Study Paper

On

e-waste management

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Table of Contents

e-waste management

Abstract:

In an approach to bridge the digital divide, it is necessary to get an affordable, equitable and quality access to ICT. It is estimated that two third of world's population is still offline so there is a need to provide affordable access to internet for all. For developing countries, it has become a priority area to alleviate poverty by promoting access to ICT.

At the same time, tremendous growth in use of ICT devices and services, faster change of technology and frequent innovations in ICT sector, had left the world with a threat of deterioration in environmental conditions and human health as the-waste of electronic and electrical equipment, which contains hazardous components, is still handled in an environmentally unfriendly manner mainly in developing nations. It is huge challenge for the nations to handle e-waste in responsible manner and protect the environment.

In this paper an approach is made towards assessing the present situation of e-waste management globally as well as in India, considering the present regulations and guidelines. It is also a fact that major part of recycling of e-waste is being handled by informal sector who have little/no knowledge about the consequences of exposure to hazardous substances.

To address the issue of e-waste management in a sustainable method, the concept of EPR (extended producer responsibility) will be helpful if the regulations incorporate monitoring and penalty clauses. The reuse of EEE has greater environmental and social benefits than recycling as it increases the useful life time of the ICT equipment and enables greater resource efficiency and energy efficiency. In developing nations, it can help in uplifting the status of the informal sector with help of education and employment.

In addition to the technical, social and organizational aspects of the EEE-waste management system, it is also crucial to consider the economic aspects, if the system has to be made financially viable and sustainable along with being socially acceptable.

1.0   Introduction:

It is a hard fact that with the voluminous increase in use of ICT devices to bridge the digital divide, there is also an alarming growth of e-waste world wide. e-waste is defined as "waste electrical and electronic equipment, whole or in part or rejects from their manufacturing and repair process, which are intended to be discarded" whereas electrical and electronic equipment has been defined as 'equipment which is dependent on electrical currents or electro-magnetic fields to be fully functional'.

There is a need for e-waste management as e-waste components may cause severe health risks and environmental damage, when crude, unscientific methods are applied for recovery of useful components. There is a need to encourage recycling of all useful and valuable material from e-wastes to preserve the natural resources.

Most of the developing countries are suffering with the rapidly growing problems of e-waste and have to have sound e-waste management systems for end of life ICT products to avoid the threat on environment and mankind.

The rapid growth of ICT, frequent innovations and technological changes are resulting in shorter life span of ICT equipment. Moreover in developing countries the quantity of imported disused Electrical and Electronic equipment (EEE) is uncontrolled .So the volume of e-waste has also increased drastically in developing and developed nations. At the same time, it is encouraging that every nation, along with going for the development in the ICT sector, is also working for 'going green' by taking care of issues like efficient use of natural resources, minimization of e-waste, sustainable recycling of e-waste and development of products with minimum use of hazardous substances.

Electrical and electronic equipment (EEE) contain valuable as well as hazardous materials and if at end of life of EEE, the hazardous materials are not disposed of scientifically it may cause serious damage to the environment and public health. The presence of heavy metals (like Arsenic, Cadmium, Barium, Lead, Lithium, Mercury, Nickel, Zinc Sulphide) and other toxic substances like PCB (Polychlorinated biphenyls) etc. may cause extreme harm, if not disposed of in environment friendly manner.

ITU has accepted the fact that the regulations in many developing countries to cover the areas of WEEE (Waste Electrical and Electronic Equipment)areinadequateas they exclude key topics and key stake holders like the informal sector. The collection, recycling, recovery and associated activities of e-waste management by the informal sector having little/no knowledge about techniques, precautions etc, cause more damage to their health and environment.

So goingin line withthe definition of environmental sustainability i.e." the ability to maintain the qualities that are valued in the physical environment by the use of design for environment principles, efficient use of non -renewable resources, efficient and environmentally sound recycling and use of renewable resources as much as possible", in order to have a sustainable policy to handle e-waste in an environment friendly manner, it is thus extremely important that policy of e-waste disposal and regulatory aspects should be stringent as well as rational.

2.0 An estimation of e-waste:

The exponential growth of internet users from 501 million in 2006 to over 1.3 billion at in 2011 in developing countries clearly indicates that the sale of computers and other terminals has grown at a lightning pace. In 2006, 44% of internet users were in developing countries whereas in 2011, 62%, were present in developing countries. Personal computer sales has significantly increased from 2000 to 2010, from about 170 million units sold globally in 2000 to about 370 million units sold in 2010. It is projected that sales in 2014 will reach an estimated 470 million units which is more than double in the last 10 years. In India, it is estimated that approximately 1.42 million PCs are getting obsolete every year.

ITU data release of June 2012 indicates that total number of mobile cellular subscriptions reached almost 6 billion by the end of 2011, and in the developing countries, about 80% of the 660 million new mobile cellular subscriptions added in 2011were generated.

The report "Recycling - from E-Waste to Resources" issued at a meeting of the Basel Convention estimated that, by 2020 in China and South Africa, the e-waste from computers would increase between 200 and 400% over 2007 figures and 500% in India. It was also estimated that by 2020 in India the amount of e-waste from mobile phones would be 18 times higher than the 2007 figures and 7 times higher in China. Basel Action Network stated that 50- 80% of e-waste generated in USA is exported to India, China, Pakistan, Taiwan and African countries.

