International Journal of Advances in Engineering & Technology, July 2012.
©IJAET ISSN: 2231-1963

CHALLENGES OF ELECTRONIC WASTE MANAGEMENT IN NIGERIA

Y.A. Adediran[1] and A. Abdulkarim[2]
Department of Electrical & Electronics Engineering, University of Ilorin, Ilorin, Nigeria

ABSTRACT
Electrical and Electronic Equipment (EEE) become technologically obsolete in a matter of months as a result of continuous development of new models. Most of the obsolete equipment find their way into developing countries who are hungry for information technology access. At the end of life, they eventually find their way into landfills as Electronic Waste (E-Waste or Waste EEE) which may pose health and environmental hazards to humans, livestock and ecology if not properly managed. This paper reviews the issues relating to E-Waste. It identifies the sources of E-Waste as well as their components and the dangers in them. Alternative initiatives and means of managing E-Waste both nationally and internationally are discussed. Recommendations are made on appropriate treatment of E-Waste in order to make the environment safe for all.

KEYWORDS: *Electronic Waste, Dangers, Nigeria & Management.*

I. INTRODUCTION

Electrical and Electronics Equipment (EEE) have generally made life easy and convenient because of their efficiency and time saving in application. Communication systems, as they are today, would not have been achievable without electronics technology. Entertainment industry (music, radio, television, cameras, etc.) would have remained crude if not for continuing development in electronic technology. Household equipment, now making use of electricity and electronics, are making domestic chores (washing, cleaning, cooling, heating, etc.) continuously easier and more convenient.

Electrical and electronics equipment, particularly electronic devices, become technologically obsolete in a matter of months as a result of continuous development of new models. This rapid technological growth leads to high rate of production of electronics equipment. Some 20 to 50 million metric tonnes of E-Waste are generated worldwide every year [1]. In the United States alone, 14 to 20 million personal computers are thrown out each year, with an annual increase of 3-5%. However, only some 13-18% are recycled. In the end, the disused equipment find their way into various directions, some ending up in landfills where they pose environmental and health hazards to humans, livestock and the soil. Some of these are incinerated, leading to environmental pollution from the fumes. The 'surviving' ones find their way into poor developing countries where, possibly out of ignorance, the equipment are carelessly handled, hence posing a serious threat to human health, soil, livestock and drinking water. Electronic equipment that has reached their end of life becomes Waste of Electrical and Electronic Equipment (Waste-EEE), or simply Electronic Waste (E-Waste).

This paper looks at the issues relating to E-Waste. It identifies the sources of E-Waste as well as their components and the dangers in them. Alternative initiatives and means of managing the E-Waste, both internationally and nationally, are discussed, and recommendations are made on appropriate treatment of E-Waste in order to make the environment safe for all.

The remainder of this paper is structured as follows: Section II defined E-Waste and gives categories of E-Waste. Section III discussed sources and generation of E-Waste. Section IV identified the hazardous components in E-Waste. Section V explains the effects of some of the hazardous E-Waste components. Section VI described some of the international initiatives and Nigeria's efforts at

managing E-Waste. Section VII discussed some of the constrains to obtaining reliable data on the amount of E-Waste generated. Section phase VIII identified some of the stakeholders at various phases of E-waste life cycle, including generation and management. Section IX proposed an effective and economical solution to managing E-Waste. Finally the paper concludes in section X.

II. DEFINITION AND CATEGORIES OF E-WASTE

There is no internationally standardized or agreed definition of E-Waste; hence, each country or organization comes up with their own customized definition. However, for the purpose of this paper, the European Union (EU) definitions of EEE and Waste have been adopted. According to EU initiative [2], therefore,

> '*Electrical and Electronics Equipment* (*EEE*) means equipment which is dependent on electrical currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such current and fields designed for use with a voltage rating not exceeding 1000 volts for alternating current and 1500 volts for direct current.'
>
> '*Waste* is any substance or object which the holder disposes of, or is required to dispose of pursuant, to the provision of national law in force.'

