Impact of Renewable Energy on Green Computing in Nigeria

Akinbo Shade Racheal

Federal University of Technology, Akure, Nigeria

ABSTRACT

The growth rate of economic wealth, population and energy consumption in Nigeria for the last few years has been tremendous and the energy consumption has been both a support and a consequence of this growth, while the global energy structure has increased the change that impact the industrial revolution. Renewable energy and Green computing require new thinking towards economic sustainable generation of energy, efficient computers that reduce carbon dioxide emissions, promote efficient operational performance at lowest cost and promote eco-friendly environment. The impact, on green computing will improve environmental, socio-political and the grid systems. This paper aims to present the benefits of using an alternative energy sources for a sustainable environment in Nigeria. In this article, study on several renewable energy sources in the scope of green computing sustainability is highlighted.

Keyword: Renewable Energy, Green Computer, Nigeria, Oil and Gas, Sustainable Energy

1. INTRODUCTION

In Nigeria, oil was discovered in 1956 in a placed called Oloibiri in the Niger Delta. This was made possible by Shell Petroleum and exploration has been on since the discovery. Nigeria joined the oil producing nations in 1958, when the first oil processed stream of 5,100 bpd production (NNPC Group). As the Biafran war ended, world oil price rises and Nigeria was able to gain high profit from the oil production. In 1977 Nigeria became a member of organisation of petroleum exporting countries (OPEC). It established the Nigerian National Petroleum Company (NNPC) as a state owned company and a major player in both the upstream and downstream sectors (NNPC Group).

Iledare and Chijioke stated in their presentation that the Nigeria oil and gas industry matured since its first discovery in 1956 at Oloibiri, suffice it to say that though the industry may have flourished to reasonable level, there are challenges that have caused setback for the industry in the country. Nigeria is currently facing significant challenges in its petroleum industry because of the changes of oil prices, pipeline vandalism and illegal refining. It is clear that the country must reduce it dependency on fossil fuel for power generation by leveraging on renewable energy to improve access to clean energy sources, thereby helping to meet sustainable development goal of affordable and clean energy by ensuring everyone has access to a reliable and modern energy services by the year 2030. (SDGs 7, 2030). There is need to take advantage of the local availability of renewable energy sources.

1.1 Implications of Nigeria Dependency on Oil for Power and Economic sustenance

According to BP statistical review in 2018, Nigeria is the second largest proven oil reserves in Africa and the tenth largest oil reserves in the world, with an estimated 37.5 billion (barrels) of crude oil deposit (as of 2017), representing 2.2% of the global total while the hydrocarbon sector also accounts for more than 75 per cent of the federal government's revenue. All the indices points to Nigeria as being heavily dependent on oil sector for most of government spending, infrastructure and economic development activities.

The dependency of any country on natural resources had been shown to affect the country's economic, social and political development negatively. The following are the implications of dependency on Oil for power generation and economy sustainability:

1.1.1 Economic implications

The impact of dependency on oil has been relatively capped with high risk. As crude oil exports continue to decline, Nigeria economy may have to depend on external borrowing to finance its annual budget. The differences in oil prices makes planning difficult. It hampers growth, impaired investment opportunities, decline the provision of government promises to its citizenry.

1.1.2 Social and political implications

Oil dependence has been linked with high poverty rates, poor health care delivery, high rates of child mortality, poor educational performance and it has led to increase in civil conflicts in the country especially in the southern part of Nigeria. Environmental degradation, pollution of

land and rivers tend to increase in the oil producing area. All these result causes political instability in the county. The negative outcomes are not inevitable since they can be avoided or at least minimized when good governance, public accountability, transparent resource management, the use of alternative energy sources and willingness of our leaders to transform oil revenues into positive outcomes are top agenda of the government.

1.2 Fossil fuel implication on the environment

Fossil, was formed in the past from the remains organism. Fossil fuel examples like coal, oil, and natural gas were from the remains of ancient plant and animal that were buried for millions of years. Fossil fuels has been in use for centuries, it is used to generate power but lots of disadvantages was associated with their use.

1.2.1 Environmental pollutions

Fossil fuels needed to be burned in order to release the energy stored in them and this practice will lead to smoke and gases being released to the air. Moreover, burning fossil fuels releases harmful particles into the atmosphere, resulting in adverse effect for humans and the earth as a whole. It also causes emission of carbon. The more the greenhouse gases is released to the atmosphere the more the heat that is trapped in the atmosphere which leads to global warming.