UNEP estimates that e-waste is increasing by 40% per year worldwide and e-waste is the fastest-growing type of waste. Between 20 to 50 million metric tons of e-waste are generated worldwide every year, representing more than 5% of urban solid waste, particularly in some developing countries where the volume is expected to grow up to 500 percent over the next decade. In India, volume of e-waste is estimated to be 0.8 million tons in 2012. According to the Controller and Auditor General's (CAG) report, over 7.2 MT of industrial hazardous waste, 4 lakh tonnes of electronic waste, 1.5 MT of plastic waste, 1.7 MT of medical waste, 48 MT of municipal waste are generated in the country annually.

3.0 Effects of e-waste on human health and environment:

e-waste is highly complex to handle because of its composition. It is made up of multiple components some of which contain toxic substances that have an adverse impact on human health and environment if not handled properly that is if improper recycling and disposal methods are deployed. So there is a need for appropriate technology for handling and disposal of these chemicals.

Basel Convention characterizes e-waste as hazardous when they contain and are contaminated with mercury, lead, cadmium, polychlorinated biphenyl etc. Wastes containing insulation or metal cables coated with plastics contaminated with or containing lead, coal tar, cadmium, Polychlorinated Biphenyl (PCB) etc are also characterized as

hazardous wastes. Also precious metal ash from printed circuit boards, glass waste from cathode-ray tubes, LCD screens and other activated glasses are classified as hazardous wastes.

Effects of some of the prime hazardous components in of e- waste are mentioned below:

S.No.	Hazardous components	Effect of Hazardous components of e-waste
1	Arsenic	Can affect skin and can decrease nerve conduction velocity. Chronic exposure to arsenic may cause lung cancer and sometimes be fatal.
2	Lead	May affect kidneys, reproductive systems, nervous connections. May cause blood and brain disorders, sometimes may be fatal.
3	Barium	Can affect heart muscle.
4	Chromium	Candamage liver, kidneys and may cause asthmatic bronchitis and lung cancer.
5	Beryllium	May cause lung diseases.
6	Mercury	Affects the central nervous system, kidneys and immune system, it impairs foetus growth. May cause brain or liver damage
7	Cadmium	May cause severe pain in the joints and spine. It affects the kidneys and softens bones.
8	BFR (Brominates flame retardants)	Can harm reproductive and immune systems, may cause hormonal disorder.
9	Chlorofluorocarbon (CFC)	May affect the ozone layer. It may cause skin cancer in human and genetic damage in organisms.
10	Polychlorinated Biphenyl (PCB)	May cause cancer in animals, can affect the immune system, reproductive system, nervous system, endocrine system . PCBs persistently contaminate in the environment and cause severe damage .
11	Polyvinyl Chloride (PVC)	PVC contains upto 56% chlorine and when burnt, produces Hydrogen chloride gas which in turn produces hydrochloric acid that is dangerous to respiratory system.
12	Dioxin	These are highly toxic to animals and can lead to malfunction of foetus, decreased reproduction and growth rates, affect immune system.

4.0   Management of e-waste:

There is no unique or ideal model for e-waste management in developing countries, each of which has its own specific environmental, social, technological, economic and cultural conditions.

Environmentally sound management of WEEE recognizes three Rs i.e. reduce, reuse and recycle. The aim would be to **reduce** the generation of e-waste through smart manufacturing and maintenance, **reuse** till functioning of electronic equipment by someone else and **recycle** those components that cannot be repaired.

A smart e-waste management system for developing countries have to assess the e-waste situation, recognize that e-wastes are a complex mixture of hazardous and non-hazardous substances and materials and need to define the integral e-waste management system taking into consideration the EEE market penetration , life cycle of ICT equipment, financing mechanisms etc.

The main aspects to be taken into account when framing ICT waste management guidelines for developing countries are:

- Policy and regulations covering import and export of EEE and WEEE in accordance with the rules of each country and with international legislation

- Defining responsibilities of prime stake holders at the level of government, supply chain, consumers of ICT equipment and entities for disposal of waste

- Extended producer responsibility (EPR) where the manufacturer's responsibility for its ICT equipment extends throughout the various stages of that equipment's life cycle with internalizing the cost of managing the equipment at end of life

- Responsible information system to have data on ICT equipment in market, disused EEE management and WEEE management and to have control on the monitoring and future planning

- Promoting employment and training for the informal sector engaged in recycling and recovery of the materials.

4.1.   ITU – Technical guidelines:

The technical guidelines along with environmental standards as recommended by ITU have been put forward to ensure that best practices are followed in handling ICT wastes.

