

Energy Policy in Nigeria: Prospects and Challenges

N. Garba, A. Adamu, A. I. Augie

Abstract—Energy is the major force that drives any country's socio-economic development. Without electricity, the country could be at risk of losing many potential investors. As such, good policy implementation could play a significant role in harnessing all the available energy resources. Nigeria has the prospects of meeting its energy demand and supply if there are good policies and proper implementation of them. The current energy supply needs to improve in order to meet the present and future demand. Sustainable energy development is the way forward. Renewable energy plays a significant role in socio-economic development of any country. Nigeria is a country blessed with abundant natural resources such as, solar radiation for solar power, water for hydropower, wind for wind power, and biomass from both plants and animal's waste. Both conventional energy (fossil fuel) and unconventional energy (renewable) could be harmonized like in the case of energy mix or biofuels. Biofuels like biodiesel could be produced from biomass and combined with petrodiesel in different ratios. All these can be achieved if good policy is in place. The challenges could be well overcome with good policy, masses awareness, technological knowledge and other incentives that can attract investors in Nigerian energy sector.

Keywords—Nigeria, renewable energy, Renewable Energy and Efficiency Partnership, Rural Electrification Agency, International Renewable Energy Agency, ECOWAS, Energy Commission of Nigeria.

I. INTRODUCTION

NIGERIA is a constitutional Federal Republic with 36 states and six geo-political zones that comprise of North-West, North-Central, North-East, South-West, South-South and South-East. The country is located in West African region that it shares borders with Benin Republic in west, Cameroon and Chad from the east and Niger Republic from the North (Nigerian Energy Support Programmed) [1].

The nature and degree to which energy demand and consumption in a national economy are so vital, it is an indication that, its availability can contribute immensely to Nigerian economic development [2]. Energy has a great impact on all aspects of our political, social and economic life. Insufficient supply of energy could limit other socio-economic activities. The extent of energy utilization in economy together with the efficacy to which different energy sources are converted into a useful energy mix, is directly related to economic development of the country [3], [4].

New policy on renewable energy and national action plan are the key elements to current energy reform in Nigeria. Nigeria is a country that has been blessed with abundant natural resources

especially non-renewable energy sources such as; solar power, hydropower, geothermal, biomass and wind power [2]. Up until now, the country depended solely on fossil fuels as the only source of energy to meet the demand from households, industries, schools, hospitals and other commercial centers. As the country looks forward to the future, capitalizing on its current economic growth prospective and privatization of the power sector, it is of paramount the country makes use its renewable energy sources which would secure the basis for future energy needs [4].

The energy situation has not been fully addressed or has been partially addressed for so many years in Nigeria. The situation is always worse and it keeps on getting worst on each of every passing day [3].

Rural Electrification Agency (REA) was developed in 2005 with a statutory function to support and provide the rural areas with access to electricity. This body is also responsible for administering Rural Electrification Fund (REF) which offers autonomous funding opportunity through Renewable Electricity Trust Fund (RETF) [1].

II. ENERGY POLICY IN NIGERIA

Nigerian Energy Policy was enacted from the Energy Commission of Nigeria (ECN) which was established by the Act No. 62 of 1979 and it was amended by the Act No. 32 of 1989 which was conducted after meeting with the Heads Economic Community of West African State (ECOWAS) in 1992 [1].

After meeting with the Heads of ECOWAS, the declaration was made in order for each member state to create an agency called Energy Commission which is charged with responsibilities for coordinating and supervising and ensuring all the energy tasks and activities are duly carried out within each member state [1].

According to Nigerian roadmap for the power sector reform which was held in August 2013, the current energy generation capacity in Nigeria was in the region of 6,000 MW as of 2013 of which 4,730 MW which is equivalent to 79% of the energy produced from burning of fossil fuels and only 1,270 MW which accounts for 21% is from hydropower which is the only current and existing renewable energy source in operating in Nigeria [3].

There are 23 grid-connecting plants in operation in the Nigerian Electricity Supply Industry (NESI).

The Nigerian National Energy Policy under ECN has

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launched Nigeria Energy Calculator (NECAL 2050) on 28th October 2015 which was held at the Transcorp Hilton Hotel, Abuja, Nigeria. The Nigerian Energy Calculator (NECAL 2050) was established by the ECN before it was formulated into current energy policy in conjunction with the United Kingdom Department of Energy and Climate Change (UK-DECC) and British High Commission in Nigeria [4].