1.2.2 Unsustainable and Non-renewable

It is obvious that we cannot rely on fossil fuels forever because fossil fuels are non-renewable, meaning they don't naturally replenish fast enough for humans to use forever. Fossil fuels take millions of years to form deep in the earth, and we cannot just sit around and wait for new coal to form. At the current usage rate, the fossil fuel may be exhausted if we did not turn to alternative energy sources. Moreover, if there is availability of coal and natural gas within the earth to keep using for many years, accessing those natural stores will only become more difficult and expensive.

1.2.3 Drilling effect

Oil drilling rigs are susceptible to catastrophic failure, the example of the deep water horizon rig that exploded in 2010, leads to several deaths and it was the largest oil spill in United State history. Accidents like these are unique to fossil fuel operations due to the flammable nature of the fuel.

1.2.4 Oil Spillage

Anna et.al (2019) submits that Nigeria happened to be the most populous country in Africa and the largest oil producer. The frequent oil spills that results from the pipeline vandalism, theft, and poor maintenance of oil production area were the major sources of environmental pollution. The crude oil leakages and other petroleum products into the environment, causes different compound to evaporate into the air, absorbed by the soil which can lead to fires outbreak. The release of particulate matter (PM) into the air are hazardous to human health. The ingestion of this contaminated water, crops, or fish; or inhalation of vaporized products cause diseases to the ecosystem.

1.3 Research Objectives

The Specific objectives of this research are to:
1. Examine renewable energy impact
2. Study the benefit of renewable energy impact on green computing.
3. Integrate renewable energy into green computing.
4. Recommend alternative energy sources in line with (SDGS) goal seven, to the relevant stakeholders in IT industry

1.4 Methodology

Designing a suitable energy for green computing is finding the ideal balance between reliability, affordability and sustainability. This paper is based on secondary data. The detailed study of the topic was collected from reference books and historical data, to understand the current scenario. Further various websites, journals, magazines and newspapers etc. were studied in order to frame the new outlook about the topic. Few sources of alternative energy sources have little effect on the environment, such as hydro-electric power, solar energy and wind power. There are few computers as seen via the internet that are experimenting with renewable energy. The methodology is to include efficiency in the contribution of the enhanced energy received directly by the sun and reduce the hardware on the computer system.

1.4.1 Design

To design the solar panel energy source the steps were put in place:

1.4.1.1 Mounting the Solar Panel

The solar panel can be mounted up the roof and the solar firmly nailed or screwed to the roof so as to have maximum harvest of sun rays by the solar. The direct exposure of solar panel to the sun will give at least 26v using voltmeter to measure the voltage.

1.4.1.2 Connecting the Charge Controller

The current from solar panels may not remain constant throughout the day, therefore, connection to the solar charge controller is necessary. The charge controller has

an inbuilt Pulse Width Modulation (PWM) charger that can be used to charge the lead acid battery in stages as it ensures long life for the battery.

1.4.1.3 Connect the Battery to Inverter

At the back of the inverter, there is 12V DC input which is connected the positive (+) terminal of the battery to the positive (+) terminal of the inverter and the negative (-) terminal of the battery to the negative (-) terminal of the inverter.

1.4.1.4 Connecting Battery to Charge Controller

The charge controller has positive (+) and negative (-) terminals for the battery. To connect it, the positive (+) from the charge controller will be connected to the positive of the battery and the negative (-) from the charge controller is connected to the negative of the battery Loading:

- The inverter will be powered and the voltmeter is used to check the voltage, which should be 230V.
- Turn the inverter off.
- Then turn off all appliances
- The inverter should be connected to the outlet of the house mains.
- Put on the inverter.
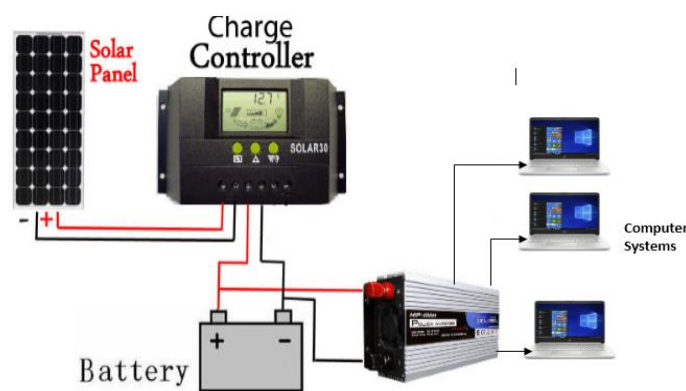
Figure 1: Architecture of the Design