The studies made by ITU –T study group 5 in the area of e-waste reduction, recycling methods and reuse of materials had been addressed by the recommendations as mentioned below :

S.No.	ITU-T specification Number	ITU-T specifications
1	ITU-T L.1000	"Universal power adapter and charger solution for mobile terminals and other hand-held ICT devices"- aims to reduce number of adapters and volume of e-waste.
2	ITU-T L.1001	Aims to reduce types of power adapters by widening the range of compatible devices, facilitating an adapter reuse and recycling. Describes the basic configurations and general requirements for universal power adapters and their interfaces: cables, connectors, current, voltage, resistibility, energy efficiency, electromagnetic compatibility.
3	ITU-T L.1100	A method to provide recycling information of rare metals in ICT goods
4	ITU-T L.1200	Direct current power feeding interface up to 400 V at the input to telecommunication and ICT equipment.
5	ITU-T L.1300	Describes best practices aimed at reducing the negative impact of data centers on the climate.
6	ITU-T L.1310	Defines energy efficiency metrics test procedures, methodologies and measurement profiles required to assess the energy efficiency of telecommunication equipment
7	ITU-T L.1400	Describes general principles on assessing the environmental impact of ICT and outlines the different methodologies that are being developed.
8	ITU-T L. 1410	Deals with the assessment of the environmental impact of ICT goods, networks and services
9	ITU-T L.1420	Provides specific guidance on energy and greenhouse gas (GHG) impacts

ITU has also come out with recommendation (L.1002) for environmentally friendly universal charger for laptops as well as other portable devices and of green batteries for smart phones and other handheld ICT devices (L.1010).

A standardized methodology for manufacturers to report the quantity of rare metals contained in their ICT devices, has been agreed by experts in Recommendation ITU-T L 1101.

A study carried out in 2012 by the University of Genoa, ITU and the Global sustainability Initiative (Ge SI), estimates that the adoption of an energy-efficient universal power adapter will eliminate an estimated 300,000 tons of e-waste annually.

The study also shows that it could reduce the energy consumption and greenhouse gas emissions of external power supplies by between 25 and 50 per cent.

ITU has prescribed for installation of technical infrastructure for proper handling of e-waste, while considering the job opportunities for the informal sector. Use of technology for recovery, reuse, disposal of WEEE in an environment friendly manner will be effective when the concerns of the national economy and society are also taken care of . Collection of information at different stages of e-waste management is also important for having control on adverse effects on population and environment.

4.2. ITU- Present activities:

The concept of environmental sustainability is having enormous importance these days as the activities towards bridging the digital divide in developing regions have resulted an alarming deterioration of the environmental condition.

To ensure the safety of mankind and environment, handling of e-waste has been assigned priority by nations based on international regulations and guidelines. ITU-T has already published a toolkit on the environmental sustainability for the ICT sector that provides technical guidelines on design for the environment principles and best practices. It also aims to build 'sustainable products' and 'sustainable buildings' through environmentally conscious design principles. The document covers issues of 'end of life management' and explores development of sustainability framework through various standards and guidelines.

ITU has joined PACE (Partnership for Action on Computing Equipment), a multi stake holder partnership which intends to increase the environmentally sound management of used and end-of-life computer equipment taking into account social responsibility and the concept of sustainable development.

ITU has also joined the **StEP** (Solving the e-waste Problem) initiative for scientific assessment and incorporation of a comprehensive view of the social, environmental and economic aspects of e-waste. It conducts research on the entire life cycle of EEE and fosters eco- friendly and energy-efficient re-use and recycling practices in a socially responsible manner.

Further, the MPPI (Mobile Phone Partnership Initiative) guidelines provide information relating to the environmentally sound management of used and end-of-life mobile phones. ITU has organized workshops for capacity building on environmentally responsible management of WEEE aiming to develop standards and policies to be incorporated in national and regional e- waste management strategies.

4.3.   Problems in the implementation of a strategy on ICT-waste:

Countries mainly developing countries face different problems in framing or implementing regulations on e-waste:

- There is no proper data about the consumption of ICT equipment, e-waste generated and managed through existing channels
- There is lack of proper policy that considers all aspects related to e-waste management including assignment of responsibilities for all stakeholders.
- Many developing countries have regulations but inadequate, as the practical socio - economic situations are not taken care of.
- Moreover, some stakeholders like the informal sector are not considered when in developing countries, they form a substantive part of the recycling process.
- In developing countries the import of used ICT goods impose again a threat on the volume of e-waste generated.
- Lack of knowledge and absence of technology in different stages of e-waste management may lead to loss of valued material and further imposing threat to health and environment.
- There is a lack of standard infrastructure in developing to deal with ICT waste
- Lack of awareness among stake holders and public in general about the responsible use of ICT goods.
- Lack of co-ordination among different stake holders in different stages of the e-waste management process.
- The policies sometimes lack practical and rational issues and so the sustainability issue is perhaps not well addressed.

5.0   Indian scenario for e-waste management:

Last few years India has emerged as one major IT hub and the consumer electronic market has grown in an exponential rate. According to Manufacturers Association of Information Technology (MAIT) the Indian PC industry is growing by 25% compound annual growth rate.   Study reports that in 2007, 2.2 million computers were made obsolete and 14 million mobile handsets replaced .

The e-waste generated was estimated to be 3,32,979, tons out of which 144,000 tons was recyclable and actually   e-waste recycled was 19,000, tons.

The e-waste processed contained 12000 tons of computers and 7000 tons of TV. It was also estimated that around 50,000 tons of e-waste was generated through import besides 3,32,000 tons generated domestically.

Developed countries find it profitable to send e-waste for reuse/ recycling to developing nations because of economic disparities e.g. cost of recycling of a computer in US is $ 20 whereas in India it is $2. So the import of e-waste to India has got enough chance to jump high. There are 10 States that contribute to 70 per cent of the total e-waste generated in the country, while 65 cities generate morethan 60 per cent of the total e-waste in India(*reference: Effective electronic waste management and recycling process involving formal and non formal sectors by S. Chatterjee and Krishna Kumar, Department of IT, CGO complex, New Delhi).*

In India, Ministry of Environment and forests (MoEF) is responsible for environmental legislation and its control. The main bodies active in e-waste management in India are CPCB, SPCBs, Gtz and industry associations such as MAIT.

