

An overview of global e-waste, its effects on developing countries and possible solutions

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Abstract. *This article aims to discuss problems associated to global E-Waste, also known as WEEE (Waste Electrical and Electronic Equipment). It provides not only an overview of the effects of WEEE at a global level but also on communities that are most affected by its devastating effects. Unfortunately, WEEE often affects the most fragile and developing countries as a result of insufficient policy and inexpensive labor markets. However, WEEE can potentially be reduced through proper regulation and systematic supply chain revisions that follow circular economy related practices.*

Keywords: WEEE, e-waste, developing countries, circular economy, global soil degradation, electrical and electronic waste, hazardous materials, environmentally friendly practices, global disease

JEL Codes: Q53, Q56.

1. Introduction

Global E-Waste or WEEE, Waste Electrical and Electronic Equipment, has become an overwhelming concern in recent times as the quantity of WEEE has increased at an alarming rate and has caused drastic consequences for developing countries. Due to the components of WEEE, dramatic effects have impacted the environments that they are discarded in. These effects spread to the inhabitants of these areas and nearby communities.

As a result of rapid increases in technology, lower prices and technologically driven lifestyles, a vast demand for electronic devices has resulted in a surplus of WEEE. Several initiatives have been created and STEP, Solving the E-Waste problem, has been an effective program. [1] STEP focuses on open communication and knowledge sharing related to WEEE among the international community and strives to increase the success of a reverse supply chain. [2] Another initiative on reducing WEEE and protecting affected environments is the Basel Convention which aims to control and avert WEEE from being transferred from developed to developing countries. [3]

China generates an estimated 12.2 million tonnes of WEEE and the United States follows them at approximately 11 million tonnes. [4] In India, the accumulation of WEEE increases at a 25% annual growth rate with Mumbai at 96,000 metric tonnes. [5] WEEE consists of approximately 50% iron and steel, 21% of plastic 13% of non-ferrous metals and various other components. Non-ferrous metals include copper,

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aluminum, silver, gold, platinum and palladium. [2] WEEE also consists of extremely harmful compounds that include lead, mercury, arsenic, cadmium, selenium, hexavalent chromium and flame retardants. [6]

The United Nations Environmental Program has reported that 20-50 million tonnes of WEEE is generated globally every year resulting in human health and environmental risks. [7] An estimated 400-700 million obsolete computers in developing countries and 200-300 million in developed countries will be cast away as waste by 2030. [8] In 2012, China managed 70% of global WEEE and the remainder went to eastern Asia and Africa. [9]

Multiple global surveys have revealed through urine tests that those directly affected by a surplus of WEEE in developing countries have high levels of hazardous substances in their internal systems. Several of the hazardous materials found in these individuals included lead, antimony, cadmium, mercury and PCBs (polychlorinated biphenyls). Those affected by these substances presented symptoms that involved shortness of breath, cough and dizziness. [10]

The consequences of WEEE will continue to inflict communities, often in developing countries, as long as regulations to divert a surplus of electrical and electronic waste are not in place. In addition to necessary policy changes, a greater understanding of how electronic waste is disposed needs to be presented to consumers. If these policies and knowledge exchange take place, there is a significant possibility to curve the quantity of waste generated from the production to the disposal level which can lead to an improved quality of life for all.

2. An explanation of WEEE and its associated consequences & solutions

WEEE can be described as any waste that comes from electrical or electronic components. Electrical and electronic products and components can be described as mobile phones, CRT's, laptops, television screens, etc. These devices are created and purchased as a result of demand that is generated by trends towards high tech lifestyles. These lifestyles have come to fruition as a result of a changing society that requires continuous connectivity and communication on a global spectrum. In modern times, lower prices for technology and an increased need for them has created a world that is addicted to technology and as a result, producers continue a supply chain that satisfies their consumers.

As electrical and electronic products become obsolete in the presence of faster and more powerful equipment, they need to be discarded. Countries such as the United States, China and India produce the highest quantities of electrical and electronic products. However, the United States does not currently have strong policies and infrastructure to process the waste associated with these discarded products. As a result, countries with little to no regulations for treating WEEE are provided with a surplus of global e-waste. Many of the most affected countries are China, India and many nation states within Africa as seen in figure 1.