2. THE CURRENT SITUATION IN NIGERIA

According to a report from the United States Agency for International Development (USAID) stated that Nigeria, is the largest economy in sub-Saharan Africa is limited in the power sector and this has constrain its growth. In addition to the report, Nigeria is endowed with large oil wells, gas and solar resources; it has the potential to generate 12,522 megawatts (MW) of electric power from the existing plants, but most time, it can only generate around 4,000 MW, which is insufficient. These factors led Nigeria to privatize her distribution companies and this leads to a higher range of tariffs.

CEIC data for electricity generation stated that from 2005 – 2019 reported that, electricity Production in Nigeria reached 7,842 GWh in Dec 2019, compared with 8,952 GWh in the previous quarter. Electricity Production data of Nigeria is updated quarterly averaging at 6,890 GWh from March 2005 to December 2019. The data reached an all-time high of 9,936 GWh in September 2015 and a record low of 3,247 GWh in June 2009. The challenges faced by the larger populace in Nigeria is not limited to: Low generation of Megawatts, Economic shut down, epilectic power supply, Negative effect on computing, IT industries cannot strive, and underperformance of most organisations.
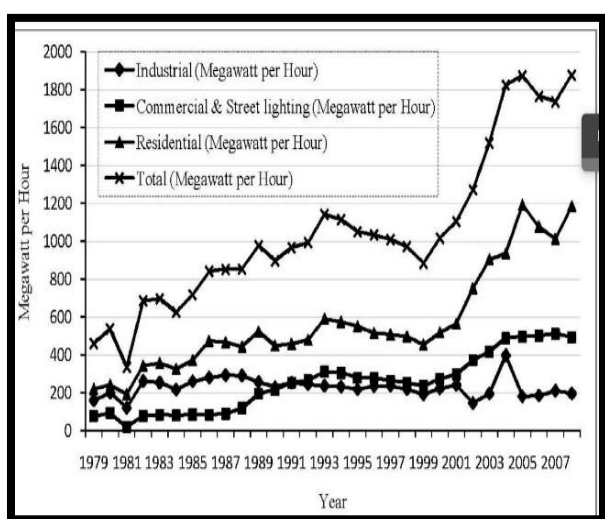
Figure 2: Electricity consumption pattern in Nigeria. Adapted from CBN.

Electricity usage in the industrial sector has been static due to the unreliable nature of the public electricity supply system in the country. As a result of this, companies have resolved to make power-generating set as a sources of energy. These results to getting only 9 billion tons in final energy, after withdrawing transformation and transmission losses.

Primary energy needed to be processed and transported before being available for end-users. The trends of the projected energy demand are shown in Figure 3 below. In 2005, the total energy demand based on 10% GDP growth rate, revealed that the household segment had the largest share of all the sectors; while the energy demand from different sector in the year 2030 plan period shows the highest growth rate in industrial, service, household, and transport sectors.
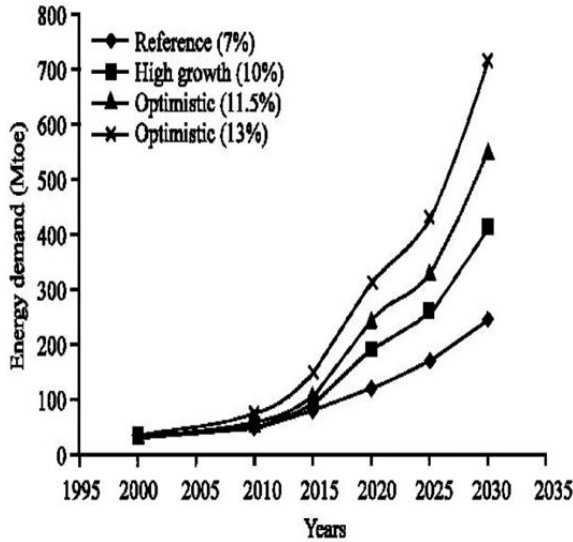
Figure 3: showing the projected electricity demand between 2000 and 2030. Adapted from ECN