These organizations are working under the guidance of MoEF. CPCB (Central Pollution Control Board) had set up a task force in 2007 to analyze the different aspects of e-waste covered in various environmental legislations in India and had drafted guidelines for environmentally sound management of e-waste.

In the beginning of 2008, the CPCB released guidelines for environmentally sound management of e-waste, which apply to all those who handle e-waste. These guidelines are first policy framework dealing specifically with prevention, management, treatment, recycling, and disposal of e-waste in India.

The policies framed, provide guidelines for manufacturers, customers, generators, collectors, recyclers, transporters, dismantlers, and enforcement agencies and prescribe procedures for handling e-waste in an environmentally efficient manner. Apart from adoption of environmentally sound technologies, they include international standards and practices like restriction on hazardous substances (RoHS) in EEE(*reference: e-waste assessment in Kolkatta Metropolitan Area – A report by IMRB international April2010 to West Bengal Pollution control Board GTZ and ICC Kolkatta)*

5.1. Existing Regulations:

i) **Ministry of Environment and Forests' E-Waste management and handling rule 2011(notified on -12th May 2011 and effective from 01-05- 2012):**

The E-waste (Management & Handling) Rules, 2011 by MoEF was notified with a primary objective to channelize the e-waste generated in the country for environmentally sound recycling . For implementation of the provisions of the rules, a guidance document was framed to help producers, consumers, collection centres, dismantlers, recyclers and regulatory agencies for effective compliance.

The rules also placed responsibility of e-waste management on the producers of the electrical and electronic equipment by introducing the concept of "extended producer responsibility"(EPR) by e-waste collection , recycling and raising awareness. EPR is one main feature of the rules, where the producers manage EEE after its 'end of life' by financing and organizing a system to comply with EPR(Fig.1).

Thus the producers are also motivated for reducing use of virgin materials, designing changes to reduce-waste generation, increasing resource efficiency and thus leading to sustainable development.

Scope of implementing the EPR by the producer is explained in the schematic diagram as below (source : CPCB) :
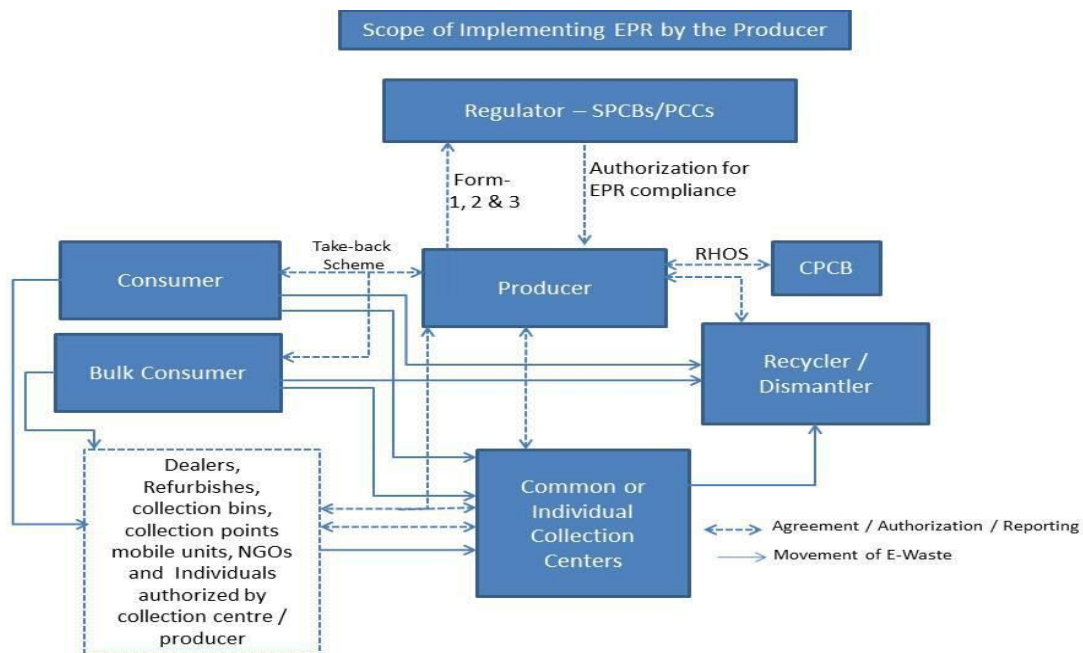
Fig 1: Scope of implementing EPR by the producer

Scientific collection of e-waste is important for environmentally sound e-waste management system. There comes the concept of collection centre that can be individual or jointly organized. In the collection centre, the collected e-waste is received and stored for dismantling or recycling.

The environmentally sound recycling of e-waste will start by decontamination/ dismantling of e-waste where the concentration of hazardous material/chemical is reduced, then valued materials are recovered and residual components are disposed in TSDF (Treatment, Storage & Disposal) facility.

There is a compliance mechanism set for producers, collection centres, consumers, dismantlers, recyclers and the regulatory bodies.

