

Green Computing Policies And Regulations: A Necessity?

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Abstract: The ever-increasing advancement in computing and information technology evidenced by the deployment of super computers and gigantic data centres across the globe had been documented as potential sources of environmental pollution, degradation and key contributing factor to the climate change problem. The inherent aspiration of organizations to maintain competitive advantage over peers is a major driving force that apparently blurs the thinking of world's multinational chief executives in respect of the impending dangers that may arise from the ever-growing large-scale ICT infrastructure deployments. Having regard to the foregoing, this paper is aimed at examining the policies, legislations and practices within the Nigerian State that have been created or pursued to curtail the adverse environmental effects of ICT infrastructure. In this paper, we had explored the practices in Nigeria by way of sociological enquiries and expert judgment. Findings revealed that though there are policies and legislations on environmental protection, there are no clear-cut specialized machineries to detect, measure, and control the environmental menace attributed to electronic dumping, and operations of data centres.

Index Terms: Green computing, Climate change, Sustainability, Environmental computing, Electronic waste, Data Centres

1. INTRODUCTION

Information Communication Technology (ICT) plays a significant role in our everyday activities. Consequent upon the proliferation of complex ICT infrastructure is the accompanying high bulk of energy consumption and electronic dumping, which has become a main apprehension both economically and environmentally. Green computing is an emerging subdomain in ICT that can efficiently assist in the reduction of the energy consumption rate, which substantially leads to CO₂ emission reduction and other environmental menaces associated with the use of ICT infrastructure. Accordingly, Green computing has become an indispensable component that needs to be taken seriously by the next generation information communication technology management. Green computing according to the International Federation of Global and Green Information Communication Technology (IFGICT) is also known as Green Information Communication Technology (GICT) or Information Communication Technology Sustainability (ICTS). It deals with the study and practice of environmentally sustainable communication and information technology. The purpose of green computing is basically to reduce the use of perilous constituents and make best use of energy proficiency by utilizing renewable energy sources and environment-friendly computing devices during the invention's lifetime as well as the realizability or biodegradability of obsolete inventions and industrial wastes. Africa countries including Nigeria has great potential to promote green computing because of higher daily solar radiation of up to 220 W/m² compared to other climes which could be as low as 100 W/m². Green computing is significant for both in handheld systems and large-scale data centres [1],[2],[3],[4]

The practice of environmentally sustainable communication and information technology is a significant guide in tackling environmental pollution and degradation as well as a core contributing factor to climate change impacts mitigation. The capability of ICT as an influential instrument to aid inclusive and environmentally sustainable development should be given more recognition due to their importance in the enhancement of developmental involvements all sectors of human life. The practices of green computing involve the application of energy-efficient central processing units, peripherals and servers as well as finding ground-breaking ways of reducing resource consumption and appropriate disposal of electronic waste. Several ICT producers and merchants incessantly invest in producing energy efficient computing devices, reducing the use of hazardous constituents and encouraging the recyclability of digital devices and printing paper. The practice of Green computing was principally made known by the Environmental Protection Agency in the United States of America in 1992 when they launched the Energy Star program. Following its launch in 1992, green computing has become a ground-breaking platform, standard and a specialist field of study respectively. It focusses on the convergence of Computing, ICT and Environmental science/engineering. Over the years, several industries as well as establishments have turned attention in apprehending how going 'green' can help in improving societal wellbeing, reduce expenditure on production and operation of facilities, and the mitigation of global emissions from industrial manufacturing, production and other economic activities. Green computing is one of the various ways of attaining the foregoing global vision of environmental protection and energy conservation. It involves a suite of approaches, and procedures, from energy efficient techniques to the study of technologies and operations conducted from day to day in the pursuit of socio-economic sustenance and wellbeing. Its goals are directed towards finding the best ways to protect and sustain the natural environment from degradation and unintended extinction thereby providing a form of assurance towards the safety of humankind. Essentially, green computing focuses on ways that aid reduction or prevention of environmental anomalies and disaster evidenced by use of high technology especially computing and related

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infrastructure. It is very vital to finding and promoting novel ways towards ensuring reduction of pollution, determination of alternative technologies as well as the formation of more recyclable products [6]. This study is aimed at examining the strategies, practices, policies, and legislations on 'environmental computing' otherwise called green computing amidst other environmental protection approaches within Nigeria, Africa's largest country by population and economy respectively. Interestingly, the government of Nigeria has a history of policies put in place for the control, regulation and management of its environment, however, this paper is an attempt towards discovering the extent to which the existing policies and strategies incorporate the principles and practices of green information communication technology.