The renewable and natural energy sources are being used to power up data centers, server rooms, computer application technology etc. Global population was 1.6 billion in nineteen hundred (1900), 2.5 billion fifty years later, and we are more than 7 billion human beings today. Wealth, estimated by the gross domestic product in real value, has been multiplied by a factor of 40 years over the same period. Energy consumption has been both a support and a consequence of this growth, rising from slightly less than 1 billion tons of oil equivalent at the beginning of the century to more than 13 billion tons today. The current primary energy consumption relies on oil for more than a third, coal for 28%, and natural gas for 23%, hydro with 7%, nuclear energy with 4%, and modern renewable energies such as wind, geothermal and solar with 3%. Renewable energies are mainly used for power generation (IFP school sources).
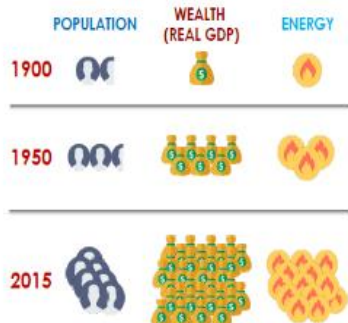
Figure 4: position of wealth, populations and energy Source: IFP School Page.

3. LITERATURE REVIEW

Adekoya and Adewale (1992), analyzed the annual wind speed mean of power flux densities for thirty stations in Nigeria, to be from 1.5 to 4.1 m/s to 5.7 to 22.5 W/m2, respectively.

Fagbenle and Karayiannis (1994), implemented a ten year data analysis plan on wind from 1979 to 1988; using the surface upper winds. The result shows that the wind has the maximum gusts.

Ngala et.al (2007), did a survey on statistical analysis of the wind energy potential in Maiduguri, Borno State, using the Weibull distribution for a ten year plan (1995 to 2004). The cost benefit analysis carried out with the use of conversion systems for the electric power generation supply in the state. The result shows the nation to be blessed with a vast opportunity to harvest wind for electricity production.

Akinbami (2001), examined the potentials of hydroelectric power in Nigeria, it shows that the power generated is 8,824 MW with an annual electricity generation potential in excess of 36,000 GW h. This results to having 8,000 MW large hydropower technology, while the remaining 824 MW is a small-scale technology. These means 24% of large and 4% of small hydropower potentials in the country, have been exploited.
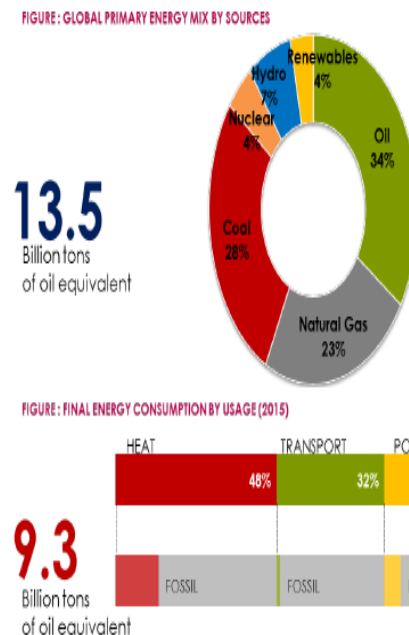
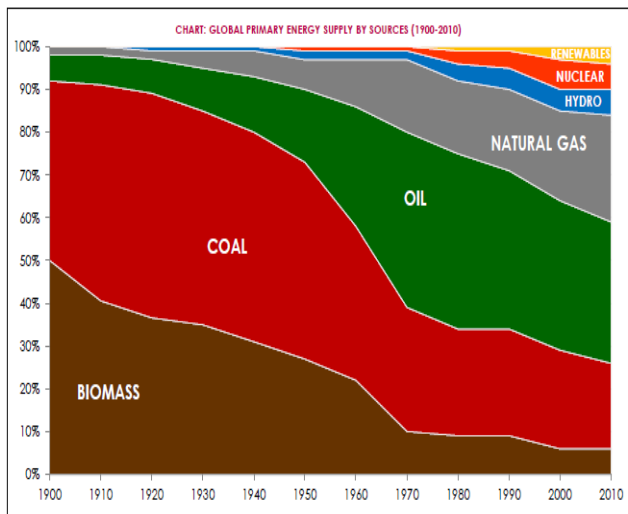**Figure 5:** Energy mx Sources: IFP School Page

Figure 6: World Energy review 2018
Source: Vaclav Smil (2010).