The mechanism sets the responsibilities for the producers in line with the extended producer responsibility guidelines. The e-waste (Management & Handling) Rules, 2011 have been notified in May 2011 and is effective from 01-05-2012. Central Pollution Control Board and State Pollution Control Boards are the implementing authorities .

ii)   **Guidelines on Implementation of E-Waste Rules 2011 issued by Central Pollution Control Board, Delhi** Ministry of Environment & Forest Government of India Central Pollution Control Board

iii)   **Department of Telecommunication notification date 25th January 2012,**to the manufacturers of mobile phone/telephone instrument to follow E-waste management and handling rule 2011 notified by Ministry of environment and Forests on-12th May 2011 while manufacturing/distributing phones as per TRAI recommendation.

iv)   **Environment/climate change-2012.(January to December 2012) Human Rights Documentation** India Social Institute , Lodhi road, New Delhi, India as a collection of previously published news and views from the print as well as the electronic media, whose reference marked at the end of each news items. Department of Documentation and Library(DDL) of the India Social Institute, New Delhi.

v)   **e-waste in India: research unit (LARRDIS), RajyaSabha Secretariat, New Delhi June 2011:**
       This publication is the next in the series of 'Occasional Paper' being brought out by the RajyaSabha secretariat on topical issues, from time to time, for the benefit of Members of Parliament. The augmentation of human capabilities due to industrial revolution is well documented. The revolutionary changes experienced in societies across the world due to the application of electronics are far more deep and widespread than the impact of industrial revolution.

       The electronics age made unprecedented impact on human society and spectacularly enhanced our connectivity across the globe. The widespread use of electronic items has made communication easier, boosted business activities and created employment opportunities. However, along with the benefits, it has brought into focus many challenges, like the rising problem of e waste that have to be boldly dealt with by society. In the current scenario, it is always possible that human health and environment would be drastically endangered if concerted legislations and actions were not taken efficient management and disposal of e-waste.

vi)   **Ministry of Environment & Forests, Govt. Of India implementation of National Clean Energy Fund project on** remediation of hazardous waste contaminated sites in the country : The project has been envisaged for

remediation of 12 priority contaminated sites across the country and has been designed to provide a detailed site investigated, design of appropriate engineering solution for remediation and also to implement actual remediation of those contaminated sites.

To realize the objective, the project has been envisaged in two phase i.e. preparation of detailed project report (DPR) for remediation of each contaminated area in the first phase and subsequently undertaking environmentally sound remediation of these sites in the second phase of the project.

5.2. TRAI Guidelines :

TRAI has endorsed the key provisions of the regulations issued by MoEF in their recommendations on Approach towards Green Telecom in 2012, where it is specifically clarified that the producer will be responsible for -

- Ensuring that, new electrical and electronic equipment does not contain Lead, Mercury, Cadmium, Hexavalent Chromium, polybrominated biphenyls (PBB) or polybrominateddiphenyl ethers (PBDE).

- Collection of e-waste generated during the manufacture of EEE and channelizing the same for recycling or disposal

- Collection of e-waste generated from the 'end of life' of their products in line with the principle of 'Extended Producer Responsibility' (EPR) and to ensure that such e-wastes are channelized to registered refurbisher or dismantler or recycler

- Setting up collection centres or take back system either individually or collectively for all EEE at the end of their life.

- Creating awareness with regard to information on hazardous components in e-waste electrical and electronic equipment

- Maintaining records of the e-waste and filing annual returns to the concerned State Pollution Control Board or Pollution Control Committee

TRAI recommended that " by 2015, all mobile phones should be free of brominates and chlorinated compounds and antimony trioxide in accordance with the e-waste (Management and Handling) Rules of the Ministry of Environment and Forests to be followed by all telecom manufacturers, as and when notified.

It has also recommended that all mobile manufacturers/ distributors should be required to place collection bins atappropriate places for collection of e-waste – mobile phones,batteries, chargers etc. The e-waste should be safely disposed orrecycled as per the prevailing standards. The collection, storage,transportation, segregation, refurbishment,

dismantling recycling and disposal of all e-waste shall be in accordance with the procedures prescribed in the guidelines by the Pollution Control Board."

5.3. DoT's action towards greening the environment :

For handling e waste in an environment friendly manner following are some of the salient features DOT has included in NTP 2012 which need specific attention by the stake holders:

➢ ***NTP 2012 reference** : To reposition the mobile device as an instrument of socio-economic empowerment of citizens –*

The concept of reuse of ICT equipment in the direction of empoweringthe under privileged can be strongly adopted to following the concept of Brazil's Computer for Connection project which is one very successful application towards bridging the digital divide and towards reducing e waste.

Brazil's "Computers for Connection" Project is an initiative to tackle digital divide and promote reuse of ICT waste. The PPP model works on joint effort to offer fully operational refurbished computers in order to support the spread of community telecenters and computerization of public schools and libraries.

➢ ***NTP 2012 reference**: To promote Research and Development, Design in cutting edge ICTE technologies, products and services for meeting the infrastructure needs of domestic and global markets with focus on security and green technologies – this* will be beneficial in the direction of manufacturing of universal accessories and reduction of RoHS in the products .

➢ ***NTP 2012 reference**: To make India a global hub for telecom equipment manufacturing and a centre for converged communication services-* To chase the goal there will definitely be reduction in import of e waste from the developed countries and the accumulation of e waste can be controlled with the help of stringent import rules.