2. Materials and Methods

A hybrid approach comprising narrative, descriptive and survey including sociological enquiries was adopted in this paper. Qualitatively, a detailed search was conducted on various online and offline databases and vital documents including reliable published and unpublished papers within the last decade on the development of environmental legislations and policies as well as those directed towards green computing practices across Nigeria, were collated and classified into legislations, policies, and operational guidelines. Emphasis was laid on established policies and regulatory frameworks on green computing and environmental protection activities across entire six geopolitical zones i.e. North-Central, North-East, North-West, and South-East, South-South, and South-West respectively. In order to build on the desk survey, the researchers also embarked on a sociological survey to collect first hand data on the opinions of fifty experts on large ICT infrastructure driven companies especially in the private sector.

2.1 Sampling

Judgmental/purposive sampling method was adopted in this paper. This reason underlying the use of purposive sampling is hinged on the need to extend the study across all regions in Nigeria. Expert knowledge on the part of the researchers on recent economic developments in various areas in geopolitical zones provided sufficient grounds to concentrate the study on locations that are potentially endowed to spearhead vital developmental programs in those regions. The six geopolitical zones were considered and from each region the most economically-active city in respect of production or commercial activities was selected. The major sources of revenue in each geopolitical zone were documented and selection of geopolitical zone or a city within a geopolitical zone was based on the potentials or affinity of that city or zone to information communication technologies and allied products. The six zones are shown in Table 1. The population and internally-generated revenue (IGR) figures were as published by the National Bureau of Statistics (NBS). The population are based on the 2016 figures from the central Bank of Nigeria published in 2018 whereas the IGR are based on the 2017 figures. Note that the IGR values are given in billions of Naira.

Table 1: Nigeria's IGR by geopolitical zone (2017 figures)

S/N	Geo-political	Population	IGR	Prominent
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	zone			export resources
1	North-Central	25,688,282	66.69	Grains, Animal feed, Shea and Grain, Iron ore and Cement, Fruit concentrate, Soy oil, Bauxite/Aluminium, Frozen french fries
2	North-East	26,263,866	30.17	Alfalfa, Honey, Raw sugar, Fish, Rice, Beef, Sugar, Cotton
3	North-West	48,942,307	101.01	Beef, Textile, Apparel, Footwear, Cotton, Rice, Frozen french fries, Iron ore, Cement, Soy bean
4	South-East	21,955,414	66.25	Shrimps, Plaster of Paris, Footwear, Coal, Cement, Rice, Animal feed
5	South-West	38,257,260	453.46	Technology, Biodiesel, frozen chicken, Ceramics, Cocoa, Asphalt shingle, Cassava flour
6	South-South	28,829,288	213.20	Bio-fuel, Grains, Animal feed, Shea, Rubber, Engineered wood, Bioplastics, Fish

In selecting the geopolitical zone of reference, IGR and the nature of exportable produce/services were considered as a reflection of the volume of economic activities across the zone and hence a reliable parameter to determining the rate of industrial activities. The South-West geopolitical zone was selected for its IGR, technological base and ICT-induced environmental impact on Lagos environment as well as the entire entity called Nigeria.

3. Results and Discussion

3.1 Environmental Legislation and Regulation in Nigeria

Ordinarily, in many countries, there are national environmental legislations and policies that would guarantee sustainable development directed towards regulation, control and management of the environment. The same is true for Nigeria. The need for optimistic and genuine planning that would stabilize human desires in contrast to the carrying capacity of the environment is a cause of concern to the Nigerian government. This concern has given rise to a number of environmental legislations, policies and management approaches. Such policies and management approaches have the following as their mainstream objectives:

- i. Integration of environmental apprehensions into the main economic decision-making process.
- ii. Creation of environmental remediation costs into the main development schemes.
- iii. Administration of economic tools for the management of natural resources.
- iv. Application of environmentally approachable technologies to key development project.
- v. The compulsory use of Environmental Impact Assessment (EIA) for key development projects.

