

BOOK CHAPTER | Sustainable Power Supply
dx.doi.org/10.22624/AIMS/REBK2022-P9

**Sustainable Power Supply:
A Catalyst for Economic Development In Nigeria**

France O. Akpojedje

Department of Electrical/Electronic Engineering,
National Institute of Construction Technology and Management (NICTM)
Uromi, Edo State, Nigeria.

E-mails: francetech007@yahoo.com; f.akpojedje@nict.edu.ng

ABSTRACT

This paper focuses on the sustainable power supply and ways to enhance it that will culminate into economic growth now and even in the future, it highlights the importance of sustainable power supply as catalyst to economic development and examines the works of some experts in the area. It also discusses the Nigeria's under development as a contribution of the inadequate and unsustainable power supply to it, stressing sustainable power supply as a tool for "Economic Growth and Development," which seems to be mirage presently. The paper having examined the Renewable Energy Sources (RES) as an option for achieving sustainable power supply in Nigeria, it then concluded that Nigeria as a country should encourage the implementation of energy mix involving conventional and renewable technologies to increase power supply that will achieve rapid economic development and generate employment capabilities for its teeming youths, thereby reducing insecurity and other crimes related vices.

Keywords: Sustainable power supply, energy mix, renewable technique,
Economic growth

Introduction

The inadequate electricity generation and limitations in the evacuation channel has remained a reoccurring issue in the Nigerian power sector today. This has led to epileptic power supply to consumers in the country which has imparted every facet of the Nigeria economy. It is on record by Economic Growth Theories, that there is direct correlation between a country's electric load growth rate with Gross Domestic Product (GDP).

Since energy plays the most vital role in the economic growth, progress and development, as well as poverty eradication and security (Oyedepo, 2012). Frequent power interruption in the Nigeria grid is a vital issue that is of a serious concern. Currently, the Nigerian power system is suffering from inadequate power generation, transmission and distribution capacity. Even at that, it is on record that only 52% of the Nigeria population is connected to the electricity grid with 48% of the country's population is in blackout. But according to some school of thought, that the available electricity capacity presently is insufficient to meet existing power needs of less than 40% who have access to the national grid (Ayamolowo et al., 2019).

Also, the connected population faces power problems 60% of the time (Aliyu, et al., 2015). A report done by Bello-Schuneman and Porter (2017) that only about 58% of Nigeria's population have access to the national grid and that this percentage, only about 30% of its current requirements are met. Nigeria as a country is currently facing acute problems in sustainable power supply to its consumers, which have hindered its development despite the nation's vast natural resources.

The power sector in Sub-Saharan Africa is in a pathetic state, despite several interventions. The most populous country in the region, Nigeria, is severely affected (Ebhotu and Tabakov, 2018). Nigeria with estimated population of 201million (Okafor, 2020) and its growth rate of 6% per annum (Oladipo and Olowu, 2014); still struggle to generate 6,000 MW (6 GW) with total combined installed capacity of 13.5 GW of the 25 operational plants.

The country's peak demand is 8.25 GW presently, hence with 2.25 GW and high power losses of about 7.5% in the lines with limited evacuation channel of about 5300 MW (Ebhotu and Tabakov, 2018); Nigerian power sector is far from giving sustainable power supply to its consumers. The question is what is sustainable power supply? It is simply defined as to meet the current energy demand by consumers without compromising the needs of the future load growth in the network. Presently, 48% of the Nigeria population still in the blackout, while 60% of the connected population face severe power problems as highlighted.

According to Lior (2008), Haberl (2006) and Rosen (2002) sustainable power supply involves the provision of energy services in a sustainable manner, which in turn necessitates that energy services be provided for all people in a way now and in the future, are sufficient to provide the basic necessities and acceptable to the communities and its people. Consequently, this paper examines sustainable power supply as a catalyst for economic growth now and even in the future.

