Where are WEEE in Africa?

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Abstract

This paper presents the findings of national e-waste assessments prepared in West Africa, which were developed under the framework of the Basel Convention "e-waste Africa project". West Africa faces a rising tide of e-waste generated by domestic consumption of new and used electrical and electronic equipment (EEE). In the five countries studied, between 650,000 and 1,000,000 tons of domestic e-waste are generated each year, which need to be managed to protect human health and the environment in the region. Aside from domestic consumption, the e-waste problem is exacerbated by an on-going stream of used EEE from industrialized countries. Although the majority of this imported equipment is destined for re-use after testing and repair, there are significant volumes that prove unsuitable for re-use and further add to local e-waste generation. Study results suggest that West Africa serves as the major trading route of used EEE into the African continent, with Ghana and Nigeria as the main import hubs.

1 Introduction

The problem of waste electrical and electronic equipment (WEEE) or e-waste in Africa only came to public awareness a few years ago. This perception changed in 2005 when the Basel Action Network documented illegal export of e-waste to Nigeria and the subsequent informal recycling and dumping [1]. A milestone for more awareness was marked by the "Nairobi Declaration on e-Waste", which was adopted at the eighth meeting of the Conference of the Parties (COP8) to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes in 2006 [2]. Since then WEEE appeared more often on the political agenda in and for Africa.

Indications grew stronger that besides Asia, also Africa was being used as a dumping ground for discarded EEE, especially from OECD countries [3–9]. However discussions also try to differentiate between the "dumping accusation" and the fact that what is perceived as a discarded appliance with little value on one side, can be sold as a valuable second-hand good on the other side. Hence several factors are contributing to the trade of used and end-of-life EEE with African countries, probably the most important being the demand in the countries of import to have access to good quality second-hand equipment at an affordable price.

While the quantitative breakdown of the problem was not clear for some times, there was always evidence that e-waste in Africa is causing adverse impacts for people and the environment. As a result various international cooperation projects in e-waste management were launched by multilateral (UN) organizations, producers from the ICT industry, NGOs and governmental organizations between 2003 and 2010 [10]. The Basel Convention "e-Waste Africa Project" [11] was launched with the intention to shed light on the issue of transboundary movement of e-waste from Europe to Africa. Specifically, the project aimed to improve the level of information available on flows of EEE and e-waste imported into West African countries, as well as on understanding to local situation. In addition it launched activities to strengthen national capacities to monitor and control transboundary movement of e-waste and to prevent illegal traffic. This paper presents the findings of national e-waste assessments prepared in Benin, Côte d'Ivoire, Ghana, Liberia, and Nigeria related to the amounts of EEE imports, EEE in use, e-waste generated, as well as environmental and socio-economic impacts of the e-waste sector.

2 E-waste volumes

2.1 Imports of new and used EEE

Most of the consumed EEE is imported into West Africa, while there are only some assembling companies, for example, in Nigeria [12]. The studies for Ghana revealed that in 2009, around 70% of all imports were used EEE [13]. 30% of second-hand imports were estimated to be non-functioning (and hence have to be declared as illegally imported e-waste): half of this amount was repaired locally and sold to consumers and the other half was un-repairable (Table 1).

A field investigation in Nigerian ports in 2010 showed that the share of used EEE imports is about half of what was found in Ghana (35%) [12]. However this data was gathered at a time when stronger enforcement by the Nigerian government made it less attractive to import used EEE. Hence it is thought that the share of used EEE imports could have been in a similar range as Ghana in the years before.

In Benin and Côte d'Ivoire, imported amounts of EEE were lower, as well as the share of used EEE. Varying between 30% for Benin [14] and 48% for Côte d'Ivoire [15], field investigations have shown that about half of the imported used EEE is actually non-functional and non-repairable, thus defined as import of e-waste. Liberia, generally seeing few imports, seems to receive relatively less used EEE with a share of 10% [16]. Rough estimations for computer imports into other African countries from the east, the south and the north [10], [11], indicate an even lower share of used EEE between 8–15%. These numbers suggest that West Africa serves as the major trading route of used EEE into the African continent, with Ghana and Nigeria as the main import hubs. In absolute numbers, however, given the significantly larger size of its population, Nigeria clearly dominates the region in the total amount of used and new EEE imports.

2.2 EEE in use

The use of EEE, in particular ICT equipment, is still low in Africa compared to other countries in the world, but it is growing at a staggering pace. For example, according to World Bank [17] and ITU data [18] in the last decade, the penetration rate of personal computers has increased by a factor of 10, while the number of mobile phone subscribers has increased by a factor of 100.