It is worthy of note that Nigeria has had several environmental policies its 59 years of existence as an independence nation. These policies though captured in various sectors are meant to deal with acts or omissions that could lead to environmental degradation in the country [6],[7],[8]. Nigeria is faced with human-induced environmental degradation which had continued resulting to huge socio-economic problems not limited to the economic development of the country but also the security and welfare of its citizenry. Some of these hostile challenges that have been recorded from the various environmental dilapidation include; deforestation, petroleum spillage, desertification, environmental pollution, climate change, global warming, breakdown of telecommunication and radar systems, etc. [9], [10],[11],[12],[13],[14]. Table 2 shows the various environmental legislations and the respective sectors to which they may be exercised. Over thirteen (13) federal legislations have been identified. In this paper emphasis is made on the principal environmental protection law i.e. NESREA Act. The principal environmental legislation is the Constitution of the Federal Republic of Nigeria (as amended). Section 20 of the said Constitution is to the effect that the government is mandated to protect, improve the integrity of environment including water, air, forest, land, and wildlife in Nigeria. All other legislations derive from the provision of the foregoing section. For instance, the effect of Constitutional provision on environmental remediation may also be adduced from Section 33(1) of the Constitution which provides that "every person has a right to life and no one shall be deprived intentionally of his life". Having regard to the fact that a healthy environment is sine qua non to a healthy life, it therefore follows that this right extends towards protection of the citizenry against hazards arising from exposures to poor and degrading environmental conditions. Section 2 of Environmental Impact Assessment Act is to the effect that every legal entity in the public or private sector must evaluate the effect of any proposed projects on the environment prior to the implementation of such a project, that is, there should be a thorough assessment of the project or activity vis-à-vis the impact of the said project on the environment and such must be evaluated and approved by a legitimate authority prior to the kick-off of such a project.

Table 2: Environmental Legislations

S/No	Legislation(short tile)	ICT-specific
1	Constitution of the FRN 1999 (as amended)	No
2	Environmental Impact Assessment Act 2004	No
3	NESREA Act 2007	No
4	Harmful Waste (Special Criminal Provisions etc.) Act 2004	No
5	Oil in Navigable Waters Act	No
6	Associated Gas re-injection Act	No
7	Water Resources Act	No
8	Endangered Species (Control of International Trade and Traffic) Act	No
9	Nuclear Safety and Radiation Protection Act	No
10	National Oil Spill, Detection and	No

	Response Agency Act	
12	Hydrocarbon Oil Refineries Act	No
13	National Park Services Act	No
14	Niger-Delta Development Commission (NDDC) Act	No
15	The Land Use Act	No
16	Sea fisheries Act	No
17	Nigerian Mining Corporation Act	No

Though environmental legislation is very critical to the success of any environmental management policy or program, regulation and enforcement are what ensure that the extant laws and policies attain their stipulated goals. To this end, Nigeria has several regulatory and enforcement agencies. Table 3 shows a list of some of these regulatory agencies.

Table 3: Regulatory and Enforcement agencies

S/No	Ministry/Agency	Function	Impact
1	Federal Ministry of Environment	Policy formulation	Nationwide
2	Federal Ministry of Water Resources	Policy formulation	Nationwide
3	National Oil spill Detection and Response Agency	Regulation and control, policy implementation	Nationwide
4	National Environmental Standards and Regulations Enforcement Agency (NESREA).	Regulation, Standards and Enforcement	Nationwide
5	National Biosafety Management Agency	Regulation and control, policy implementation	Nationwide
6	Erosion, Floods and Coastal Zone Management	Control	Nationwide
7	Nigerian Nuclear Regulatory Authority	Regulation and control, policy implementation, and enforcement	Nationwide
8	Department of Climate Change	Policy formulation and implementation	Nationwide
9	Energy Commission of Nigeria	Regulation and control, policy implementation	Nationwide
	Drought and Desertification Agency	Regulation and control, policy implementation	Nationwide
	Directorate of Petroleum Resources	Regulation and control, policy implementation	Nationwide
	Environmental Protection Agencies in the States of the Federation	Regulation and control, policy implementation, enforcement	State and Local Councils

National Environmental Standard and Regulations Enforcement Agency (Establishment) Act 2007

The Second Schedule of Constitution provides for legislative powers and grants exclusive legislative powers to the federal legislature on many sectors that can predispose to environmental pollution and degradation such as water bodies, air, nuclear energy, national parks, mines, atmosphere, wireless communication, etc. It follows that all