4. RENEWABLE ENERGY

It serves as an alternative energy to the traditional one that relies on fossil fuels, as it tends to be friendly to the environment without being harmful.

4.1 Solar

The capturing of radiant energy from sunlight and the conversion to heat or electricity produces solar energy. The Photovoltaic (PV) system convert sunlight to electricity with the use of solar panel cells. The major advantage of this type of energy is that the sunlight is endless. The availability of technology has helped in harvesting it and there is a limitless supply of solar energy. Relying on solar energy than fossil fuel will help to improve public health and environmental conditions. In the long term, solar energy could also eliminate energy costs, and in the short term, reduce your energy bills.

Limitations:
Solar energy reduces cost but on the long run, there may be a significant high cost associated with it and this will make it an unrealistic expenses for most households. Every home owners needs to have the ample sunlight and space to arrange their solar panels, these limits who can realistically adopt the technology at the individual level.

4.2 Wind

The wind farm is used to capture the energy of wind flow by using turbines and converting it to electricity. Though the forms of converting wind energy varies but wind-powered generating system can power many different organizations, while single-wind turbines are used to help supplement pre-existing energy organizations. Utility-scale wind is a type of farm that are purchased by contract or wholesale. Wind energy does not pollutes the air because they are clean source of energy. It does not emit carbon dioxide, or release any harmful products that can cause environmental degradation. It has no negative effect on human health like smog, acid rain, or other heat-trapping gases. Investing in wind energy technology will open up new opportunities for jobs, as the turbine on farms needed to be serviced and maintained by individuals to keep it running.

Limitations
Wind farms are usually situated far from cities, they are built in remote areas, but the electricity is mostly needed in the cities. It has to be transported through transition lines and this leads to a higher costs. The merit is that, wind turbines has less pollution but some cities opposed them, based on the fact that they dominate skylines and generate noise. Wind turbine also threatens local wildlife like birds, which are sometimes killed by striking the arms of the turbine while flying.

4.3 Hydroelectric

Dams are what people refer to as hydroelectric power. The operation involves water flow from the dam's turbines to produce electricity, known as pumped-storage hydropower; while the Run-of-river hydropower uses a channel to funnel water through rather than powering it through a dam. Hydroelectric power is very versatile and can be generated using both large scale projects, like the Hoover Dam, and small scale projects like underwater turbines and lower dams on small rivers and streams. The main advantage of hydroelectric power is that, it does not generate pollution, and it is a much more environmentally-friendly energy option for the environment.

Limitations:
Although, hydroelectric power has no pollution to the environment but it disrupts the passage of water and this affects the animals that live in them, it changes the water levels, currents, and migration paths for many fish and other aquatic animals within the ecosystem. Most hydroelectricity facilities use more energy than they were able to produce for consumption, and the storage systems may need to use fossil fuel to pump water.

4.4 Geothermal

It is a type of energy that is produced from heat that is trapped beneath the earth's crust right from the formation of the earth for about 4.5 billion years ago and from radioactive decay. Whenever a large amount of the

heat escapes naturally, all at once, it will result to occurrences, such as volcanic eruptions and geysers. The heat, when captured is used to produce energy. Geothermal energy is not a common type of energy but it has a significant potential for energy supply. It can be built in an underground compartment which leaves little footprint on the land. Geothermal energy is naturally replenished it and does not run a risk of depleting on a human timescale.

Limitations

The major disadvantage of geothermal energy is that, it is costly to build the infrastructure, so also its vulnerability to earthquakes in certain regions of the world.

4.5 Ocean

The waves that originates from the ocean can produce two types of energy namely, thermal and mechanical. Thermal energy relies on the warm water surface temperature to generate energy, while mechanical energy comes from the ebbs that flows from the tide, to generate its energy. These are created by earth's rotation and force of gravity from the moon. It is predictable and easy to estimate the amount of energy that will be produced. The energy that comes from sun and wind is not as consistent as wave energy because wind energy is abundant and most populated cities tend to be near oceans and harbors, thereby making it easier to harness for the local population.