The calculator was first used and initiated in the United Kingdom (UK), but now it is used as significant tool for attaining sustainable energy targets in Nigeria. This is an energy planning tool which was developed in order to relate with the

long-term energy demand and supply pathways to greenhouse gas emissions for up to the target year of 2050 [4].

The Nigerian Energy source for households, industries and other commercial places is mainly from burning fossil fuels. Kerosene is chiefly dominant sources in the households, with gas being the less used [5].

From Fig. 1, it could be deduced that there are continuous growing concerns on how the country could harness all the available energy sources both conventional and unconventional in order to meet the energy demand.

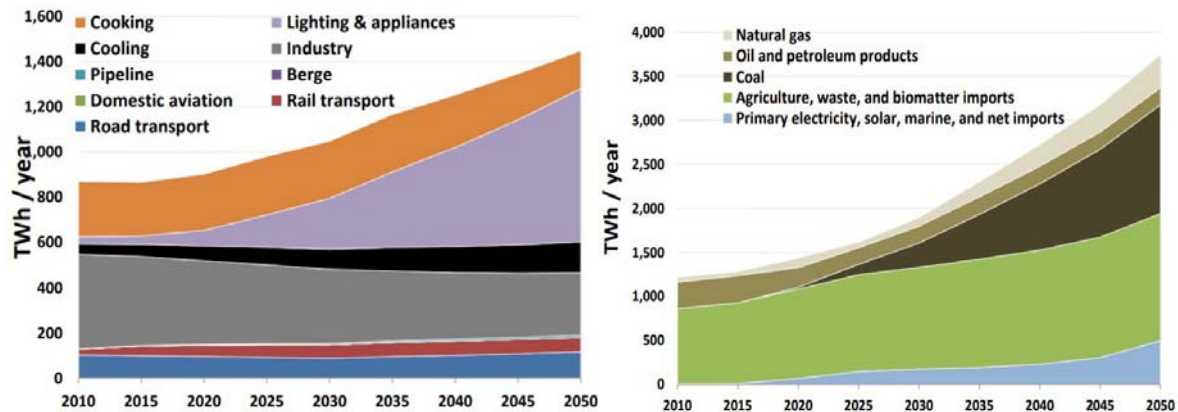


Fig. 1 Nigerian Energy Demand Forecast by Sector with the Least Development Effort Possible on all Options and Nigerian Energy Sources Forecast with the Least Development Effort Possible on all Options [3]

A. Major Objectives of National Energy Policy

1. To speed up the process of acquisition and dispersion of technology and management expertise in energy sector and local involvement in energy sector industries for stability and self-reliance.
2. To effectively use the country's abundant natural energy sources in order to promote international partnership.
3. To foster international cooperation in energy market and project development in platforms for effective development.
4. To ensure a proficient and cost-effective consumption pattern of energy resources.
5. To guarantee a comprehensive, combined and well-informed energy sector plans for active participation.
6. To guarantee the expansion of the country's energy resources, with diversified energy resources option, for the attainment of national energy security and an effective energy distribution system with an optimum energy mix.
7. To ensure suitable, reliable and sustainable supply of energy at effective costs in an environmentally friendly manner, to the different sectors of the economy for the national development [3].

III. ENERGY SOURCES IN NIGERIA

Nigeria has about 12,500 MW of the installed generation capacity. The two reliant sources are mainly the fossil fuel (gas and thermal) and hydropower which are 87% and 13% respectively [5]. In addition, it is worth to note that, only

3,500MW to 5000MW is being produced and available for onward transmission to the final consumers [6]. The electricity is only distributed to the consumers who are connected to the grid, though these consumers suffer from often outages which resulted in the consumption of energy per capita to be amongst the least in African continent which has been estimated to be less than 200 kWh [5].

Nigeria is an oil rich country with abundant natural resources of renewable energy sources such as; hydropower, biomass, solar power, biomass and geothermal. Most of the energy consumption comes from conventional sources which are not renewables such coal, oil and natural gas. This is one of the reasons why Nigerian energy sector is so vulnerable because of over-dependence on fossil fuel [7].

Nigeria is the biggest oil producer in Africa. It is the country with the largest natural gas reserves within the continent of Africa and it is the fifth ranked exporter of Liquefied Natural Gas (NLG) in 2018 [5].