Definition Of Terms

- a. **Sustainable Power Supply:** is when the electric energy generated meets the present demand without compromising the needs of the future load growth. It balances the composition between energy security, economic development and environmental protection. The sustainable power supply takes account of the incorporation of renewable energy into the existing energy mix, but it does not eliminate the efficient use of conventional to ensure sustainable energy security. Meanwhile, sustainability required four dimensions such as: economic, political, social and environmental impact.
- b. **Economic Development:** is an increase in the production of economic goods and services, compared from one period of time to another. It can be measured in nominal or real terms. Traditionally, aggregate economic growth is measured in terms of Gross National Product (GNP) or Gross Domestic Product (GDP). But the most accurate measurement of growth is real GDP. It removes the effect of inflation. The GDP growth rate uses real GDP.
- c. **Catalyst:** is defined as those substances or things that alter the rate or precipitate an event.

- d. Sustainable Electric Energy Supply as catalyst will facilitates or encourages Economic Growth without necessarily depleting itself. Sustainable energy (power) supply is the stamina of every modern economy and acts as a catalyst to industrialization of a nation. Thus, Sustainable Power Supply is an enhancer for Economic Growth (Development) without distorting itself in the process.

State Of The Nigeria Electricity Grid

The Nigeria electricity generation is dated back to 1896 with the use two generators to provide 60 kW to consumers. That is the total energy demanded by consumers is less than 60 kW. From then, the Nigerian electricity grid continue to expand with increase in energy demand by consumers. The Nigerian electricity grid expansion started with the establishment of the Electricity Cooperation of Nigeria (ECN) in the year 1962, later the ECN and the Niger Delta Authority (NDA) were merged with a decree to form the Nigerian Electric Power Authority (NEPA) which later metamorphosis into Power Holding Company of Nigeria (PHCN).

The PHCN was the sole custodian of the generation, transmission, distribution and sale of electric energy to consumers in the country. PHCN was later unbundled by an ACT in 2005 into GenCos (Generation Companies), TransCo (Transmission Company) and DisCos (Distribution Companies). The TransCo was known as the TCN (Transmission Company of Nigeria) which is under the control of the Federal Government.

The unbundling of the Nigeria electricity grid was in anticipation of a better services to consumers (citizens) but this hope has been dash after many years of unbundling the Nigeria electricity grid. It is on record that less than 40% of the Nigeria population have access to the grid (Ayamolowo et al., 2019). Even at that, the available electricity is insufficient to meet the needs of the 40% of the population. According to Aliyu et al. (2015) the connected population faces power problems 60% of the time, and this makes large segment of the Nigeria population to rely on alternative power supply using mostly fossil fuel to take care of their daily energy need.

This is as a result of frequent power interruptions that is recurrent in the Nigeria electricity sector. According to Akpojedje et al. (2018) the frequent power interruptions occurred due to system faults, inadequate or poor power generation and equipment limitations in the system which has resulted to epileptic power supply.

The evergrowing energy need of consumers is constantly widening the gap between the energy generated and energy demand. The country installed generation capacity is about 13.5 GW and the generated capacity is 6 GW, while the peak energy demand is 8.25 GW. This establishes the energy supply gap between the energy demand and supply. The poor state of the Nigeria grid has forced the rural dwellers that are deprived of electricity supply to depend on wood fuel as source of light and cooking medium. It is on record that over 70% of Nigerians living in the rural areas make use of wood fuel and consumes over 50million tonnes of wood fuel annually, a rate which exceeds the replenishment rate through various afforestation programme (Oyedepo, 2012).

Sustainable Power Supply And Economic Growth

To highlight the importance of sustainable power to economic growth, lets briefly examine some experts works on the issue.

It is on record by Economic Growth Theories, that there is direct correlation between a country's electric load growth rate with Gross Domestic Product (GDP). Many experts have been able to relate Sustainable power supply importance to Economic Growth. Sustainable power supply involves the provision of energy services in a sustainable manner, which in turn necessitates that energy services be provided for all people in ways that, now and in the future, are sufficient to provide the basic necessities, and acceptable to communities and people (Lior, 2008; Haberl, 2006 and Rosen, 2002).