Limitations:

It serves as an advantage to those that live near the ocean as they benefit directly from wave energy. The disadvantage of ocean energy is that it can disturb the ocean' delicate ecosystems. Although it is a very clean source of energy, large machinery needs to be built nearby to help capture this form energy because it can cause disruptions to the ocean floor and the sea life that habit it. Another factor to be considered is that whenever rough weather occur, it changes the consistency of the wave, which can make it to produce lower output when compared to normal waves without stormy weather.

4.6 Hydrogen

The combination of hydrogen and other element forms a gas that does not occur naturally on its own; it is a combination of other elements, such as oxygen to make water. Hydrogen when separated from another element can serve as both fuel and electricity. It is also used as a clean burning fuel, which leads to less pollution and a cleaner environment. It is very good for fuel cells that are similar to batteries for powering an electric motor.

Limitations:

Hydrogen energy needs to be produced, it is inefficient when it comes to preventing pollution.

4.7 Biomass

This energy is formed from the organic matter of plants and organisms; the use of wood for fire is a good example of biomass that most people are familiar with. The energy sources generated from biomass is called bioenergy and different methods is used to generate the energy. It can be captured by means of burning biomass, or by harnessing methane gas that is produced by natural decomposition of organic material in the ponds or landfills. Using biomass for the purpose of energy production creates carbon dioxide that escapes to the air; but the regeneration of plants can consume the same amount of carbon dioxide, which is said to create a balanced atmosphere. Biomass can be used in many of ways as it applies to our daily lives, both for personal use and in businesses.

Limitations:

Although new plants need carbon dioxide to grow, plants take time to grow. We also don't yet have widespread technology that can use biomass in lieu of fossil fuels.
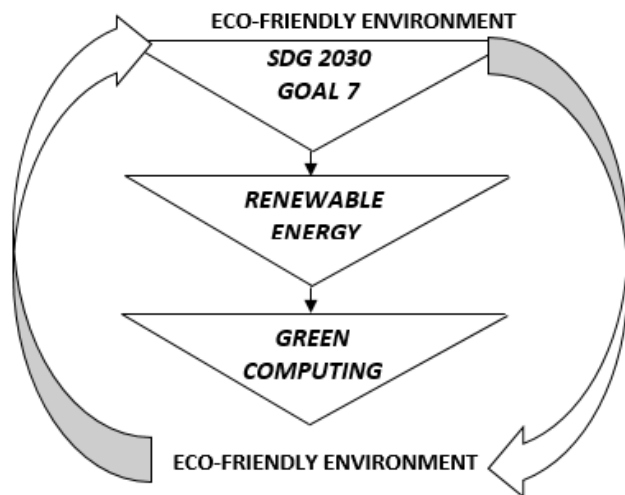
5. GREEN COMPUTING

The use of environmentally responsible and eco-friendly computers and their resources is known as green computing. In the field of information technology, green technology deals with the application of gadgets as well as other devices, which reduce energy consumption and save the environment. IT applications includes: hybrid and electric cars; solar and panels; smartphones; computers; tablets with less battery power; energy efficient monitors; industrial Internet and cloud computing. The numbers of green devices and gadget is growing per time. Green refers to the efficient use of resources in computing and information technology infrastructure.

The effectiveness of green computing emphasizes on minimizing the hazardous environmental effect, economic sustenance and increased system performance. Green technology field covers a broad spectrum of subject with alternative energy-generation, electricity consumption techniques and use of eco-friendly or recyclable materials to implement sustainable digital services. Green technology is used to conserve energy as well as create alternatives to fossil fuel that are more environmentally friendly. Fossil fuels creates waste as a

by-product of their production. Solar, wind, and hydroelectric dams are examples of green technologies that are safer for the environment and don not produce fossil fuel waste by-products. Besides the environmental benefits, these alternative energy sources can be harnessed as a sources of power to home or a utility power plant. Green technology is also employed for the conservation of energy such as the installation of energy-efficient fixtures and LED light bulbs.

5.1 The integration of renewable energy and green computing

Renewable energy and green computing will promote the goal seven of the sustainable development goal, for clean and affordable energy by 2030. It will promotes economic development and create jobs in the local environment, as it can be applied in small, medium, and large-scale systems in a distributed and centralized application. Thereby making renewable energy source for green computing a worthwhile investment and this will also enhance eco-friendly environment.