➢ ***NTP 2012 reference**: T*o promote creation of jobs –* The handling of e waste in an environment friendly manner, also considering the socio economic aspect with respect to managing the informal sector, can create number of jobs for the poor unemployed people engaged in recycling and recovery of the material. E waste management is one of the area where creation of jobs for the poor can be explored in a larger scale.

DoT's vision "*to provide secure, reliable, affordable and high quality converged telecommunication services anytime, anywhere for an accelerated inclusive socio-economic development*" definitely urges for socio economic development in line with UNDP's MDGs (Millenium Development Goals) / SDGs (sustainable Development Goals).

5.4. Works of the Research unit of RajyaSabha Secretariat

The Research unit of RajyaSabha Secretariat in June 2011, has also suggested following for proper management of e-waste in India :

- ➢ Need for stringent health safeguards and environmental protection laws in India specifically prioritizing and properly monitoring the following areas of concern-

    - o Extended Producers Responsibility (EPR)
    - o Import of e-waste under license
    - o Producer-public-government cooperation
    - o Awareness programs
    - o Choice of safer technologies and cleaner Substitutes
    - o Monitoring of Compliance of Rules by the authorized Government bodies
    - o Efficiency in regulatory mechanism strengthened by manpower and technical expertise
    - o Reduction of e -waste at source

- ➢ Investment Opportunities - Clean technologies today offer big investment opportunities covering areas such as LED lighting, water purification, recycling of e-waste, food processing, wind power, solar power etc.

- ➢ Recognizing the Unorganized Sector in India – considering the social and economic condition of Indian labour force this issue is extremely important for handling e waste in an environment friendly way, keeping in mind the interest of the poor labourers.

5.5. Stakeholders:

(i) **Government:** The central and state Government authorities are the policy makers on management of e-waste and the regulations there of .The policies define the responsibilities of different stake holders in e-waste management.The government is also to take care of the informal sector engaged in the chain of e-waste management. They should have monitoring mechanism for compliance of the regulations.

(ii) **Supply chain:** Comprising of producers (manufacturers, importers and assemblers), distributors, traders who have to maintain proper data for information of the regulators and consumers. They have to research and developenvironment friendly techniques for cleaner production and maintenance of EEE. In line with EPR, they have to install collection centres for the disused/ end of life ICT products.

(iii)**Consumers of ICT equipment:**They have to act for responsible use of ICTequipmentsand properly handle the disused items. Bulk consumers who are bulk users, have to keep record of e-waste generated and dismantled/ recycled.

(iv) **Entitiesfor disposal of wastes:** The recyclers, dismantlers, re-conditioners, collectors and companies handling disposal of e- waste have to comply with the regulations of government, and have to manage e-waste in an environmentally sound system in line with

international standards. They have to take care of the informal sector carrying out major part ofdisposal of wastes.

(v) **NGOs/local authorities:**They have to work on protection of environment and health.They have to work for the interest of consumers and the informal sector engaged in the chain of e-waste management.

(vi) **Media/Education sector**: Has a fundamental role in   creation of environmental awareness among consumers focusing to children and young people,   to ensure that disused ICT equipment is taken to collection points and consumers behave in a responsible manner.

5.6. Extended producer responsibilities (EPR) and few good practices in India:

Though not enough, the take back policies by the MNCs in line with the EPR (extended producer responsibilities) aim towards reduction in the accumulation of e-waste and protection of environment. Some of the initiatives taken in India are mentioned below:

5.6.1. Lenovo initiatives:

- All Lenovo products sold in India comply with RoHS (Restriction of Hazardous Substance)requirements as per India's E-waste management and handling rules 2011.
- Lenovo has partnered with Sims Recycling Solutions India Pvt Ltd to comply with the new India E-Waste management and Handling Rules in providing drop-off centres and environmentally sound management of end of life equipment
- Sims India provides 1491 points of presence throughout India.
- Lenovo India offered a voluntary PC Recycling Service for collecting and recycling end of life Lenovo branded products from private households (consumers) and business customers.
- During the calendar year 2011, this program collected and recycled 2.12 metric tons of customer returned equipment. Lenovo India also recycled 143 metric tons of Lenovo owned equipment (e.g., employee replaced equipment, channel returns) during calendar year 2010 and 30 metric tons in 2011(Letter on Lenovo's progress of ROHS dated 2.9.2014 by Robert J. Taylor Director of Environmental Affairs, Corporate Quality programs, Safety and Standards, 1009 Think Place, Morrisville, NC 27560).

5.6.2. Dell Activities:

Diverted over 68 million kg (150 million lbs.) of end-of-life electronics globally from landfills in fiscal year 2011, a 16% increase over fiscal 2010.

Since it launched its recycling program globally in 2006, the company has recycled more than 125 million kilograms of electronic equipment and is on track to recycle more than one billion pounds of e-waste by 2014. Piloted a battery recycling program where a customer gets a discount on their new purchase of a li-ion laptop battery upon the return of an identical non-working one.

5.6.3. NOKIA activities:

Nokia began its e-waste management campaign in 2008 when e-waste disposal was given little attention.

Nokia set up drop boxes across the country to take back used phones, chargers and accessories, irrespective of the brand, at Nokia Care Centres   or Priority Dealers. It had a number of campaigns involving public. The total quantity of mobile phones and accessories collected from the campaigns since its launch in 2009 is 160 tons. The e-waste collection has grown from three tons in 2009 to 65 tons in 2012

Nokia has sound recycling system and almost 100% of the materials in a phone are recovered and reused. Besides this, a number of innovative campaigns started by Nokia to collect discarded sets.