According to Oyedepo (2012) sustainable power supply plays a vital role in the economic growth, progress and development, as well as poverty eradication and security of any nation. Economic growth presently and in the future is critically dependent on sustainable power supply to its consumers. The sustainable power supply must be affordable, accessible and environmentally friendly. Security which is one of the bedrock of economic viability of a country and public health are closely interrelated with sustainable power supply (Ramchandra and Boucar, 2011).

Sustainable power supply enhances and contributes to the wellbeing of people and the economy of the nation. The standard of living of a given country which can be directly related to the per capita energy consumption is a measure of the per capita income as well as a measure of the prosperity of a nation (Rai, 2004). According to Rai (2004) the per capita energy consumption is a measure of the per capita income as well as a measure of the prosperity of a nation.

Sustainable power supply contributes to the sustainability of basic needs and provision of such as lightings, use of appliances, etc., thus defining the standard of living of a given country. Conversely, inadequate access to sustainable power supply contributes to poverty, deprivation and economic decline (Oyedepo, 2012). Sustainable power supply and poverty reduction are not only closely connected, but also with socioeconomic development which involves productivity, income growth, education and health (Nnaji et al. 2010). Also, Aladejare (2014) mentioned that accurate supplies of modern electricity for commercial and industrial sector now signify high economic prominence of a country.

The relationship between electricity supply and economic growth has been established, hence sustainable electricity supply and consumption have beneficial economic, social, environmental and well-being implication (Okafor, 2020). But poor electricity supply has adverse implication such as low productivity of Nigeria's SMEs and economic sectors have been attributed to poor electricity infrastructure and supply (Okafor, 2020).

It is on record that more than 800 companies shut down operations and 83,000 jobs were lost because of poor supply in 2009 and this decreased the contribution of the manufacturing sector to GDP (Okafor, 2020). Consequently, a sustainable power supply is a catalyst to economic growth now and even in the future. It can therefore be concluded that sustainable power supply plays a key role in achieving sustainable development, balancing economic and social developments of the country.

Sustainable Power Supply, A Tool For Economic Growth: The Nigeria Situation

At this juncture, we shall quickly examine the power situation in Nigeria taking into account some commentaries by power systems experts relating Africa and indeed Nigeria's under development and the contribution of the lack of adequate and sustainable power supply to it.

The inadequate electricity generation and distribution has remained a re-occurring issue in the Nigeria power sector today. This has led to epileptic power supply to consumers in the country which has imparted negatively on every facet of the Nigeria economy. Currently, the Nigerian power system is suffering from inadequate power generation, transmission and distribution capacity. The Nigeria as a country is currently facing acute problems in Sustainable Supply of Electricity to its consumers, which have hindered its development despite the nation's vast natural resources.

Your Black Gold, (2008), "Africa's Electricity Crisis sustains Poverty: once the sun goes down in Africa, about 75% of the population lives in world of darkness. Day-to-day living conditions suffer from no electricity. Up to 250million Africans have no electricity and are left to use kerosene lamps or burning fire... Africa needs more energy access, which will alleviate poverty by increasing local commerce, creating more jobs, enhancing incomes and improving safety". Eberhard (2009) describes Africa as an 'unplugged' continent because, at a total of 68 GW power generating capacity, the 48 countries of Sub-Saharan Africa's power production is no more than that of Spain.

South Africa alone generates about 40 GW, while the remaining nations accounts for 28GW, an equivalent of the installed capacity of Argentina. Only about 75% of the remaining 28 GW of installed capacity are currently available for generation owing to a variety of causes, including aging plants and lack of maintenance.

Former President, Chief Olusegun Obasanjo in 2001, summed the deplorable state of the Nigeria infrastructures as “the Nigeria power generation dwindled to absolute minimum and power supply meant for darkness than light.....”