Figure7: Renewable energy and green computing integration

5.2 Positive effect of Green Computing to Nigeria IT Industries

The toxic materials and chemicals used in manufacturing the electronic devices and e-waste that contributes to the pollution of the environment. Air, water, food and soil which affect our daily life are getting polluted. The number of computers, servers and other electronic devices are increasing day by day which causes lot of heat and gases and this in turn leads to the increase of electricity consumption. The effect in general leads to health hazards and global warming. The positive effect of green computing to IT industries in Nigeria are:

5.2.1 Energy saving

The utilization of renewable energy on devices leads to the decrease of electricity consumption which causes less consumption of fossil fuels. The reduction of energy in green computing technology, translates into lower carbon dioxide and heat emission, from fossil fuel used in power plants and transportation.

5.2.2 Environment friendly

The technology employs different innovative methods to create a number of eco-friendly products. It offers environmental solution for the disposal and recycling of waste. Moreover, it effectively changes the waste production in such a way that it does not harm the environment.

5.2.3 Cost effectiveness

To conserve energy resources means lesser energy will be required to produce and dispose of products which later save energy and money.

5.2.4 Reduce Health hazards

To reduce the risk of health hazards in laptops such as chemical known to cause cancer, alternative energy is the way out because it reduces the amount of heat produce from the electronic devices which causes damages in human, promote the reuse and proper recycling.

5.2.5 Effective use of natural resources

The use of natural resources, which are readily available, provides eco-friendly environment and less harmful effect.

6. EXPECTED ROLES OF STAKEHOLDERS

Nigeria, faces enormous challenges in addressing its energy deficit as well as meeting its development objectives. However, renewable energy looks promising as the solution to meet the future energy needs, if all the relevant stakeholders can play their part; right from the policy formulation to full implementation of actualizing green technology via the use of renewable energy, since Nigeria has abundant resources in this area. The expected relevant stakeholder's expectations are:

6.1 Government

The government should develop policies on energy efficiency and integrate them into the current energy policies. This will guide the citizens towards an efficient usage of its energy resources.

6.2 Professional Bodies

IT professional bodies in Nigeria for example Nigeria Computer Society (NCS), Computer Professional

Registration Council of Nigeria, (CPN) and National Information Technology Agency (NITDA), needs to create awareness and enforce policies that will help in integrating renewable energy and green computing to bring about sustainable environment.

6.3 Standard Organization of Nigeria

Standards Organization of Nigeria, SON is committed to provide standards and quality assurance in services and products in Nigeria, should carried out their services according to international standard and ensure the continual improvement of eco-friendly computing devices. SON should ensure that sub standards products must not see their way into the country. Certification of only eco-friendly IT products into the country must be a major goal of the agency.

6.4 Banks

The Central Bank of Nigeria, should encourage various stakeholders by establishing a renewable energy funding/financing agency.

6.5 Investors

Investors should be given a single digit loan finance for investing in renewable energy and green computing to ensure energy for all in line with Sustainable Development Goal 7 (Affordable and Clean Energy) on or before year 2030.

7. CONCLUSION

Conclusively, there is no perfect sources of energy: it is about finding the best suitable one from reliability, affordability and the preservation of the environment. As resources are not going to lack in a close future, the major issue of the coming century is climate change. The goal is clear: we need to achieve a "net-zero" emissions world as a matter of urgency, in order to avoid the worst effect of a changing climate. Solar energy will play vital roles in the future and in almost everything we humans do. A solar powered laptop will help people around the world and reduce the production of power cables, indirectly helping the cause of green computing and improving efficiency for many processors of a laptop and helping the computer directly improving itself.

REFERENCES

1. Akinbami JFK, "Renewable Energy Resources and Technologies in Nigeria": Present Situation, Future Prospects and Policy Framework'. Mitigation and Adaptation Strategies for Global Change 6:155–181. Kluwer Academic Publishers, Netherlands; 2001.

2. Adekoya LO, Adewale AA, "Wind energy potential of Nigeria. Renewable Energy 1992, 2(1):35–39. 10.1016/0960-1481(92)90057-A

3. Fagbenle RO, Karayiannis TG: "On the wind energy resources of Nigeria" International Journal of Energy research.1994,18(5):493–508. 10.1002/er.4440180502

4. Ngala GM, Alkali B, Aji MA:"Viability of wind energy as a power generation source in Maiduguri, Borno state, Nigeria". Renewable energy 2007,32 (13):2242–2246. 10.1016/j.renene.2006.12.016.