objects within the contemplation of exclusivity and matters emanating therefrom are to be controlled by the Federal Government. Notwithstanding the foregoing, States of the Federation can assume concurrent and residual legislative powers to legislate on matters not specified in the exclusive legislative list for example, waste management which by extension include electronic wastes and dumps. It should also be noted that the NESREA Act empowers the agency to encourage States and Local Government Councils to establish environmental protection and management agencies hence, States can make laws that extend the coverage of the principal law. Historically, the National Environmental Standard and Regulations Enforcement Agency (Establishment) bill was passed into Law in 2007 and took effect the same year. This subsisting federal legislation was principally aimed at the management and control of environmental challenges and creation of awareness on environmental protection. The legislation is also known as the NESREA Act owing to the fact that the legislation established the mainstream federal agency i.e. the National Environmental Standards and Regulations Enforcement Agency (also known as NESREA for short). The role of the legislation in ensuring environmental awareness and compliance, mandate and power, functions and the administrations of environmental laws in Nigeria had been a subject of great concern because of the uncertainties which are obvious in the legislation. However, the NESREA Act unlike its predecessor, the Federal Environmental Protection Act of 1988(which has been repealed by the extant law), has thirty-three (33) subsidiary regulations emanating from it and created by the Federal Ministry of Environment, through which the legislation attains its stipulated mandate. The Act created the National Environmental Standards and Regulations Enforcement Agency which is the principal federal agency with mandate to protect the integrity of the nation's environment. As a law enforcement agency, the NESREA (as it is called for short) has jurisdiction to enforce all environmental guidelines, regulations, policies, frameworks, standards, and laws including international conventions, protocols and treaties endorsed by Nigeria. Figure 1 shows the various activities of the NESREA as an enforcement agency of the federal government.

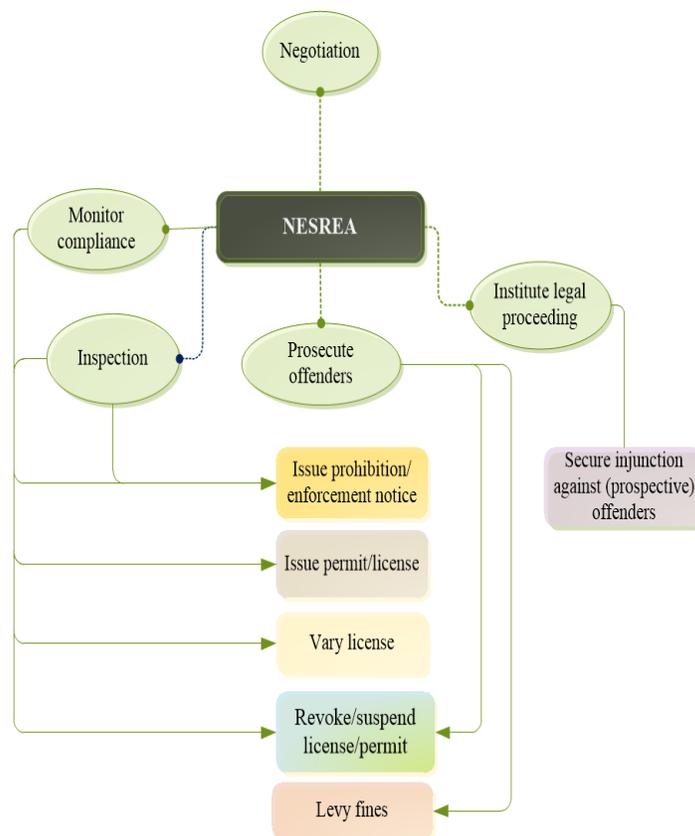


Figure 1: NESREA and its operations

The legal mandate of the agency is sacrosanct and clearly contained in Section 2 of the establishing law which provides that:

“the Agency shall have responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of Nigeria's natural resources in general and environmental technology, including coordination and liaison with relevant stakeholders within and outside Nigeria on matters of enforcement of environmental standards, regulations, rules, laws, policies and guidelines”.

3.2 Environmental Problems in the light of ICT Pervasiveness

Environmental issues are scientifically challenging as a result of the constant variations in atmospheric parameters which is mostly caused by human activities especially via the deposition of electronic wastes, emissions from large data centres, ICT equipment production factories, etc. [10],[11],[12]. These substances often initiate a cycle of reactions in the atmosphere leading to changes in atmospheric component parameters especially temperature which subsequently affect other atmospheric constituents [13],[14],[15],[16]. These changes could be understood more through constant monitoring and analysis of the various atmospheric parameters over a period so draw up a conception of the propensities of their acceleration [17]. ICT and Computing models have been deployed have been developed to foster atmospheric parameters monitoring and analysis [16],[17]. Atmospheric parameters monitoring has become a very crucial issue globally due to its numerous

implications in agriculture, telecommunication, transportation, military operations, forecasting, etc. [11]. In Nigeria and most developing countries of the world, research on atmospheric pollutions and degradation are still very much behind due to lack of affordable computerized meteorological instruments as well as technical expertise. These instruments are critical in the detection and management of environmental hazards that have affected agriculture and other aspects of human endeavours. ICT is a two-edged sword. On one side, its use and misuse can impact negatively on the environment whereas on the other hand, when cautiously used, it can also nurture confidence, openness, reliability and inclusivity beneficial to all [18]. ICT is also a significant response for effective and equitable adaptation and mitigation of environmental dilapidation issues, hence, the authorities and governments [19],[20],[21],[22],[23] should consider formulating and promoting green computing policies to address the diversity and ambiguity associated with the impact of technology on the nation's environment.