The question now is: “Has the situation changed 20 years after “? NO.

Amanze-Nwachukwu, (2010), summarized the power situation in Nigeria as follows: While businesses crumble by the day owing to this long-running problem, with manufacturing companies spending so much to generate its own power pushing up costs and eating into profits, generator dealers are the beneficiaries of the rots and decays in the power sector as virtually every business in the country patronizes them. Is there any family today in this hall without a generating set with at least the popular “I Better Pass My Neighbour“ or Solar powered inverter system? In the houseThe answer is obvious: there is none.

Aliyu (2012) electricity supply that can lead to sustainable development has to be reliable, affordable, economically viable, socially acceptable and environmentally sound for the socio-economic well-being of all.

Uujamham in his Public Lecture at the Faculty of Engineering Lecture Series, University of Benin, Nigeria: stated that “to put the Transformation Agenda of Nigeria on course, Adequate Electric Power is the key, and I quote: “in dealing with these Two Transformers (electric power and human capital development) that will stimulate our Transformation Agenda, we deliberately leave the attention we pay to other sectors at the present economic level, while focusing essentially on these two issues financially, aids, priorities, information, debates, etc. As these two starts to blossom, others would then gain inspiration and flower”. He further re-emphasized that it is the biblical case of “Seek Ye First the Kingdom of Heaven and His Righteousness and All The Rest Will Be Added Unto It”. (Matt. 6:33).

For this reason, the Transformation Agenda, should centre on two transformers, the first being “Electric Power”. He concluded “Seek Ye First Electrical Power with the appropriate Human Capital Development and all others will be added unto it”. The quest for Electric Power, the prime mover is the separator between development and poverty. It is the litmus test and catalyst. It is the lack of it that has invited and cultured poverty, stagnated the growth and establishment of industries, discouraged foreign investment, stagnated capital inflow, discouraged tourism, perpetrated poverty and unemployment, resulting in street organized crime.

From the above narratives, it is obvious that Reliable and sustainable power access is the life-wire of any country economic growth. **WITHOUT SUSTAINABLE POWER SUPPLY, THERE IS NO ECONOMY.** Energy is the key, the sine qua non, to sustainable development, but unfortunately, Nigeria is becoming a "can't do" nation with respect to delivery of efficient, reliable, and sustainable electrical power to the citizens of Nigeria. The major problem facing Nigeria today apart from insecurity resulting from unemployment, is the Lack of adequate and reliable electric power supply to its citizenry.

This has greatly hampered the economic and social development of the country and is almost grinding the country to a halt. Sustainable power supply will lead to employment generation, thus reducing the high rate of insecurity in the country. In Nigeria, it is estimated that only about 10% of rural dwellers and about 40 percent of urban families have access to electricity that is usually interrupted and unreliable, and only about 30% of their demand being met.

Nigeria has various forms of energy resources including crude oil, natural gas, coal, hydropower, solar and wind, yet it is bedeviled with poor, inadequate and unreliable power supply. In spite of her wealth ironically, only about 49% of the population has access to electricity, with only about 30% of their demand for power being met. The power sector is plagued by recurrent outages to the extent that about 90% of industrial customers and a large majority of residential and other non-residential customers provide their own power at a huge cost to themselves and to the economy.

Thus, Nigeria has been tagged a 'A Diesel Generator Economy'. Electricity consumption in Nigeria is one of the lowest in the world. Despite the abundance of these potential energy resource base, a survey by TNS RMS, a leading global research organization reports that 51% of Nigerians lack access to electricity from a survey of 5000 respondents across the 36 states of the federation. Nigeria today, is a Nation Lacking in the Midst of Abundance, Poverty in Richness and darkness in the presence of illumination (sunrise).