Table 1. Categories of Electrical and Electronics Waste [2]

S/N	CATEGORY	TYPICAL EXAMPLES
1	Large Household Appliances	Refrigerators, freezers, washing machines, clothe dryers, microwaves, heating appliances, radiators, fanning/exhaust ventilation/conditioning equipment
2	Small Household Appliances	Vacuum cleaners, other cleaners, sewing/knitting/ weaving textile appliances, toasters, fryers, pressing iron, grinders, opening/sealing/packaging appliances, knives, hair cutting/drying/shaving devices, clocks, watches
3	IT and Telecommunication Equipment	Mainframes, microcomputers, printers, PC (desktop, notebooks, laptops), photocopiers, typewriters, fax/telex equipment, telephones
4	Consumer Equipment	Radio and TV sets, video cameras/decoders, Hi-fi recorder, audio amplifiers, musical instruments
5	Lighting Equipment	Luminaires for fluorescent lamps, low pressure sodium lamps
6	Electrical and Electronic Tools (excluding large-scale industrial tools)	Drills, saws, sewing machines, turning/milling/sanding/sawing/cutting/shearing/drilling/punching/folding/bending equipment, riveting/nailing/screwing tools, welding/soldering tools, spraying/spreading/dispersing tools,
7	Toys, Leisure and Sports Equipment	Electric trains, car racing sets, video games, sports equipment, coin slot machines, biking/diving/running/ rowing computers
8	Medical Devices	Devices for radiotherapy/cardiology/dialysis, ventilators, analyzers, freezers, fertilization tests, detecting/preventing/monitoring/treating/alleviating illness, injury or disability
9	Monitoring and Control Instruments	Smoke detectors, heating regulators, thermostats, measuring/weighing/adjusting appliances for household or laboratory use, other industrial monitoring and control instruments
10	Automatic Dispensers	for hot drinks, hot or cold bottles/cans, solid, products, money, and all kinds of products

III. SOURCES AND GENERATION OF E-WASTE

The average life cycle (or obsolescence rate) of an equipment is the time span after which the item comes to its end of life. It is defined as [2]

$$Average\ life\ cycle = Active\ life + Passive\ Life + Storage \quad (1)$$

where

Active life is the number of years the equipment can be efficiently used;

Passive life is the time period, after Active Life, when the equipment can be refurbished or reused;

Storage is the time during which the equipment is stored and at repair shops before dismantling.

In developed countries, passive life and storage life are virtually non-existent; hence, the average life cycle of electronic equipment is generally the same as the Active life. Therefore, the passive and disposal times are taken care of by the developing countries to which the equipment are transported and where second-hand market exists for them. Therefore, the new source of E-Waste in developing countries is the E-Waste trade value chain from the developed countries to developing countries [3, 4]. Huge markets of E-Waste thus exist in developing countries where used computers and their peripherals, mobile phones, etc. are imported as functional or junk materials. According to Computer and Allied Product Dealers Association of Nigeria, for example, up to 75% of electronics shipped to the Computer Village in Ikeja, Lagos are irreparable junk. Nigeria, like almost all other African countries, has a thriving market for these electronics junks as a result of hunger for information and for global IT relevance in order to bridge the digital divide. These countries are also too poor to purchase new and modern electronic products that have to be imported since there is no capacity either to manufacture them or to safely dispose of them. Africa, in particular, is the latest destination for E-Waste, referred to as the 'digital dump' by the Basel Convention Network (BAN) [5], since many Asian countries are now coming up with legislation that bans uncontrolled importation of certain categories of used Electrical and Electronics Equipment. However, such trade has been discovered to be unfair to developing countries because of the inherent dangers that E-Waste poses to the environment, humans, livestock, soil and ecology as in [3, 6, 7].

IV. E-WASTE COMPONENTS

Technological growth resulting from, for example, technological obsolescence of electronic products leads to an increase in the amount of E-Waste generated. It is also becoming easier and more convenient to change malfunctioning equipment than to repair or fix them. While electronic products may contain reusable and valuable materials [8], most of the components in E-Waste are however hazardous and toxic, hence unsafe to the environment. Table 2 contains some electronic items and their associated components. The cathode ray tube (CRT) of a TV or computer monitor, for example, contains lead, antimony, phosphorous, etc. in some proportions, while circuit boards in different electronic products contain lead, beryllium, antimony and brominated flame retardant (BFR). Other toxic substances contained in various electronic items include selenium, antimony trioxide, cadmium, cobalt, manganese, brome and barium, amongst many others.

