and also drive economic growth. The plan focused on Nigeria's pathway to achieving net-zero emissions by 2060. The Vice President Yemi Osinbajo and other key players in the energy industry were part of the launch, yet the public awareness was still poor. It is quite disheartening that most part of the populace, both the learned and the unlearned are yet to understand the programme called energy transition. They are yet to be acquainted with what energy transition is all about; how it impacts them, the benefits therein, and the need to follow the plan. Although the government had been fighting hard on the decarbonization of the environment, but the campaign of using energy transition as a means is very poor. Till now, the Nigerian citizens don't understand how internal combustion engine vehicles and diesel generators increase the amount of carbon in the atmosphere. On a serious note, there is a clear need for Nigerians to openly engage themselves more critically and robustly, beginning from the grassroot in conversations on our global climate future. More importantly, there is need for every Nigerian to take ownership of the energy transition pathways of the nation and put in place a proper plan that will address its growth (Ritchie and Roser, 2020).
2. **High Cost of Transiting:** Another key challenge to energy transition in Nigeria is the high cost involved in energy transition. At the launch of Nigeria's energy transition plan, the government said it will need about $410 billion (about ₦308 trillion) to reach Net-Zero by 2060. But the fundamental question in the heart of the government was the how in getting such huge amount of money. It is indeed a high cost of transiting from the current carbon energy sources. For instance, to make energy transition possible, there is need to invest on new technological advancement and its sustainability. But the financial involvement in such new technologies and its sustainability inevitably raises a high cost implication. The International Energy Agency (IEA) estimated globally that over the next decade, $1 to 1.3 trillion will be required to invest mainly in renewable energy, plus up to $1 trillion per annum in energy sustainability (Ritchie and Roser, 2020). Honestly, the scale of financial involvement in the energy transition plan is clearly huge. All these huge costs are literally not within the reach of Nigeria. However, it was advised that prior to the formal flag-off of the energy transition plan, the country should explore bilateral support from foreign countries in getting international funding, which the government needs for the capital-intensive energy transition plan. This was part of the premise that made the UK government at COP27 to provide £95 million fund to support climate-resilient agriculture, or CRA, in Nigeria.
3. **Lack of Requisite Technological Skills:** Considering the level of innovative skills required to completely transit to the net-zero carbon emission state; the energy transition plan has been declared globally as the next industrial revolution of the world. This industrial revolution for energy transition requires new technological advancement especially in electrification (Ritchie and Roser, 2020). Unfortunately, Nigeria as a country lacks the requisite technological skills to embark in any of the key advancements. For instance, one of the main causes of air and noise pollution in cities is the exhaust of vehicles powered by internal combustion engines. But switching the current cars on the road to electric vehicles would be of significant contribution in reducing local pollutant concentrations. This is especially true of NO_2 (nitrogen dioxide), which will thus also reduce the number of premature deaths. In this energy transition, electric vehicles are a major turning point in public transportation, as most developed countries are already transiting to electric transport

systems as a backbone to smart cities of the future. Another main cause of air pollution in the cities is the cooking and heating systems in our homes and buildings. According to a European Union (EU) survey that was carried out specifically for the energy transition plan; the use of heat pumps and extensive renovations that fully integrate smart technologies will mean that electricity will grow from 42% of final energy demand in 2030 to 72% in 2050 (Murtaugh and Krystal, 2021). This is possible with them because they possess the requisite technology, but contrary is the case with Nigeria, and this is one of the biggest challenges of Nigeria in this energy transition plan.

4. **Poor Policy Regulation:** Poor policy regulation is another key challenge of Nigeria in this energy transition plan. Globally, perhaps the most important driver of this current energy transition compared to the previous transitions is that it is being driven by government policy and regulation. This current energy transition plan is indeed driven by a different policy stage. For instance, policy to reduce global warming, policy to mitigate climate change, policy of transition process, regulation to technological introduction, electrification regulation and marketing policy. Nigeria as a country has been known for its policy summersault for many years now. A typical example is the privatization policy that breed high level of corruption in the society, and the sudden change of mind. In addition, the current failure of market prices on petroleum, goods and services in the society at large is quite disturbing. Policy makers are already foreclosing that the same poor policy regulation might plague the energy transition plan. As a result, the renewable energy and other carbon-free forms of energy might ultimately suffer in policy regulation to drive the intended industrial revolution (Ambrose, 2020). Obviously, it is impossible to run the energy transition plan without the support of good government policy regulations to encourage investment. Indeed, having good government policy and regulation to drive the energy transition in Nigeria is a big challenge that must be given attention.
5. **Negative Influences of *International Oil Companies* (IOC):** *International Oil Companies* (IOC) are oil companies that trade on oil or gas related product internationally or publicly. The jobs of these companies cut across the entire petroleum value chain from oil exploration and production (upstream) to transport, refining, and marketing (downstream). They contribute heavily to the climate change problem in Nigeria by polluting the atmosphere with carbon gases through their exploration activities. Unfortunately, their activities cannot be stopped because they provide about 80% of Nigerian revenue. Besides, every effort to ask them to improve on their activities in carbon gas emission, has been met with strong opposition from indigenous interest groups sponsored by the OICs (Ray, 2011). They understand the vulnerability of Nigerians, hence they will negatively influence Nigerians against each other. These negative influences are to enable them continue in their carbon emission activities despite the growing environmental, social and economic concerns of the nation.