If we compare power generation in developed nations with Nigeria, it will be observed that a ratio of close to 1million persons to 1000 MW, or 1 kW of electric power availability per person appears the minimum for all developed nations of the world. For instance, the United Kingdom, with a population of under 60million people has installed Electric Power Capacity of 80,000 MW. South Africa with about 45million population has over 40,000 MW. However, Nigeria with a population of over 150million was struggling to put on the national grid, only 3,000 MW with the hope of achieving 6000 MW by the end of the year 2012, as at then. This is far cry from about 150,000 MW of power if we are to be among the developed nations of the world.

Renewable Energy Technologies A Way In Enhancing Sustainable Power Supply In Nigeria

Considering the abundant of Renewable Energy Sources (RES) such as solar, wind, hydro, biomass, geothermal, tidal energy, etc., it is envisaged that Nigeria electric power sector will undergo a tremendous change in terms of harvesting the potentials and translating it to electrical energy that will boost the generation capacity.

Renewable technologies are technologies deployed practically for useful utilization of the abundant renewable sources for the benefit of mankind. The need to diversify the country's energy supply mix using the renewable technologies to support and enhance the existing energy supply for sustainable power supply has become imperative and it is a welcome initiative.

Energy supply mix can enhance power supply sustainability and also, improve socio-economic growth that will impact job creation, crime reduction and global warming through the use of renewable technologies. With the current global trend towards Renewable Energy Sources (RES), it is expected that RES demand and utilization will skyrocket due to environmental concerns and harmful effects of traditional fossil fuel (Ayamolowo et al., 2019). The Federal Ministry of Environment of Nigeria with the assistance of the United Nations Development Programme (UNDP) is currently implementing a policy called Nigeria Renewable Energy Master Plan (REMP).

The aim is to increase the contribution of RES for at least 10% of the total energy consumed in Nigeria by the year 2025. Joy Ogaji, the executive secretary, Association of Power Generation Companies (APGC) made the vision of the GenCos know that, the GenCos is targeting 30,000 MW generation by the year 2030 with 3,000MW from Renewable Energy Sources (RES) and 27,000MW from power plants. Similarly, the REMP made a short term, medium term and long-term plan for targeted energy harvest from Renewable Energy Sources (RES) from Nigeria as estimated of 16,000 MW; 30,000 MW and 192,000 MW respectively (Sambo, 2009). Table I presented renewable energy expected to account for 13%, 23% and 36% of the total energy generation (Ayamolowo et al., 2019).

Table I: Nigeria Renewable Energy Contribution to Electricity Generation Target (Ayamolowo et al., 2019)

Resources	Short-Term (MW)	Medium-Term (MW)	Long-Term (MW)
Hydro	2,030	6,664	67,000
Solar	5	121	505
Biomass	Nil	100	800
Wind	1	20	40

The Renewable Energy Sources (RES) are key components of sustainable power supply and development. They generally cause less environmental impact than other energy sources, cannot be depleted while fossil fuel sources are been diminished by exploration and extraction.

RES flexibility and its abundance provide assurance for sustainability and standalone system. Thus, providing economic benefits to small business and isolated population.

Wayforward: Mix Energy Supply, A Step Towards Achieving Sustainable Power Supply

Nigeria, the giant of Africa has adequate and abundance Renewable Energy Sources (RES), if well harvest and reorganized, it will culminate into sustainable power supply. It has been established that there are various ways to enhance sustainable power supply that will improve economic development now and even in the future. The abundant of Renewable Energy Sources (RES) and Energy Efficiency (EE) are two components that can ensure sustainable power supply.

Therefore, sustainable power supply involves the overall use of energy efficiency and energy mix supply. These are highlighted briefly as:

- a. **Energy Efficiency (EE):** involve improvement in practices and product that reduce the energy necessary to provide services. It encompasses conserving a scare resource; improving the technical efficiency of energy conversion, generation, transmission and end-user devices. Energy efficiency products help to do more work with less energy. Rosen (2009) defined energy efficiency as essentially using less energy to provide the same service.