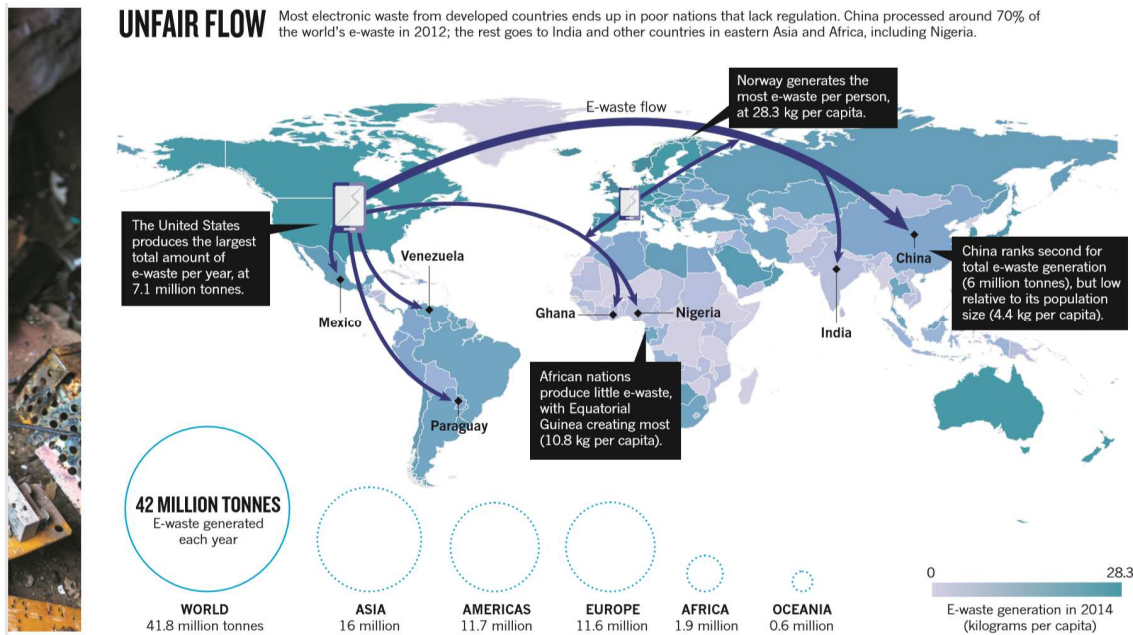


Fig 1. Unfair Flow [11]

After this waste has been deposited in the aforementioned developing countries, the materials are often poorly managed and can often lead to chemical remnants being deposited into local ground and water supplies. These hazardous remnants can then end up in both the food and water supply that reaches to the locals of these communities and nearby regions resulting in severe health risks. An overview of hazardous materials released into communities as a result of improper e-waste disposal can be seen in figure 2.

Although the problem of WEEE is extreme, there are ways in which to curtail its effects. The primary way to reduce the problem is to begin with the origin of the product. Manufactures should begin implementing new manufacturing processes that use more renewable materials for non-critical components. If this new process can be implemented, there could be an increased reduction in the quantity of e-waste generated from the start and therefore the process of recycling and disposal of these products and materials can be done in a non-invasive environmentally friendly process. An example of this process can be seen in Fig 3 and 4.