Table 2: Hazardous components in E-Waste items [9,10,11]

ITEM	HAZARDOUS COMPONENTS
Cathode Ray Tube	Lead, antimony, mercury, phosphorous
Liquid Crystal Display	Mercury
Circuit Board	Lead, beryllium, antimony, BFR
Fluorescent Lamp	Mercury, phosphorous, flame retardants
Cooling systems	Ozone depleting substance (ODS)
Plastic	BFR, phthalate plasticizer
Insulation	ODS in foam, asbestos, refractory ceramic fibre
Rubber	Phthalate plasticizer, BFR, lead
Electrical Wiring	Phthalate plasticizer, BFR
Batteries	Lead, lithium, cadmium, mercury

V. DANGERS IN E-WASTE

As depicted in Table 2, E-Waste contains toxic substances such as lead, chromium, mercury, etc. that are hazardous to human health in particular, and the environment in general. Table 3 summarizes the

effects of some of the most hazardous E-Waste components, viz. mercury, lead, chromium, brominated flame retardants and cadmium..

Table 3: Effects of E-Waste on humans [9, 10, 11 ,12 13, 14]

TOXIN	TYPICAL SOURCES	EFFECTS ON HUMANS
Mercury	Fluorescent lamps, LCD monitor, switches, flat panel screens	Impairment of neurological development in fetuses and small children, tremours, emotional changes, cognition, motor function, insomnia, headaches, changes in nervous response, kidney effects, respiratory failures, death
Lead	CRT of TV, computer monitor, circuit boards	Probable human carcinogen, damage to brain and nervous systems, slow growth in children, hearing problems, blindness, diarrhea, cognition, behavioural changes (e.g. delinquent), physical disorder.
Chromium	Untreated and galvanized steel plates, decorator or hardener for steel housings	Asthmatic bronchitis, skin irritation, ulceration, respiratory irritation, perforated eardrums, kidney damage, liver damage, pulmonary congestion, oedema, epigastric pain, erosion and discolouration of the teeth, motor function
BFR	Plastic casings, circuit boards	May increase cancer risk to digestive and lymph systems, endocrine disorder
Cadmium	Light-sensitive resistors, as corrosion retardant, Ni-Cd battery	Inhalation due to proximity to hazardous dump can cause severe damage to the lungs, kidney damage, cognition

Apart from the hazardous effects on humans, it is discovered that E-Waste leaches the soil due to the presence of mercury, cadmium, lead and phosphorus in it. E-Waste can also cause uncontrolled fire risk, leading to toxic fumes. In addition, uncontrolled burning, disassembly and disposal of E-Waste can cause a variety of environmental problems such as groundwater contamination, atmospheric pollution, and occupational and safety effects among those directly or indirectly involved in the processing of E-Waste [12, 16].

VI. E-WASTE MANAGEMENT INITIATIVES

It is worrisome that a lot of Nigerians are unaware of the dangers inherent in careless handling of E-Waste. It is, therefore, common to see both young and old scavengers rummaging through solid waste heaps at dumpsites without caring about the health implications of such dangerous means of livelihood. It is therefore pertinent to discuss alternative ways of managing E-Waste, particularly in healthier and safer ways, the focal point of which is reducing, reusing and recycling (3Rs). The discussion will look first at the international initiatives, after which it zeroes in on the local (Nigerian) efforts at managing E-Waste.

6.1. International Initiatives

Table 4 identifies some initiatives that have been taken to manage E-Waste by international organizations and agencies, and also summarizes some features of these initiatives. The initiatives are in recognition of the fact that there is a large gap between developed and developing countries as regards E-Waste management in terms of policies, institutional framework, infrastructures and legislation, amongst others.