In Nigeria today, a lot of energy is wasted because households, public and private offices, as well as industries use more energy than is actually necessary to fulfill their needs. One of the reasons is that outdated or obsolete and inefficient equipment and production process is being used today. Since the need of energy is far outweigh it supply currently, primary energy conservation, rationalization and efficient method for use of energy is needed immediately.

- b. **Hydro Power:** Only 19% of the revealed hydro power resources is currently been explored on the larger scale. Studies show that small hydropower (SHP) potential sites exist in virtually all parts of Nigeria and these rivers, waterfalls and streams with high potentials for Hydropower, should be properly harnessed to give rise to decentralized use and provide the most affordable and accessible option to off-grid electricity services especially to the rural communities.

- c. **Solar Energy:** Nigeria has abundant solar energy resources and can learn from the example of Kenya. Kenya is the world leader in the number of solar power systems installed per capita. In Kenya most rural and remote areas, light turns on as night falls at the end of a sunny day. More than 30,000 very small solar panels, each producing 12 to 30 watts, are sold in Kenya annually. Most Kenyans prefer to cater for their electric power needs via solar systems rather than connect to the country's electric grid. Investigations revealed that out of the 185 number of hotels in Nairobi, 40 percent caters for their energy needs through off-grid sources, mostly solar.

Also, only about 20% of Kenyan household are connected to national grid, but with as little as 100 US Dollars for solar panels and wiring, the PV system can be used to charge a battery to provide each household with electric power for most part of the day. In Nigeria, solar energy resources remained untapped due to the huge financial involvement in procuring the kits. However, Kenya has evolved policies to reduce importation tariffs on solar energy kits to encourage individuals and corporations to invest and use solar to power domestic and industrial operations, and the resulting benefit is enormous. The Kenyan model, as far as solar system is concerned is hereby recommended for Nigeria to reduce the dependence on the grid and ensure sustainable development.

- d. **Wind Energy:** Nigeria can also explore its potential in the area of wind energy which is capable of generating over 50,000 MWh/yr of electricity.
- e. **Bio-Energy:** Nigeria is rich in Bio-energy resources and should explore the opportunities in this area to improve its power generation.

Above all, there is strong need for re-orientation of both the producers and consumers of electric energy alike. “Politics”, “Nigeria factor” and “Corruption” should be checked to ensure transparency and commitment to achieve the desired goal in the Nigeria power sector.

Conclusion

From the energy outlook of the country, it is very clear that the energy demand is very high and is increasing geometrically while the supply remains inadequate, insecure, and irregular and is decreasing with time; the energy mix is the way to a sustainable power supply that will culminate into economic growth now and even in the future. Fossil resources which are fast being depleted apart from being environmentally non-friendly. The energy supply mix must thus be diversified and strengthening through installing an appropriate infrastructure and creating full awareness to promote and develop the abundant renewable energy resources present in the country as well as to enhance the security of continuous power supply to its citizens.

Nigeria has the required potentials of energy resources, both conventional and renewable energy sources to provide adequate and sustainable power supply to its citizens. South Africa generates 90% of the total power from coal and Nigeria has this in abundance but have been neglected. We are rich in natural gas, solar energy, hydropower, wind and bio-mass. Yet, Nigeria has one of the lowest consumption rates of electricity per capita in the world. It is obvious that the roles of **‘Sustainable power supply play in economic growth** is significant in both developing and developed countries.

Nigeria as a country should encourage the implementation of **Energy mix involving conventional** and **Renewable Technology** to achieve rapid economic development and generate employment capabilities for its teeming youths, thus reducing insecurity and other crimes related vices.