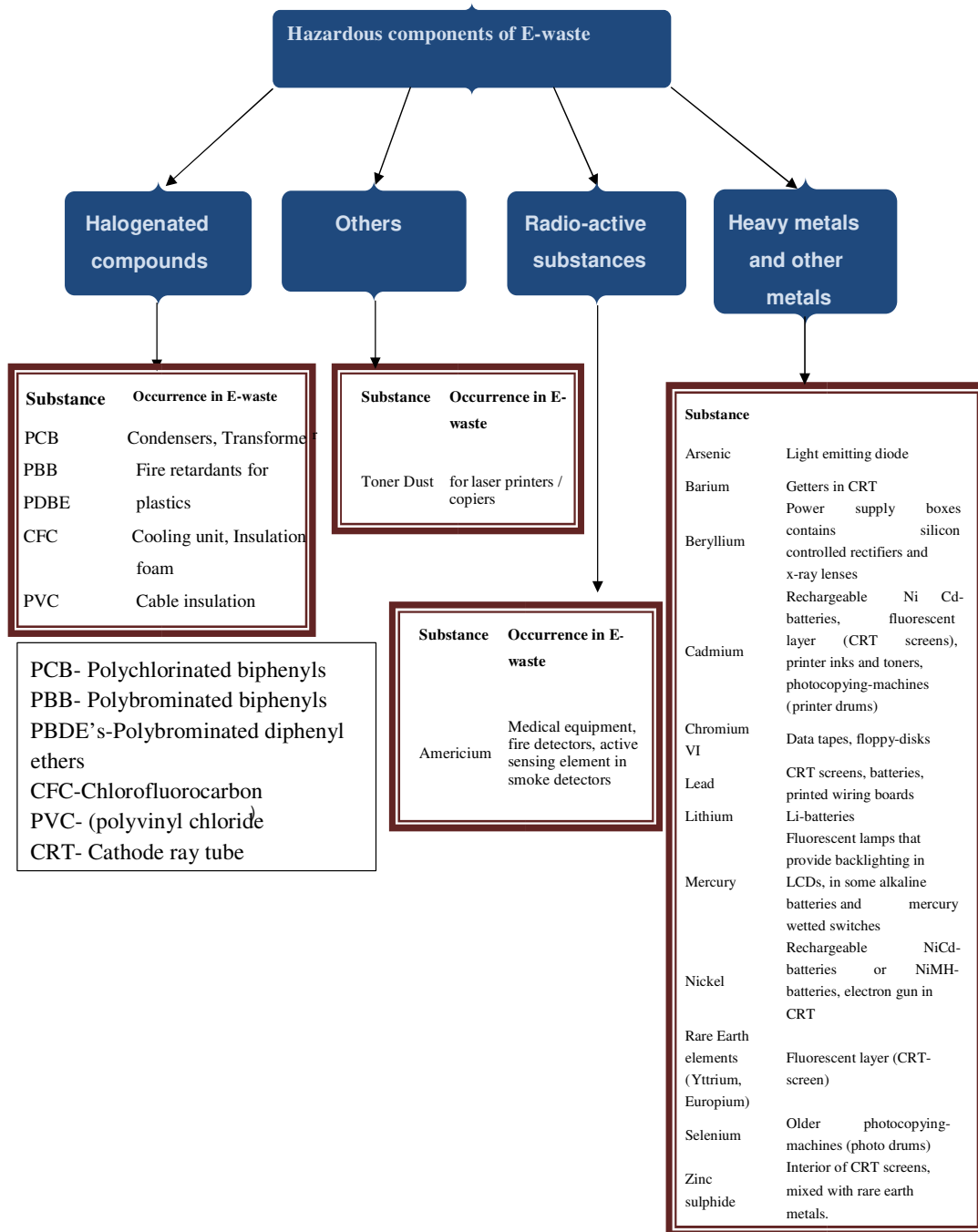


Fig 2. Hazardous Components of E-Waste [12]

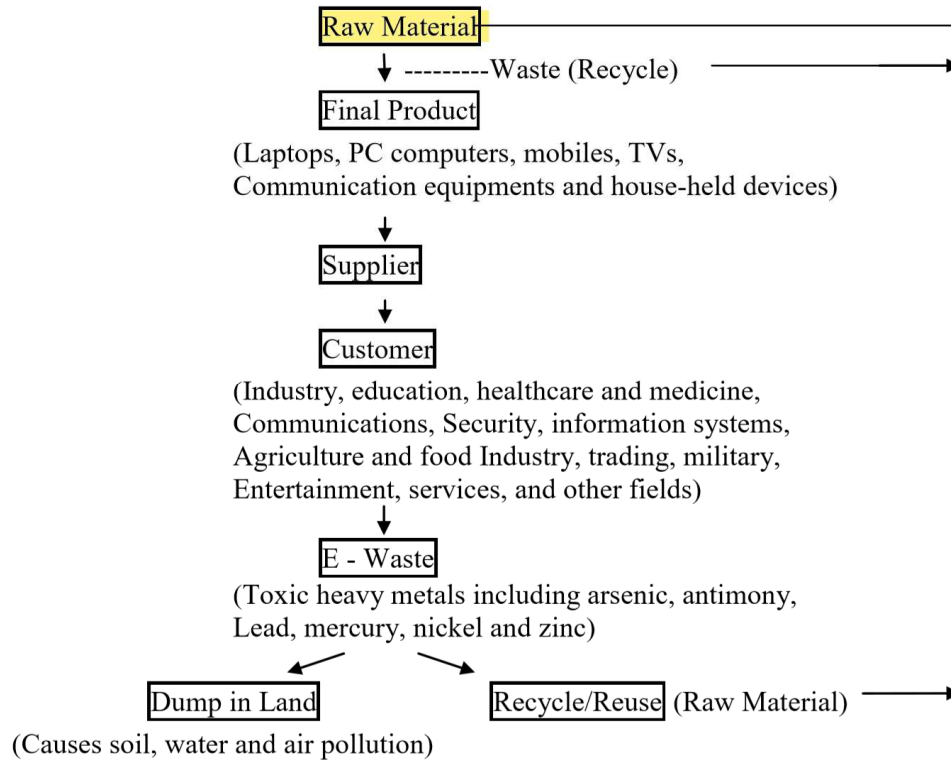


Fig 3. E-Waste Development and Processing [13]