5. Sunday Olayinka Oyedepo, "Energy and sustainable development in Nigeria: the way forward Energy, Sustainability and Society" volume 2, Article number: 15 (2012) https://link.springer.com/article/10.1186%252F2192-0567-2-15

6. Anna Bruederle and View ORCID: "Effect of oil spills on infant mortality in Nigeria", PNAS March 19, 2019 116 (12) 5467-5471; first published March 5, 2019 https://doi.org/10.1073/pnas.1818303116 Edited by Anthony J. Bebbington, Clark University, Worcester, MA, and approved February 1, 2019 (received for review October 24, 2018).

7. U.S. Energy Information Administration, Biomass Explained, Retrieved From: https://www.eia.gov/energyexplained/?page=biomass_ho Shuja et al. Journal of Internet Services and Applications (2017) 8:9 DOI 10.1186/s13174-017-0060-5

8. Sonika Muriel Pinto1, Vemuri Divya2, Varsha R3, Nalina, "Green Computing and Energy Consumption Issues in the Modern Age" V4 International Journal of Engineering and Techniques - Volume 4 Issue 3, May - June 2018

9. M. R. Sudha*, Komal Aman Singha, A. Saravanakumarb M. R. Sudha et.al. "A Survey of Green Computing for an Energy Initiative" / International Journal of New Technologies in Science and Engineering. Vol. 2, Issue 3, Sep 2015, ISSN 2349-0780

10. Saravanakumar A, Komal Aman Singh, M.R. Sudha, M. R. Sudha et.al. A Survey of Green Computing for an Energy Initiative / International Journal of New Technologies in Science and Engineering Vol. 2, Issue 3,Sep, ISSN 2349-0780,(2015)

11. Piotr Pazowski, Maria Curie Skłodowska University, Poland (2015) GREEN COMPUTING: Latest Practices And Technologies for ICT Sustainability (2015).

12. Prof Chijioke Nwaozuzu and Isreal Onyije, Emerald Energy Institute (for Petroleum & Energy Economics, Policy and Strategic Studies), University of Port Harcourt, Port Harcourt, Rivers State, Nigeria.

13. The director, EEI, Prof Wumi Iledare Presentation on the passed PIGB titled "The Petroleum Industry Governance Bill: Critical Reforms Issues and Resolutions". https://www.mordorintelligence.com/industry-reports/nigeria-oil-and-gas-market 24/3/2020

14. I R Irina Romanova," Oil boom in Nigeria and its consequences for the country economic development". Term Paper, 2007 27 Pages, Grade: 1, 3.

15. CBN: Central Bank of Nigeria Statistical Bulletin. CBN Press, Abuja; 2009. Energy Commission of Nigeria (ECN): Renewable Energy Master Plan. 2005.

16. https://www.justenergy.com/blog/7-types-of-renewable-energy-the-future-of-energy/ 9/03/2020

17. Energy.gov, Advantages and Challenges of Wind Energy, Retrieved from: https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy

18. U.S. Energy Information Administration, What is U.S. Electricity Generation by Energy Source? Retrieved From: https://www.eia.gov/tools/faqs/faq.php?id=427&t=3

19. Bureau of Ocean Energy Management, Ocean Wave Energy, Retrieved From: https://www.boem.gov/Ocean-Wave-Energy/

20. https://www.quora.com/What-are-the-advantages-of-green-computing 21/3/2020

21. https://www.energymixreport.com/nigeria-petroleum-industry-reforms-understanding-the-elements-of-the-petroleum-industry-governance-bill-pigb/ 22/3/2020

22. https://andreacper5ra.weebly.com/advantages--disadvantages.html 24/3/2020

23. https://greentechbox.com/why-green/the-main-features-and-benefits-of-green-technology.html 24/3/2020

24. https://www.nnpcgroup.com/NNPC-Business/Business-Information/Pages/Industry-History.aspx

25. https://news.energysage.com/disadvantages-fossil-fuels/ Energy Sage- Small Energy Decision.

26. https://www.ceicdata.com/en/indicator/nigeria/electricity-production

27. https://www.usaid.gov/powerafrica/nigeria

28. Punch Newspaper June 16, 2019 Nigeria's Crude Oil Resources Fall to 36.97 Billion Barrels.

29. BP Statistical Review of World Energy 67th Edition, June 2018.

30. United Nation Sustainable Development Goal 2030 (SDGS).