Of particular importance is the Basel Convention which is an international treaty on the control of trans-boundary movements of hazardous wastes and their disposal. It was designed to reduce the movements of hazardous waste (excluding radioactive waste), and specifically to prevent transfer of hazardous waste from developed countries to less developed countries [17]. The Basel Convention is of particular importance to Nigeria as the 1988 Koko case, in which five ships transported 8000 barrels of hazardous waste from Italy to Nigerian town of Koko, was one of the incidents that led to the creation of the Convention. This international initiative is one of the bold attempts made to control international flow of wastes which is to the disadvantage of the developing countries. The Convention makes illegal hazardous waste traffic criminal, though without enforcement provisions; and parties to the Convention must know the import bans of other Parties.

Table 4: International Initiatives on E-Waste Management [9, 17]

S/NO.	ORGANISATION/ AGENCY	FEATURES OF INITIATIVES
1	The Basel Convention	Set up: - the Mobile Phone Partnership Initiative (MPPI) - the Global Partnership on E-Waste - the Global Partnership on Computing Equipment
2	G-8 3Rs	- Agreed upon by the G8 leaders in Tokyo in April 2005 - Works closely under the Basel Convention 3Rs: Reduce, Reuse, Recycle
3	StEP (Solving the E-Waste Problem)	- Offspring of UN University, UNEP and UNCTAD - Role is to provide analysis and dialogue to reduce environmental risk and enhance development Objectives: to optimize the life cycle of EEE
4	UNEP/DTIE ((IETC)	- Implementation of Integrated Solid Waste Management (ISWM) Project - Based on 3Rs and covers all types of wastes in integrated manner - Supported a city-level E-Waste assessment study for Mumbai and Pune in India
5	GeSI (Global e-Sustainability Initiative)	- Consists of ICT service providers and suppliers , supported by UNEP and ITU - Objectives: to share experience and knowledge, to work with stakeholders, to manage their own private sector operations, to raise awareness, to engage in research and benchmarking.
6	GTZ	- provide support in E-Waste management in different countries e.g. in Yemen - supporting Indo-European E-Waste initiative

6.2 Nigeria's Efforts in E-Waste Management

There has not been any serious initiative in Nigeria as regards management of E-Waste. There are, however, a sizeable number of government agencies that should be directly or indirectly involved in E-Waste management. Among these are

- Federal Environmental Protection Agency (FEPA)
- National Environmental Standards and Regulations Enforcement Agency (NESREA)
- National Emergency Management Agency (NEMA)
- National Space Research and Development Agency (NASRDA)
- Nigeria Customs Service (NCS)

There is, therefore, some institutional framework in place though its effect is yet to be felt. In order, therefore, to effectively address the issues surrounding E-Waste management in Nigeria, a number of challenges must equally be addressed. For example,

- There is no legislation to control the flow of used consumer electronic products;
- Used electronic products are not regarded as contraband by the Nigeria Customs Service as long as appropriate duties and taxes are collected on them [18];
- There is no public awareness on the inherent dangers of handling E-Waste which, for example, is regarded as a business opportunity, except for smelting of scrap metals;
- There are no E-Waste recycling facilities in the country;
- There is poor (if any) corporate social responsibility on the part of industries on E-Waste.

An attempt was made by NESREA in 2009 by sponsoring an international conference on E-Waste control tagged 'The Abuja Platform on E-Waste'. Also, the first international E-Waste Summit in Nigeria was held from 24th to 25th February 2011 in Lagos with the theme 'Regulation and Management of E-Waste in Nigeria'. This was the first Summit of its kind in Nigeria and probably in Africa following the International Conference on E-Waste Control held by NESREA in 2009. The conference called on the Federal Government to encourage and enforce collection, recovery, re-use and recycling (3R) of E-Waste.