One way these oil companies are able to continue their negative influences is through lobbying efforts within the host communities and the government. Lobbying can be defined as the conduct of activities aimed at influencing people in carrying a proposed bidding, especially through financial inducement. This influence of lobbying from these oil companies have been quite successful for many years in a country like Nigeria. For about 20 years up to the year 2005; some of the big oil companies in Nigeria have spent millions of dollars in anti-climate change lobbying and providing misleading information about climate change to the general public. They have successfully influenced the Nigerian system negatively in order to continue their exploration activities even at the detriment of lives, development and economy of the country (Uyigue, Agho and Edevbaro, 2007). Again, this is one of the greatest challenges of energy transition in Nigeria, and it is hydra faceted due to corruptions. **Conclusion:** It has been globally been accepted that the burning of fossil fuels has brought about greenhouse gases emission into the atmosphere especially since after the industrial revolution of 1750. This has increased the Earth's atmosphere with an average temperature of 1.02°C warmer in 2020 than the last 50 years. This increase in temperature has brought about g**lobal warming,** hence causing climate change like melting of the polar ice caps, rising of sea levels and extreme weather events such as hurricanes, floods and fires. All these clamored for solution, and the main solution is to engage energy transition plan based on renewable energy sources. A huge contribution to renewable energy sources come from electrification. However, it can be established that energy transition is near impossible in Nigeria due to those expatiated challenges facing the country. Therefore, if those challenges are still standing as bottleneck in Nigeria, there might definitely be no headway to energy transition; except they are considerably addressed. **Recommendations:** A public awareness sub-unit of

the energy transition committee should be set up to go around the country at the local community levels. This unit is expected to create very strong sensitization that will cause citizen to be aware and commit themselves towards energy transition. Since energy transition has high cost implication in Nigeria, there is need to create public-private partnership in financing the plan. This partnership can also involve foreign companies. Asking for the support of foreign economic partners can also help.To close the gap on poor technological skill in Nigeria towards the energy transition plan, the government should engage the academics and the industries to the task of research-based development that will revolutionize energy transition. To eliminate poor policy regulation in Nigeria towards the energy transition plan, a proper legislation with consequences should be carried out and properly implemented right from the grassroot to the top. The legislation should ensure that the high and mighty in the society are not spared, in order to serve as deterant. International Oil Companies (IOC) in Nigeria influences and cover up bad conducts because there are too many corruptions in the system. If these corruption sagas can be done away with in Nigeria, energy transition plan can easily be implemented in the nearest future.

References

Ambrose, J. (2020). Carbon emissions from fossil fuels could fall by 2.5bn tonnes in 2020. *The Guardian*. ISSN 0261-3077. Retrieved 27 April 2020.

Emodi, N.V. & Boo, K. (2015). Sustainable Energy Development in Nigeria: Overcoming Energy Poverty. *International Journal of Energy Economics and Policy*, 5(2), 580-597.

Horn, J., Rosenband, L. and Smith, M. (2010). *Reconceptualizing the Industrial Revolution*. London: MIT Press. ISBN 978-0262515627.

Mann, P., Gahagan, L. & Gordon, M. B. (2009). Tectonic setting of the world's giant oil and gas fields, in Michel T. Halbouty (ed.) Giant Oil and Gas Fields of the Decade, 1990–1999, Tulsa, Oklahoma: *American Association of Petroleum Geologists*, p. 50, Retrieved 22 June 2009.

Mohammeda, Y. S., Mustafa, M. W., Bashir, N. & Mokhtar, A. S. (2013). Renewable energy resources for distributed power generation in Nigeria: A review of the potential. *Renewable and Sustainable Energy Reviews 22*, 257–268.

Murtaugh, D. & Krystal, C. (2021). China's Climate Goals Hinge on a $440 Billion Nuclear Buildout. *Bloomberg*. Retrieved 2022-07-31.

Oyedepo, S.O (2014), Towards achieving energy for sustainable development in Nigeria. *Renewable and Sustainable Energy Reviews 34*, 255–272.

Ray, I. (2011). Bengal Industries and the British Industrial Revolution (1757–1857). *Routledge.* pp. 7–10. ISBN 978-1136825521.

Ritchie, H. & Roser, M. (2020). Energy: Our World in Data. Retrieved 2022 at http://ourworldindata/fossil-fuels.

Scholten, D., Criekemans, D. & Graaf, T. V. (2020). An Energy Transition Amidst Great Power Rivalry. *Journal of International Affairs*, 73 (1), 195–203.

Smil, V. (2010). *Energy Transitions: History, Requirements and Prospects*. WestPoint: Praeger. ISBN 978-0-313-38177-5

Tian, J., Yu, L., Xue, R., Zhuang, S. & Shan, Y. (2022). Global low-carbon energy transition in the post-COVID-19 era. *Applied Energy*. **307**: 118205. doi:10.1016/j.apenergy.2021.118205. ISSN 0306-2619. PMC 8610812. PMID 34840400.

Uyigue, E., Agho, M. & Edevbaro, A. (2007). Promoting Renewable Energy and Energy Efficiency in Nigeria. Report of Conference host by CREDC in University of Calabar, Nigeria on 21st November, 2007 (available online: http://credcent.org/wpcontent/uploads/2016/05/Full_Report_REEE_Conference.pdf)

Wrigley, E. A. (2018). Reconsidering the Industrial Revolution: England and Wales. *Journal of Interdisciplinary History*, 49 (1), 9–42.

Zhang, S. (2020). Air Pollution Is Killing More People Than Smoking: Fossil Fuels Are Largely to Blame. *Pacific Standard*, Retrieved 5 February 2021.