The Nigeria's natural gas and crude oil resources are the backbone for the country's economy. The country completely depends on oil revenue generated. The economy of Nigeria is affected by changes in crude oil prices. The International Monetary Fund (IMF) forecasts that Nigeria's crude oil and natural gas exported to other countries has earned the country with \$55 billion in 2018, which far greater than \$23 billion earned in 2016 [5].

A. Renewable Energy Sources

Renewable energy is a term applied to those energy sources

and their technologies that are not depletable. This is the reason why they are referred to clean energy. They are environmentally friendly too [6].

The most common renewable energy sources are:

1. Solar Energy
2. Wind Energy
3. Hydro Energy
4. Biomass Energy
5. Geothermal Energy

1. Solar Energy

Nigeria is a country blessed with solar energy with an average daily sunshine of 6.5 hours, which ranges from 4 hours at the coastal areas to 9 hours at the far north. The average solar radiation in Nigeria is 3.5 kWh/m² a day at coastal latitude and 7 kWh/m² at the far north. Solar radiation is almost everywhere in Nigeria which makes it viable for electricity generation [7].

The solar power capacity has grown rapidly and it has developed into fastest growing source of renewable energy across the globe [4]. Though, in 2019, almost 109 GW of solar PV was installed globally which is around the same as in 2018. The ever-growing installations of solar PV were due to the policy support and sharp drop in the technology costs and concern to the environment [3]. However, with the current economic downturn as a result of COVID-19, the demands from the households will be significantly affected because of the financial uncertainties faced by the customers. The same case applied to the industries and other commercial installations which are likely to be affected negatively as discretionary expenditure will be deferred, and preserving short-term cash flow will become a priority [2].

Fig. 2 shows the testing of solar photovoltaic panel. The solar photovoltaics (PV) are manufactured from the silicon or other materials that can convert sunlight directly into electricity. The solar PV can generate electricity for households and other commercial areas either through mounting panel at the rooftop or community projects that can power the entire community. Solar farms can generate power for many households and industries using mirrors to concentrate solar radiation across acres of the solar cells [6].



Fig. 2 Testing of solar PV panel [6]

2. Wind Energy

The promotion for renewable energy in the world has taken the center stage due to global issues and environmental concerns [8]

An appropriate design for the available wind resources provides possibility for suitable planning and project could be executed by the developer, government agency as well as investors. Wind characteristics reflects on which type of wind turbine systems could be used for each location, ranging small, medium, and large turbine based on the existing technologies [3].

Wind energy is one amongst the fastest-growing renewable energy technologies. According to International Renewable Energy Agency (IRENA), the world-wide installed wind power capacity both offshore and onshore has increased in almost 20 years from 7.5 GW in 1997 to around 564 GW in 2018 [9]

Most of the areas and locations that are suitable for the installations of wind power are remote areas because of their wind characteristics. Nonetheless, offshore wind also offers a great potential [6].

3. Hydropower

Hydropower plants use the energy of the dropping water in order to generate electricity. The turbine in the hydropower system transforms the kinetic energy of the dropping water into mechanical energy, and then the generator converts the mechanical energy into electrical energy [10].

Most of the hydropower plants use dam or river to store water in a reservoir. The water which is released from the reservoir runs through the turbine thereby spinning it, which in turn triggers the generator to produce electricity [10].

Components of Hydropower Plant

1. Dam: It increases the water level of the river in order to create the falling water. The role of the reservoir that is formed is to store energy.
2. Turbine: The strength of the falling water makes the blades of the turbine to spin. The turbine converts the kinetic energy of the water that flows into mechanical energy.
3. Generator: The generator is directly connected to the turbine by shafts and possibly gears. As the turbine spins, the generator also spins and converts the mechanical energy into electrical energy.
4. Transmission Lines: The transmission lines conduct electricity to the households and other commercial areas.

4. Biomass Energy

Biomass is a renewable energy that is obtained from both plant and animal materials. In most of the developing countries, biomass is used for cooking and heating. The use of biomass fuels for transportation and electricity generation has increased tremendously in most developed countries. It also helps to curtail the effect of greenhouse gases such as sulphur and carbon dioxide which causes global warming [10].