Currently, NESREA is conducting a nationwide series of sensitization workshops on the newly gazetted National Environmental Regulations which are in four categories. Regulations governing the use and disposal of electronic waste fall under Category III. According to the regulations, every facility is expected to have a waste management plan which must be submitted to the Agency. Violation of this provision by an individual attracts a fine not exceeding N 200 000 or to imprisonment term not exceeding 6 months. For a corporate organization, the corresponding penalty is N 1 million, with an additional fine of N 50 000 for every day the offence subsists. While this effort of NESREA is commendable, Nigerians are waiting for its implementation. Some attempt is also being made by the Basel Convention office in Nigeria though it addresses solid waste in general.
The latest known initiative is coming from the Nigerian Society of Engineers (NSE) through its Environment Division which organized a conference in November 2010 in Abuja with the theme 'Environmental Impact of Telecommunication Projects in Nigeria'. The main concern of participants at the conference, through its communiqué, was the inherent dangers posed by E-waste whose quantity is continually increasing at a fast rate while the governments at all levels are doing little or nothing to address the situation. Since this initiative is coming from a professional body, it is hoped that a substantial progress would be made in recommending to governments at all levels the need to legislate on E-Waste management.

VII. CONSTRAINTS TO RELIABILITY OF INVENTORY DATA IN NIGERIA

In the developing countries, of which Nigeria is one, there are serious constraints to obtaining reliable data on the amount of E-waste generated. This makes any E-waste inventory model developed for developing countries to lack merit. Some of the constraints are summarized as follows:

- Historical sales data of electrical/electronic equipment are rarely available.
- Export/import data are unreliable because of uncontrolled importation and generation of E-waste.
- The dynamic nature of electronics market makes it difficult to calculate the stock data for private and industrial sectors.
- Storage data may not be available because storage may be in the formal/informal sector.
- Obsolescence rate is prolonged because of cheaper options for repair, thus leading to reuse of EE equipment.
- Data related to recycling are difficult to track and are not easily available because majority of the E-waste items are dismantled to recover usable parts and materials of economic value.
- E-waste residues are dumped in landfills without any assessment of quantity and quality.
- Historical saturation levels/penetration rates may be available only to a limited extent.

VIII. STAKEHOLDERS IN E-WASTE GENERATION AND MANAGEMENT

Figure 1 depicts the major stakeholders at various phases of E-waste life cycle, including generation and management.