3.3 Curbing ICT-induced environmental degradation

The use and misuse of ICT facilities could be detrimental to the society and could impact negatively on the health and economy of the citizenry. The need for green computing strategies and platforms is becoming necessary to curtail the growing environmental pollution arising from ICT use and disuse. To examine the extent to which the extant laws captures the regulation and control of ICT-induced environmental degradation, it is instructive to note the provisions of the extant federal law, i.e. NESREA Act. This legislation is the backbone on which most States derive their environmental protection laws. The effect of Section 20(1) of Act is that the Agency has powers to formulate regulations that reflect standards and specifications directed at protecting the quality of the nation's air resources. This provision is connected to the duty of the government to promote public health, welfare, natural development and productive capacity of its animal, human, marine and plant life. It is instructive to note that this provision extends to the following:

- i. control of substances released to the air such as pollutants (emissions from data centres) which are likely to result in deterioration of property, human, animal, marine or plant health
- ii. use of appropriate techniques to prevent and control atmospheric pollution
- iii. control atmospheric particulate pollution associated with energy sources (generators, batteries, uninterrupted power units, etc.) deployed by factories, industries, power generating facilities
- iv. evaluate the health hazards associated with indiscriminate siting of telecommunication base station without recourse to radiation pollution.
- v. determine standards to be used in evaluating emissions from mobile and stationary source adjudged to contribute to air pollution that could threaten public health or welfare...

In the light of the foregoing provision, it may be adduced that the extant law has covered the field of ICT-induced environmental challenges especially those arising from data centres. However, a careful examination would discover that the data centres may not have been contemplated in the Act as a major contributor to environmental degradation. Consequent upon this gap, it is important to define and extend the provisions of this law by the agency. Accordingly, green computing policy would not only ensure the use of sustainable technology in the operations of companies and industries but would also define, initiate and promote researches on measures and technologies that could be used in studying and understanding the emissions from computing infrastructure vis-à-vis the impact such emissions could exert on the immediate surroundings. This would assist in promoting innovative ways to the mitigation and management of such environmental problems.

3.4 Strengthening environmental institutions

There is a need to strengthen the current environmental regulatory institutions in order to create a satisfactory framework and mechanisms for monitoring, administration and management of environmental laws and policies. In order for these laws and policies to flourish adequately in Nigeria, these laws and policies should be laid on the following sustainable development ideologies:

- i. Precautionary Principle (2P): This principle entails that where there are fears of serious or irreparable impairment, the deficiency of full scientific knowledge should not be used as a motive for deferring cost-effective means for the prevention of environmental dilapidations.
- ii. Polluter Pays Principle (3P): This advocates that the polluter should be responsible for the cost in the prevention and management of pollution.
- iii. Pollution Prevention Pays Principle (4P): This inspires establishment to invest absolutely in the prevention of pollution.
- iv. User Pays Principle (UPP): This as to do with the fact that the cost of a resource to a handler should contain all the environmental costs connected with its abstraction, renovation as well as the costs of alternative or inevitable impending uses.
- v. Principle of Subsidiary (PoS): This entails that decisions on environmental dilapidation should be made by those communities that are affected or possibly by the establishments closest to them on their behalf.
- vi. Principle of Intergenerational Equity: This entails that the desires of the present-day generation are met without compromising the capability of imminent generations in meeting their own desires.
- vii. Principle of Intragenerational Equity: This entails that the various groups of people within the country as well as within the present-day generation have the right to benefit correspondingly from the exploitation of resources and that they have an equal right to a clean and healthy environment.

4. CONCLUSION

This paper examines the extent to which the extant environmental protection laws encompass the principle and practices of green computing in the pursuit of sustainability

and development. The findings showed that though there are policies and legislations on environmental protection, there are no clear-cut specialized machineries to detect, measure, and control the environmental menace attributed to electronic dumping, and operations of data centres in Nigeria. The paper concludes that the inherent gap in the legislations are due to the fact that advancement in technology may not have been contemplated during the time the said laws and policies were articulated and enacted. Going forward, the paper supposes that the deployment of large data centres are on the increase in Nigeria especially in the industrial cities such as Lagos and that electronic wastes are imminent as well as the generation of greenhouse emissions from the operations of such large data centres having regard to the fact that those facilities are seldom replaced by their owners over time even when their manufacturers declare them unfit for use. It is recommended that the policies be reviewed and green computing or environmental computing practices and offence carefully adumbrated.

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