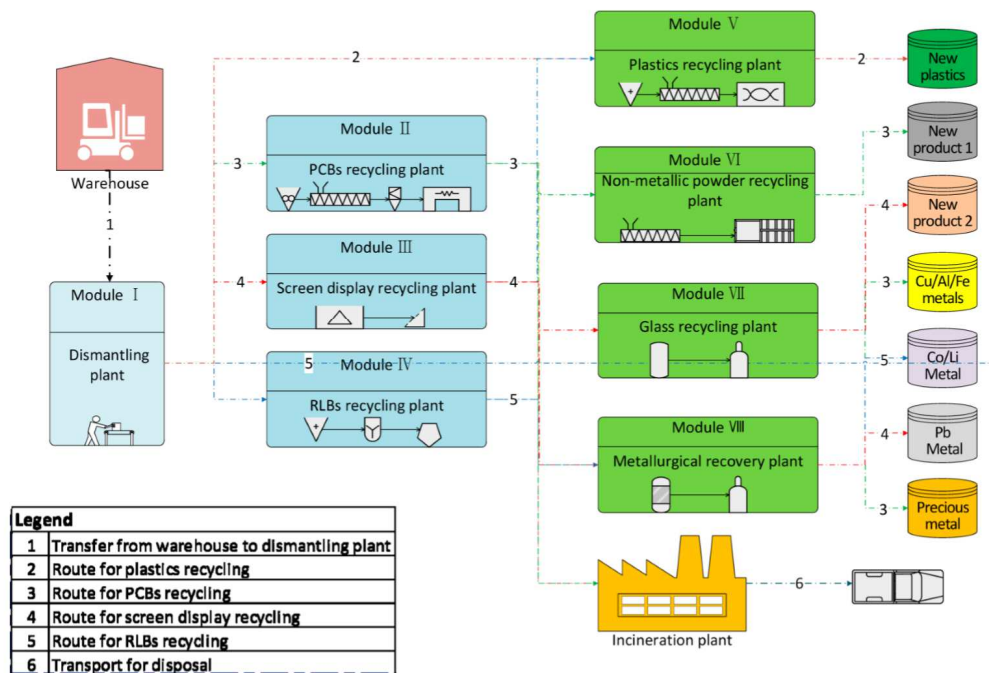


Fig 4. Vision for EIP of E-Waste Recycling in Modular Fashion [14]

As seen in the previous figures, it is possible to process e-waste if done in a responsible and systematic way. It is reasonable and economically sensible to properly dispose of e-waste as it reduces harmful global effects and allows for the possibility of reprocessing discarded electrical and electronic products in a financially beneficial way. These concepts will be further explored in this article from a circular economy perspective.

3. Methodology and research objectives

The purpose of the presented research is to observe how WEEE is generated, explore its consequences and suggest possible solutions to this problem. The data presented in this article has been carefully selected from recent research related to WEEE. The literature was selected for its quantitative and qualitative data that provides information for the aforementioned purposes of this paper.

This article aims to summarize the current situation surrounding WEEE to provide information to additional researchers to explore ways of eliminating e-waste and creating processes that involve environmentally friendly practices. The article does not aim to create new practices for handling WEEE but does aim to take existent information and provide it in a clear and understandable format. The article also takes the concept of a circular economy into account in order to present solutions to ending e-waste in a beneficial way to all associated parties.

4. China, India and Ghana

Three of the most affected regions of WEEE are China, India and Ghana. These countries are affected not only by WEEE but also by the burden of supplying global technology. China, India and Ghana have been selected for both the development and disposal zones of electrical and electronic products as a result of their current policies and economic situations. These developing regions offer the proper environment for production and e-waste accumulation as a result of the previously stated reasons and for inexpensive labor.