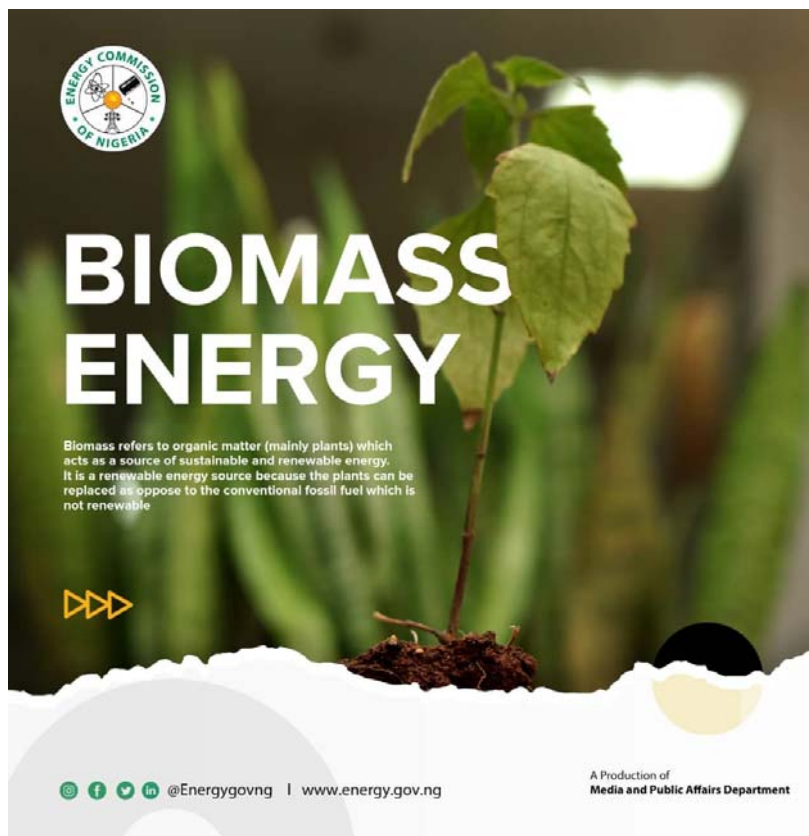


Fig. 3 Plant of biomass [9]

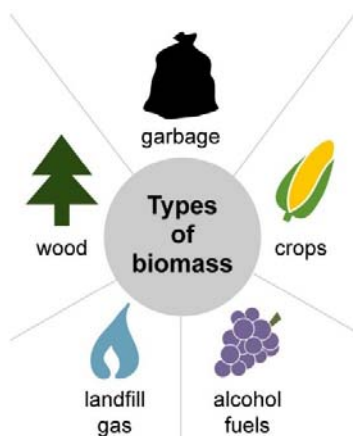


Fig. 4 Types of biomass energy [9]

Fig. 3 shows plant of biomass and decay of organic matter. Biomass could be burned directly for heat or converted into liquid and gaseous fuels through different processes. The sources of biomass energy include;

1. Wood and wood processing wastes: These include firewood, wood pallets, wood chips, furniture mill sawdust and black liquor from pulp and paper mills.
2. Agricultural crops and waste materials: Such as corncobs, soybeans, sugarcane, crop and food processing residues.
3. Municipal solid waste: Paper, cotton, food and wool products.

4. Animal manure and human sewage [9].

Fig. 4 shows the sources/types of biomass energy. The biomass energy could be obtained from garbage, wood or wood chips and from dead plants and animal organic matter.

5. Geothermal Energy

Geothermal energy is a renewable energy source obtained from the heat of the earth. The word geothermal comes from the Greek words geo which means earth and thermal which stands for heat. Geothermal energy is mostly used to heat buildings and to generate electricity [11].

Geothermal energy is the energy derived from the sub-surface of the earth or earth crust. Geothermal energy has been used for many purposes such as heating or cooling purposes. It can also be harnessed to generate electricity [12]. This is an energy obtained from the earth's core. It is derived from the heat produced during the original formation of the earth and decay of the radioactive materials. Thermal energy is stored in rocks and fluids in the center of the earth [13], [14].

There was Implementation of Renewable Energy Sources (RES) directive in 2009 with the aim to reduce the amount of greenhouse gas emitted to the atmosphere. The effect of greenhouse gas emission could result into climate change leading to global warming [11].

In Europe and other parts of the world geothermal water is used frequently for generation of electricity, heating and agricultural purposes [13].

B. Conventional Sources of Energy (Non-Renewables)

The conventional energy sources are the sources of energy that are non-renewables such as fossil fuels. These include coal, nuclear, oil and natural gas. Energy plays an important role for the live of humans and development of any country's economy [15].