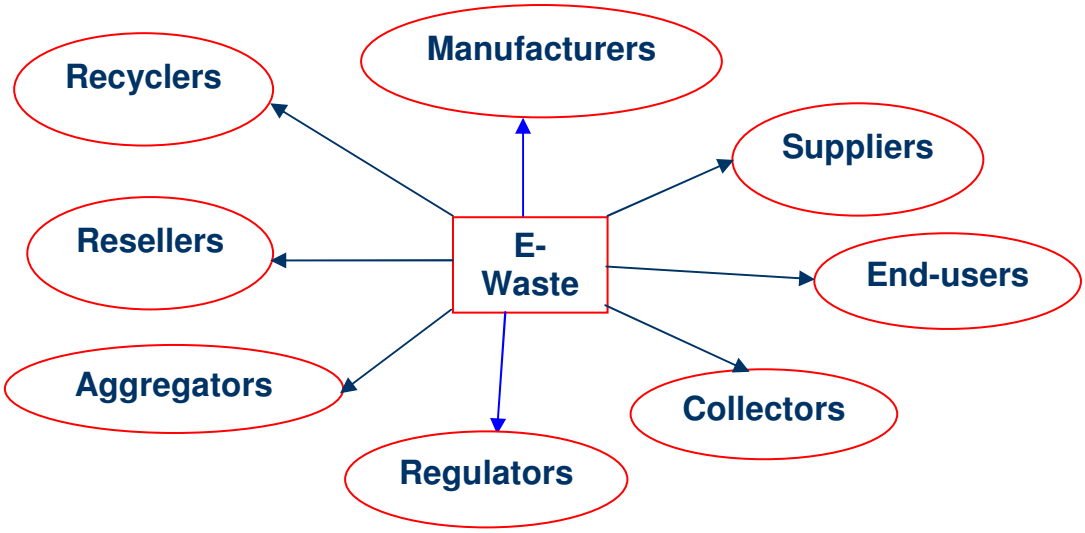

Figure 1: Stakeholders in E-waste generation and management

Governments play a dual role: as generators and as regulators. They generate E-waste when they dispose of their old or dysfunctional EEE and replacing them with new ones. They play the regulatory role through agencies like NESREA, FEPA and Nigerian Customs Service (NCS). For example, the NCS regulates the inflow of Waste-EEE from developed countries and collects tariffs on legally imported ones. Unfortunately, though NCS collects revenue for the Federal Government and cooperates with NESREA in the interception and re-exporting of E-waste on E-waste laden vessels, the organization is however limited to obeying government fiscal policies by collection of tariffs and taxes, while used electronics products are not considered as contraband as long as duties and taxes are collected on them [18].

Sellers of office equipment in developed countries find electronics equipment obsolete on yearly basis because of manufacture of new models. Photocopiers, computers, printers and fax machines are typical examples of electronics equipment that 'run' quickly into such technological obsolescence. In the developed world, such equipment are donated to schools and charities for use or resale [19, 20], while the dysfunctional ones are shipped to poor developing countries where they eventually become E-waste.

IX. E-WASTE MANAGEMENT TECHNOLOGIES

Recycling is an effective and economical solution to managing electronic waste. It is one of the components of the 3R options of reduce, reuse and recycle E-Waste. There are many benefits to be derived from recycling E-Waste. Among these are the following:

- Most electronic devices contain a variety of materials, including metals that can be recovered for future uses.
- Intact natural resources are conserved by dismantling and providing reuse possibilities.
- Air and water pollution that could be caused by hazardous disposal is avoided.
- It leads to reduction in the amount of greenhouse gas emissions caused by the manufacturing of new products.

Reuse, in contrary to recycling, extends the lifespan of a device before eventual recycling.

There are four main steps involved in the recycling of E-Waste, viz: collection, transportation, treatment, and disposal.

X. CONCLUSION

E-Waste (or Waste-EEE)

E-Waste management has become a topical issue, particularly because such waste now easily find their way into developing countries where they are carelessly and uncontrollably dumped in landfills. It is increasingly causing concern all over the world because of its hazardous effects on humans,

livestock and the ecology if not properly disposed of. Basically, everyone is a stakeholder in the generation of E-Waste as consumer, seller, producer, importer, etc. Therefore, effective and efficient management of E-Waste concerns everyone who must play their role in order to make the environment safe and healthy. The NSREA intervention in Nigeria is therefore a welcome development.