References

1. Akpojedje, F. O., Ogujor, E. A and Folorunso, O. (2018). Influence of Optimal Network Reconfiguration of Electric Power Distribution Feeders on Power Loss Minimization: A Comprehensive Review. IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE), Vol. 13, Issue 2, pp. 42 – 56.
2. Aladejare, S. (2014). Energy, Growth and Economic Development: A Case Study of the Nigerian Electricity Sector. Amer. J. Bus. Econ. Manag. 2(2), pp. 41 – 54.
3. Aliyu, A. S., Dada, J. O and Adam, I. K. (2015). Current Status and Future Prospects of Renewable Energy in Nigeria, Renew. Sustain. Energy Re., Vol. 48, pp. 336 – 346.
4. Aliyu, M. K. (2012). Solar Energy for Sustainable Power Supply in Nigeria. SweetCrude, Enugu, from Nuhu Bamali Polytechnic, Zaria, Kaduna State. Retrieved from: <https://sweetcrudereports.com/solar-energy-for-sustainable-power-supply-in-nigeria/> on the 25th November, 2021. Time 5:52PM.
5. Ateba, B.B., Prinsloo, J. J and Gawlik, R. (2019). The Significance of Electricity Supply Sustainability to Industrial Growth in South Africa. Energy Report 5, Elsevier, pp. 1324 – 1338.
6. Ayamolowo, O. J., Buraimoh, E and Salau, A. O. (2019). Nigeria Electricity Power Supply System: The Past, Present and the Future. Conference Paper Presented at 2019IEEE PES/IAS Power Africa, doi:10.1109/PowerAfrica.2019.8928767
7. Bello-Schunemann, J and Porter, A. (2017). Building the Future: Infrastructure in Nigeria Until 2040. Institute for Security Studies (ISS), West Africa Report.

8. Ebhota, WS and Tabakov, PY. (2018). Power Inadequacy, the Thorn in Economic Growth of Nigeria. *International Journal of Applied Engineering Research*, Vol. 13, Number 16, pp. 12602 - 12610
9. Haberl, H. (2006). The Global Socioeconomic Energetic Metabolism as a Sustainability Problem. *Energy* 33: pp. 842 – 857.
10. Kenny, A. (2015). The Rise and Fall of Eskon and How to Fix It Now. *Policy Bull. South Afr. Inst. Race Rel.* 2(18), pp. 1 – 22.
11. Lior, N. (2008). Energy Resources and Use: The Present Situation and Possible Paths to the Future. *Energy* 31: pp. 87 – 99.
12. Nnaji, C., et al. (2010). In: Nnaji CE, Uzoma, CC (eds) *CIA World Facebook, Nigeria*, <http://www.cia.gov/library/publications/the-world-factbook/geos/ni.html>
13. Oladipo, F and Olowu, T. O. (2014). The Nigerian Power System Till Date: A Review. *International Journal of Advance Foundation and Research in Science & Engineering (IJAFRSE)*, Vol. 1, Issue 5, pp. 1 – 4.
14. Okafor, C. C. (2020). Towards Sustainable Power Supply and Consumption of an Emerging Economy (Nigeria). *Journal of Economic Development, Environment and People*, Vol. 9, Issue 4, pp. 6 – 21.
15. Oyedepo, S. O. (2012). Energy and Sustainable Development in Nigeria: The Way Forward. *Energy, Sustainability and Society*, a springer open Journal, <http://www.energysustainsoc.com/content/2/1/15>; pp. 1 – 17.
16. Ramchandra, P and Boucar, D. (2011). *Green Energy and Technology*. Springer, London Dordrecht Heidelberg New York.
17. Rai, GD. (2004). *Non-Conventional Energy Sources*. Khanna Publishers, Delhi.
18. Rosen, MA. (2002). Energy Efficiency and Sustainable Development. *Int. J Global Energy Issue* 17: pp. 23 – 34.
19. Rosen, MA. (2009). Energy Sustainability: A Pragmatic Approach and Illustrations. *Sustainability* (1): pp. 55 – 80.
20. Sambo, A. S. (2009). The Place of Renewable Energy in the Nigerian Energy Sector. A Paper Presented at the World Future Council Workshop on Renewable Policies, Addis Ababa, Ethiopia.