All Nokia phones and accessories sold worldwide are RoHS (Reduction of Hazardous Substances) compliant since 2006. It is claimed that since 2006 Nokia devices, chargers and headsets have been free of PVC (polyvinyl chloride), and since 2009 brominated, chlorinated compounds and antimony trioxide are fading out. Since the beginning of 2010 all new Nokia devices are said to be free of these substances.

5.6.4. ITC IT e-waste Policy:

IT e-waste is a subset of e-waste and covers IT equipments like computers, printers and accessories, Network equipment, IT accessories and associated cables. ITC has a sound policy for handling the IT waste and salient features are mentioned. The lifecycle of all IT assets from acquisition to disposal is to be managed in a manner which conforms to sound environmental norms.

- Preferential dealing with IT vendors having sound E-Waste management processes
- Extending the useful life of IT assets to postpone / minimize generation of E-Waste
- Responsible disposal processes conforming to regulatory requirements and best practices
- Apart from internal re-use, option to extend use outside ITC through donation to bonafide philanthropic institutions extending the useful life of IT assets.
- Only such IT assets which are non-operational and can not be reused for any other alternate purpose should be considered as IT E-waste for disposal.

5.7. Concerns/ Challenges in e -waste management:

Following are the some of the major issues that need attention while handling e-waste:

- The data for information on e-waste is estimation and there is a problem in finding information on imports of e-waste. Most studies have concentrated on devices like mobile, computer and TVs while the domestic appliances also contribute to a considerable proportion of e-waste. There is a need to have credible data covering wide range of products across sectors
- Waste collection, transportation, processing and recycling is dominated by theinformal sector. The sector is well networked and unregulated. There are serious issues regarding leakage of toxins into the environment hampering workers' safety/ health.

- There is a need for establishment of collection channels for e-waste from thegenerator to the recycler. Presently as the standards are not followed by the collectors (mainly the informal sector), the environmental, health and safety norms are hampered. The formal sector having large infrastructure and high operational cost finds difficulty in competing with the informal sector.

- The informal sector needs specific attention to be handled properly considering the socio economic condition so that the solutions for environment friendly management of e-waste are found to be rational for the stake holders

- There is a lack of fund and capacity in Government for monitoring and enforcement of the regulations

- Awareness regarding the hazards of e-waste is low because of structural deficiency in implementation of policies, poor literacy and poverty of an important major stake holder (informal sector)

- The e-waste management system is mostly manual and low tech and the 'take back' by producers is limited to few IT equipment and few formal collection centres. There is lack of effort from producers that results in limited implementation of EPR. In absence of accountability and penalty criteria in the regulation, it is difficult to monitor the EPR activities.

5.8. Towards Sustainability:

ITU-T has provided support and guidance for environmental sustainability for the ICT sector for maintenance and operation of ICT devices and services through number of standards and recommendations.

A toolkit has been evolved by ITU-T containing detailed discussions on topics like Sustainable ICT in corporate organizations, Sustainable products, Sustainable buildings, End-of-life management, General specifications and KPIs, Assessment framework for environmental impacts including standards, guidelines and available methodologies. It is well understood that there is a need of having comprehensive strategy for sustainable electronic product design, production and e-waste management.

Presently the sustainability issues at the stages of product design or production mainly incorporated environmental sustainability and so fall short of social, economic and ethical sustainability. To have an e-waste management system which is environment friendly, the following aspects are to be taken into consideration:

- Remuneration for research and development in the areas of green design/ development and maintenance of ICT products

- Incorporation of enforcement clauses in national regulations in a rational way considering the economic conditions of the society

- Recognition of the importance of the life cycle assessment to have proper estimation on the generation of WEEE

- Consideration of ethical aspects while addressing the supply chain performances including handling the issues of the informal sector engaged in recycling stages of e-waste management in developing nations

- Building up the confidence of civil society and consumers in the existing system of e-waste management through mass awareness

With the broad definition of sustainability encompassing economic, social and environmental aspects, it is now necessary mainly for the developing nations, that the international standards/ policies/ guidelines should be adjusted considering the socio-economic condition of a nation. Being in line with UNDP's millennium development goals, it is an important criterion for a green society to be socially and ethically sustainable.

6.   Conclusion:

ITU has agreed to the fact that there is no unique or ideal model for e-waste management in developing countries, each of which is characterized by its own specific environmental, social, technological, economic and cultural conditions.

With a view to bridge the digital divide, there is exponential growth in the use of **Electrical and electronic equipment**(EEE) and so there is alarming effect on environment and human health when the ICT wastes are not disposed of scientifically. There is an emergent need to implement the existing policies and guidelines in line with the international standards and practices for an healthy e-waste management system.

Government policies should encourage the reuse of EEE aiming to minimize and recycle **Waste Electrical and Electronic Equipment** (WEEE). The **Extended Producer Responsibility**(EPR)do need to have clear regulations to mandate the 'take back' activity of companies strictly.

There is a clear need to have proper information system through standardized mechanisms. Eco-design can have a positive impact in reducing the rate of WEEE generation, facilitating the management of e- waste and recovery of materials, achieving cost reductions.