REFERENCES

[1] Electronics Takeback Coalition (2010) "Facts and Figures on E-waste and Recycling" www.electronicstakeback.com; Updated June 4.
[2] UNEP, (2007a) E-Waste: Volume I Inventory Assessment Manual. United Nations Environment Protection" 123 pp.
[3] Schmidt, C. W, (2006) "Unfair Trade e-Waste in Africa", *Environmental Health Perspective*, Vol 114, No 4, April, pp 232-235.
[4] Townsend, T. G. (2011) "Environmental Issues and Management Strategies for Waste Electronic and Electrical Equipment. *Journal of Air & Waste Manage. Assoc. Vol* 61pp 587–610
[5] Weil, N, (2005) *E-waste Dumping Victimizes Developing Nations, Study Says*, IDG/PC World News, October 31.
[6] Osuangwu O. E. & Ikerinonwu, C, (2010). "E- Cycling E-Waste The Way Forward for Nigeria IT and Electro-Mechanical Industry", *International Journal of Academic Research*, Vol 2 no 1, available @www.ijar.lit.az.
[7] Luther L., (2010) "Managing Network Waste: Issues with Exporting E-Waste" *Congressional research service*. Available @www.crs.gov
[8] Gupt, V. Laul, P. & Syal, S, (2008) "E-waste – A Waste or a Fortune?", *Current Science*" vol 94, no 5, 10th March, pp 554-555.
[9] UNEP, (2007b) *E-Waste: Volume II E-Waste Management Manual United Nations Environment Protection*, 124 pp.
[10] MoEF, (2008) *Guidelines for Environmentally Sound Management of E-waste*, Ministry of Environment and Forests, Delhi, India; March 12, 84 pp.
[11]ENVIS, (2008) "*Electronic Waste",* ENVIS Newsletter, Mumbai, India;.
[12] Pinto, V. N. & Patil D.Y, (2008) "E-waste Hazard: The Impending Challenge" *Indian Journal of Occupational and Environmental Medicine;* vol 12 Issue 2.
[13]Osuagwu, O. E. & Ikerionwu C, (2010) "E-cycling E-waste The Way Forward for Nigeria IT and Electro-mechanical Industry" *International Journal of Academic Research;*
[14] Chen, A. Dietrich, K. N. Huo, X. & Ho S, (2011) "Developmental Neurotoxicants in E-Waste" *An Emerging Health Concern. Environmental Health Perspectives",* vol 119, no 4, April, pp 431-438.
[15] Wikipedia, (2011a) *Electronic Waste*. http://en.wikipedia.org/wiki/Electric_Waste. Accessed 19/7/2011.
[16] Ban, B. Gang J., lim J., Wang S., An K. & kim D, (2005) "Studies on the reuse of Waste Printed Circuit Board as an Additive for cement Mortar", *Journal of Environmental Science and health. Tylor and Francis* Vol 40 pp 645-656
[17] Wikipedia, (2011b) *Basel Convention*. http://en.wikipedia.org/wiki/Basel_Convention._Accessed 31/8/2011
[18] Nigeria Customs Service, (2011) *Challenges Facing Effective Management and Regulation of E-waste*. A paper presented by Nigeria Customs Service at a two-day summit of Regulation and Management of E-waste in Nigeria (Eko E-waste Summit), February.
[19] Columbia University, (2006) *Electronic Waste Recycling Promotion and Consumer Protection Act* (Final Report of the Workshop in Applied Earth Systems Management, MPA Program in Environmental Science and Policy"
[20] Umesi, N.O. & Onyia S, (2008) "Disposal of e-wastes in Nigeria: An Appraisal of Regulations and Current Practices", *International Journal of Sustainable Development and World Ecology;* pp 565-573.

Authors biography

Yinusa Ademola ADEDIRAN is a professor of Electrical and Electronics Engineering presently is the head of Electrical and Electronics Engineering, Faculty of Engineering and Technology, University of Ilorin. He Obtained Doctor of Philosophy, Federal University of Technology, Minna, Nigeria , Master of Science (M.Sc.) in Industrial Engineering University of Ibadan and Master of Science (M.Sc.) in Electrical Engineering (Telecommunications Option) with Distinction, Technical University of Budapest, Hungary. He has published seven (7) books including Reliability Engineering, Telecommunications: Principles and Systems (First Edition), Fundamentals of Electric Circuits, Introduction to Engineering Economics, Applied Electricity, and Telecommunications: Principles and Systems (Second Edition) and Fundamentals of Electric

Circuits. The author has published over 70 journals, Conferences and manuscripts in Electrical & Electronics Engineering. Professor Yinusa Ademola Adediran is a Registered Engineer, Council for the Regulation of Engineering in Nigeria **(COREN).** He is a member of several professional society including Fellow, Nigerian Society of Engineers **(FNSE),**Member, Institute of Electrical & Electronic Engineers, USA **(MIEEE),** Corporate Member, Nigerian Institute of Management, Chartered **(MNIM),**Member, Quality Control Society of Nigeria **(MQCSN)**.

Abubakar ABDULKARIM is an Assistant Lecturer in the Department of Electrical and Electronics E Engineering, Faculty of Engineering and Technology, University of Ilorin. He obtained Master of Engineering (M.Eng.) in Electrical Engineering, University of Ilorin, Nigeria and Bachelor of Engineering (B.Eng.) in Electrical Engineering, Bayero University Kano (BUK), Nigeria. He has published some journals and conferences papers in Electrical & Electronics Engineering**.** He is a member of professional societies including Corporate Member, Nigerian Society of Engineers **(MNSE),** Member, Institute of Electrical & Electronic Engineers, **(MIEEE).**