As a result of these conditions, these developing countries suffer the most severe consequences associated with WEEE. Due to the production and disposal of WEEE in these regions, health and environmental damage are prevalent. These e-waste related problems coupled with weak infrastructure within these developing countries leads to severe human and environmental impairment.

China and India's WEEE legislation is lacking and not properly enforced. While in Africa, there are close to no related laws. In China, the system involves roughly ten associated departments to coordinate WEEE that produces fees for disposal and monitors pollution and illegal imports. However, there is very little communication among the different departments which leads to a lack of continuity. [11]

Organizations such as the Basel Convention have been created in order to help prevent the spread of hazardous materials related to WEEE from being illegally dumped in developing and weak nation states. However, there are only 87 associated parties, excluding the United States, that have been willing to ratify the connected amendments. In addition, only a few of nation states have any control over the import of toxic WEEE, such as the situation in India where they have failed to legally ban the dumping of these hazardous materials. [11]

An example of how WEEE has affected these developing countries can be seen in the landfilling of burnt CRT's in these regions that leads to lead being drained from these devices into local vegetation. Cadmium present in mobile devices can pollute 600 m3 of water. As a result of this leakage, surrounding soil can face long term risks and spread poison into local crops that eventually leads to disease among those living in these areas. [15]

China currently has 106 different government certified organizations that are focused and capable of dismantling 100 million various obsolete household appliances per year. However, they only manage to handle 40 million household appliances. The remainder of the 100 million obsolete products are passed down to salesmen who sell this scrap material to uncertified disposal plants that pay higher premiums than certified disposal facilities. There are approximately 300,000 of these individuals in Beijing alone. However in Ghana, people literally separate WEEE from garbage and then sell it also to uncertified disposal plants. [11]

5. Circular economy as a potential solution to WEEE

A circular economy functions in such a way that it examines not only the end of a products' life cycle in terms of how those discarded products are recycled and repurposed, but it also explores how those products are created in order to operate at a mutually beneficial level for both the producers and consumers. In addition, it exists as environmental protection for a modern and developing society. Its primary goal is to analyze and generate environmentally friendly processes to produce materials and products that can be refurbished in an inexpensive manner and allows for continued innovation in a responsible direction.

Electrical and electronic devices can be created and repurposed in a circular economy and this can reduce the dramatic effects placed on developing countries lacking proper infrastructure and policy related to WEEE. It can aide producers with ideas of how to make products that are environmentally friendly from the start through using materials that are non-environmentally damaging. Therefore, it can generate ideas of ways to eliminate hazardous substance from being used and instead use safe materials that can be recycled and reprocessed.

At present, circular economy approaches to production and reprocessing can be viewed as expensive and unbeneficial to the producers. However, with continued research and progress, new materials can be integrated that serve similar processes and do not damage surrounding communities. [16] In some situations, higher costs associated with green supply production may be perceived but in many situations a switch to green supply practices improved a companies' branding image and customers were willing to spend more on a product that they feel reflects them. One study showed that approximately 75% of consumers were persuaded to make purchases based on a particular companies enviromental focus and green practices. In addition, 80% of consumers indicated that they would be willing to spend more for enviromentally friendly products. [17]

Therefore, if companies make the move towards environmentally friendly production of electrical and electronic devices, their market could exponentially expand and they may in fact increase their revenue. This benefit would help the producers, consumers and environment and reduce global disease and WEEE. The concept of a circular economy has been proven as an effective means to protect society and the environment if properly integrated. [18]

6. Conclusions

WEEE is an overwhelmingly increasing global problem that must be resolved in order to preserve the inherent safety of all forms of life and the environment. WEEE is generated as a result of consumer demand to satisfy their technological needs in a continuously developing world. However, it does not need to be a global problem.

It is possible to reduce the spread of disease and environmental destruction by taking necessary precautions that can be possibly affirmed through concepts related to a circular economy. A circular economy allows for the possibility of reliable and responsible supply chains that continuously take into account human welfare and environmental protection. This type of economy can be established in such a way to be beneficial for both producers and consumers.

Electrical and electronic devices will be continuously generated as a resulted of a technologically driven world. This reality is apparent and currently unstoppable as we as a society constantly demand more from the resources and equipment that we have available. Therefore, it is everyone's responsibility to make logical and environmentally friendly decisions from the start of a supply chain to how we dispose of our obsolete devices. If this can be achieved, innovation can continue to flourish, and we can also help to reduce the damage done to our world.

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