In Indian context, **Ministry of Environment and Forests** in the E-waste (Management & Handling- Rules, 2011) has clarified about the Reduction in the use of hazardous substances (RoHS) in the manufacture of electrical and electronic equipment where attempt is made to get ensured that new electrical and electronic equipment does notcontain Lead, Mercury, Cadmium, Hexavalent Chromium, poly-brominated biphenyls (PBB) or poly-brominateddiphenyl ethers (PBDE) which is to be achieved within a period of three years from the date of commencement of these rules.

MoEF is also promoting the 3R Concept (Reduce, Reuse and Recycle) for Hazardous Waste ManagementMoEF has also defined the responsibilities of **Central Pollution Control Board**(CPCB)and **State Pollution Control Board**(SPCB) who are acting as monitoring authorities in respect of management of e-waste in India. Briefly the main functions of CPCB are:

- Coordination with State Pollution Control Boards

- Preparation of Guidelines for Environmentally Sound Management of e-waste

- Conduct assessment of e-waste generation and processing

- Recommend standards and specifications for processing and recycling e-waste

- Documentation & compilation of data on e-waste

- Conducting training & awareness program

- Enforcement of reduction in use of hazardous substances(RoHS)

- Incentives and certification for green design/products

The collection, storage, transportation, segregation, refurbishment, dismantling recycling and disposal of e-waste is also defined by the guidelines issued by the Central Pollution Control.

The DoT guidelines in the direction "*to develop a robust and secure state-of-the-art telecommunication network providing seamless coverage with special focus on rural and remote areas for bridging the digital divide*" have also specific regulations for the environmental and health issues arising from the telecom network. The remuneration for adoption of green policyand incentive for use of renewable energy sources can be one practical and sustainable method for managing e-waste in Indian socio cultural environment. By promoting the use of energy efficient equipment and renewable energy technologies, and also adopting measures for reduction of carbon footprint, the concern for e-waste is also addressed in direction of long term sustainability.

7. **Recommendations: A multi programme approach is required to improve upon the e-waste management in the country which is summarised in the recommendation belongs:**

7.1 Tax incentive may be considered to telecom product manufacturing companies which institute environmentally safe production systems and products, to offset any incremental cost involved in the process. Tax incentive may be given to companies engaged in scientifically recycling of e-waste till end of life of the product.

7.2. There is an urgent need of generating awareness among the people about the best practices for collection mechanism of e-waste, to be followed to avoid dumping of waste in landfills, and to channelize the waste through standard methods of e-waste disposal management.

7.3. All the equipment manufacturers, service providers and Government sectors should be mandated to spread awareness regarding hazards of e-waste. All the telecom equipment manufacturers specifically mobile hand set manufacturers should disclose to the customer harmful materials used in their products so as to make customers aware of safe disposal methods, through different media. They are also required to include, in their user manual, all the details of health hazards due to use of different hazardous materials in the product (if, any) and the scientific methods for safe disposal at end of life product.

7.4. Telecom equipment manufacturers and service providers may be advised to create a set up within the organization for safe disposal of e-waste. Providing training and education to the people engaged in recycling, recovery of material and safe disposal of e-waste may also be part of the duty of manufacturers and service providers under corporate social responsibility.

7.5. The concept of donating used EEE to the poor/ backward children for developing their skills is to be encouraged, mainly among schoolchildren and youth, which in turn will help in cleaning the environment.

7.6. Legislations for imports have Clear Guidelines regarding entry of hazardous substances along with the import of products. If required appropriate legislative measures may need to be taken.

7.7. As the waste disposal is a subject of state, municipal authorities in each city may also be entrusted with the job of collection of e-waste and its disposal in accordance with the guidelines and coordination with State Pollution Control Board which in turn can be transported to the recycler for proper management in environment friendly way.

7.8. Collection and maintenance of data on e-waste is extremely important to start corrective actions on policy and implementation. For e-waste management, there is a need for conducting assessment of e-waste generation, and formulation of standards and specifications for processing and recycling e-waste.

7.9. Finally, Case studies in different areas depending on socio economic conditions may be started for sustainable decisions in respect of e-waste management.

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Abbreviations	
BFRs	Brominated Flame Retardants
CRC	computer refurbishing centres
CFC	Chlorofluorocarbon
CPCB	Central Pollution Control Board
EEE	Electrical and electronic equipment
EPR	Extended Producer Responsibility
e-waste	e-waste" refers to electronic waste (computers, printed circuit boards, cell phones, flat screen monitors, CRTs, etc).
GHG	Greenhouse Gas
GeSI	Global sustainability Initiative
Gtz	GesellschaftfürTechnischeZusammenarbeit GmbH, Game Trading Zone
ICT	"Information and Communication Technologies." -ICT refers to technologies that provide access to information through Telecommunications.
KPIs	Key Performance Indicators
MAIT	Manufacturers Association of Information Technology
MPPI	Mobile Phone Partnership Initiative
MoEF	Ministry of Environment and Forests
PCB	Polychlorinated biphenyls
PVC	Polyvinyl Chloride
PACE	Partnership for Action on Computing Equipment
RoHS	Restriction on hazardous substances
RET	Renewable Energy Technology
SPCBs	State Pollution Control Board
St EP	Solving the e-waste Problem
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WEEE	Waste Electrical and Electronic Equipment