Coal substitutes wood to become the chief energy source. Oil substitutes coal to be the central energy source. The shift from fossil fuels to renewable energy has emerged to due to the effects caused by conventional energy sources [8].

The challenges of ever-growing demand for energy and supply together with environmental pollution need policies on energy resources. A strategic transition towards more efficient energy requires a systematic approach and actions which involve policy at all levels from local to global [4].

Conventional sources of energy have resulted in different types of pollution to the environment. The most prevalent ones include air pollution, acid rain, and greenhouse gas emissions. As a result of burning fossil fuels, chemicals such as carbon monoxide, carbon dioxide, nitrogen dioxide and sulphur dioxide are all released into the atmosphere [2].

IV. ENERGY PROSPECTS

Apart from the uncontrollable natural phenomenon, insufficient energy supply is the ultimate threat to the peaceful, equitable and continuous co-existence of humans and this is related to the unguided human activities, some of them are political and apolitical. A condition whereby several people have enough to throw away, there are number of humans waiting who are living in abject poverty. This has constituted to what is called imbalance in the scale of social egalitarianism [1].

The economic, social and cohesion implications of energy poverty are becoming massive, specifically in some regions where the level of income is very low and the cost of energy technology is very high such as Sub-Saharan African. Nearly 1.1 billion of people around the globe were living without access to energy and electricity. The African continents are hit worse than any other part of the world in which only 1 out of 3 are connected to the grid [2].

The Nigerian energy sector plan was to achieve sustainable energy through RES [14]. The country's energy sector is set to achieve another goal and objective through oil and gas sub sector. The priorities for power sector and sector identified by Nigerian Government are to increase the power generation from the current 3.5MW to 20GW by 2018 and extend what was obtained from 2018 350GW by 2043, with priority of harnessing other alternative sources of renewable energy by 2023 [16].

It is not shocking that the World Bank has ranked Nigeria as the second largest country in the world only behind India and the first in the Sub-Saharan African whose most of the people in the country are deprived from access to electricity [17].

A green transition scenario is the best, because once all the country's plans are fully implemented, they will lead to significant transformation in the energy sector. Both the on-grid

and off-grid are developing at a fast rate, and by 2030, about 90% of the population would have access to electricity [18].

A. Energy Challenges in Nigeria

Rising demand for electricity in Sub-Saharan Africa especially Nigeria needs a major expansion in the power sector. In the case of Nigeria, the electricity supports a growing range of residential, services and industrial [19].

Nigeria is blessed with renewable energy resources that can be harness to generate electricity. Nigeria has abundant renewable energy sources which include; solar power, small and large hydropower, biomass, geothermal and wind power [20]. The Nigerian Electricity Regulatory Commission (NERC) is a devoted body committed to encouraging investment in renewable energy generation in Nigeria [1]. The obstacles behind the development of renewable energy in Nigeria include large production of oil and gas from South-southern part of the country together with fuel subsidies, lack of transparency/market information on private sector opportunities [20].

There is a great challenge with high insufficient energy supply within the country. There are issues from the frequent pipeline damages by Niger-Delta militants that are fighting Nigerian government for proper infrastructure in their region. Some the vandalized pipelines include; Trans-Niger line that passes through Bayelsa to Rivers State and extended to Delta State [21].

V. CONCLUSION

In conclusion, if Nigeria were able to formulate a policy that can encourage the harnessing of both conventional and unconventional energy simultaneously, this could help in meeting the demand for the energy and supply. The over-dependence on fossil fuel is doing more harm than good to the country's economic development. The health issue is also significant factor to consider, burning fossil fuels will only increase the greenhouse gas emissions thereby causing a lot pollution to the country. The harmful effects of these gases are what the country are craving to curtail by 2030.

The energy resources are abundant within the country, but the stumbling blocks are lack of good policies. Most of the rural areas are struggling with the current insufficient energy. Only few households have access to electricity. With the current rank by the World Bank as the largest country in the Sub-Saharan African whose most of its citizen are deprived from the access the electricity, something urgent needs to be done. Private investors are also way forward.

VI. RECOMMENDATION

Good policy implementation is the key to sustainable energy development. In setting goals and objectives, they must be feasible within the time frame set. Renewable energy is the future, this the energy that is cheap, clean and eco-friendly. From environmental perspective they are also safe. For instance, solar energy is available in almost part of the country. If the solar energy is properly harnessed, then the country can get some certain percentage of energy from it which could be

extend to national grid. More mini/micro hydropower and few large hydropower plants should be installed in order to increase from the 16% of the energy generated from the hydropower.

The country needs to create awareness on how renewable energy could help in curtailing the effect of greenhouse gases which is mostly caused by burning fossil fuels.

Technical expertise is also needed especially for installation of wind power, solar power and hydropower. Knowledge is the key to this future dream. But, above all, good policy implementation is the crucial factor to meet the challenges of energy demand in the country.

Nigeria: The Way Forward.

REFERENCES

- [1] Nigerian Energy Support Programmes (NESP), 2015. The Nigerian Energy Sector: An overview with a special emphasis on renewable energy, energy efficiency and rural electrification.
- [2] The Federal Republic of Nigeria, 2016. National Renewable Energy Action Plans (NREAP) (2015-2030) First Version. Adopted by: Inter-Ministerial Committee on Renewable Energy and Energy Efficiency (ICREEE).
- [3] Musbaudeen, O. B., Abdallah, D., Adetunji, A., Ahmed, S., Ahmed, Y., Ayoola, B., Idowu, A., Isa, K., Oluwadamilola, P. and Wasiru S. 2019. A Review of Nigerian Energy Policy Implementation and Impact.
- [4] Bala, E. J. 2015. "Nigeria Energy Security and Emissions Scenarios to 2050. Paper presented at the Int. Conference on 2050 Calculator by Prof. E. J. Bala, Director-General Energy Commission of Nigeria.
- [5] Energy International Agency, 2020. The U.S. Energy Information Administration. "Country Analysis Executive Summary: Nigeria. pp. 1–10.
- [6] Henry, A. and Reuben, O. "Assessment of Nigerian Renewable Energy Potentials and Energy Poverty; Challenges and Prospects. vol. IX, no. Vi, pp. 1–19, 2020.
- [7] Akorede, M. F., Ibrahim, O., Amuda, S. and Otuoze, A. 2017. "Current Status and Outlook of Renewable Energy Development Current Status and Outlook of Renewable Energy.
- [8] Idris, W. O., Ibrahim, M. Z. and Albani, A. 2020. "in Nigeria," pp. 1–16, 2020.
- [9] International Renewable Agency (IRENA). Global Energy Transformation: A Roadmap to 2050 (2019 Edition).
- [10] Arthouros, Z., and Rana, A. 2019. Renewable Energy Report, 2019. Global status report, 2019.
- [11] Schiffer, H-W. 2016. World Energy Resources, 2016. World Energy Council.
- [12] Arthouros, Z. and Rana, A. 2019. Renewable Energy Members, "Renewables 2019 global status report 2019," 2019.
- [13] Boguniewicz-zablocka, J. and Łukasiewicz, E. 2019. "Analysis of the Sustainable Use of Geothermal Waters and Future Development Possibilities — A Case Study from the Opole Region, Poland.
- [14] Aggarwal, V., Meena, C. S., Kumar, A. and Alam, T. 2018. Potential and Future Prospects of Geothermal Energy in Space Conditioning of Buildings: India and Worldwide Review."
- [15] Lu, Y., Khan, Z. A., Alvarez-alvarado, M. S., Zhang, Y. and Huang, Z. 2020. A Critical Review of Sustainable Energy Policies for the Promotion of Renewable Energy Sources, pp. 1–30.
- [16] Olagunju, O. O., Onuoha, B., Saibu, O. M., Eneanyi, N. A. and Akintunde, O. 2020. Appraisal of Nigeria's Energy Planning: Prospects for Sustainable Development. pp. 1–9.
- [17] The Nigerian Energy Report, 2017. The advance of Renewables in Nigeria. Disruptors: How off-grid energy companies are closing Nigeria's energy access gap.
- [18] Roche, M. Y., Verolme, H., Agbaegbu, C., Fishedick, M., Oladipo, E. O. and Fishedick, M. 2019. Achieving Sustainable Development Goals in Nigeria power sector: assessment of transition pathways Achieving Sustainable Development Goals in Nigeria's power sector: assessment of transition pathways. Policy, pp. 1–20.
- [19] World Energy and Outlook Special Report, 2019. International Energy Agency (IEA). "Africa Energy Outlook, 2019".
- [20] Olanipekun B. A. and Adelakun, N. O. 2020. "Assessment of Renewable Energy in Nigeria: Challenges and Benefits.
- [21] Paul, O. U., Albert, O. and Adeiza, A. S. 2019. Electricity Crisis in