The per capita use of EEE varies between 4.6 kg (Liberia) and 44 kg (Nigeria) per inhabitant (Table 1). It is interesting to note that Ghana and Nigeria have a penetration rate almost as high as more developed countries like Morocco and South Africa, although their development status (for example, measured by GDP) is much lower. This is an indication that, due to the intense trade of used EEE, people in Ghana and Nigeria have better access to lower priced EEE. From this perspective, the import and trade of used EEE is in support of the UN Millennium Development Goals as a means to foster ICT for development.

2.3 E-waste generated

Estimations for e-waste generated are also given in Table 1. It can be assumed that at least 50% of e-waste was generated out of the consumption of new or used EEE of good quality with a reasonable life-span. In addition up to 30% of waste originates from the consumption of EEE which was imported as used EEE of unclear quality. For the five selected West African countries this is between 650,000 and 1,000,000 tonnes of domestic e-waste generated per annum (see also Figure 1), which at a certain point needs to be managed. In addition to this number it is roughly estimated that in the past years a total of at least 250,000 tonnes of e-waste per annum was "illegally" entering the ports of the five selected West African countries. This number is comparable to the total amount of e-

Country	**Year**	**Imports of EEE**		**EEE in use**		**E-waste generated**	
		tonnes/ year	thereof used EEE	tonnes	kg/ inhabitant	tonnes/ year	Thereof collected
Benin	2009	16'000	30%	55'000	6.32	9'700	N/A
Côte d'Ivoire	2009	25,000	48%	100,000	4,8	15,000	N/A
Ghana	2009	215,000	70%	984,000	41.0	179,000	172,000
Liberia	2009	3,500	10%	17,000	4.6	N/A	N/A
Nigeria	2010	1,200,000	35-70%	6,800,000	44.0	1,100,000	N/A

Note: The data presented is based on the e-waste country assessment reports of the respective countries as cited in the text. Numbers for EEE and e-waste represent the sum of all appliances summarized as categories 1-4 of the European WEEE Directive.

Table 1: Quantitative data for imports, EEE in use and e-waste generated in West African countries.

waste generated in a small European country like Belgium or the Netherlands and equates to about 5% of e-waste generated in the European Union.

Figure 1 presents the breakdown of EEE imports and e-waste generated for Ghana and Nigeria, which are by far the dominant countries in absolute numbers. It should be noted that these absolute numbers are theoretical figures representing the amount of appliances becoming obsolete: the actual volumes reaching the waste stream depend on the efficiency of collection. Collection rates vary among the countries and reach up to 50% in Nigeria and 95% in the case of Ghana.

The high collection rate in Nigeria and Ghana is due to the informal sector being very active in e-waste recycling, which is triggered by the high volumes of traded used EEE. Hence almost all of the collected material reached the informal recycling sector, while formal recycling operations played a negligible role so far. Even though Côte d'Ivoire has an important informal sector as well, the field study suggests that only small amounts of e-waste are collected from consumers and large volumes of e-waste remains with consumers in stock. It seems that the existing informal sector in Abidjan mainly focuses on repair and refurbishment, and that only the residual fraction that is unrepairable is sold as scrap to foreign dealers. In Benin and Liberia, the informal e-waste sector is relatively small and focuses on the re-use of scrap metals for producing kitchenware, tools, etc.

3 Impacts of current recycling practices

3.1 Current recycling practices

Informal activities in the e-waste recycling chain are present in all countries and include collection, manual dismantling, open-burning to recover metals and open-dumping of residual fractions. While in some countries these activities are performed by individuals with a low material throughput (e.g. in Benin and Liberia), Côte d'Ivoire, Ghana and Nigeria reveal an organized informal sector with medium to high volumes of processed materials (e.g. steel, aluminum and copper). Informal recycling locations are often found adjacent to markets for used EEE. A known example is Alaba International Market and Ikeja Computer Village in Lagos, Nigeria [19].

Informal recycling processes apply manual dismantling with simple tools like hammers, screwdrivers, chisels etc. as the primary treatment to physically separate the heterogeneous materials and components. After dismantling and pre-processing, components with a re-use value are sometimes sold to repair shops for further sale on the second-hand market. The remaining valuable components containing copper, aluminium, steel and wiring boards are classified for further treatment or export. Open-burning is widely used in all studied African countries to recover metals, such as copper, steel, and aluminium from wires and other EEE components. In Nigeria, indication was also found of further "refining" techniques, such as de-

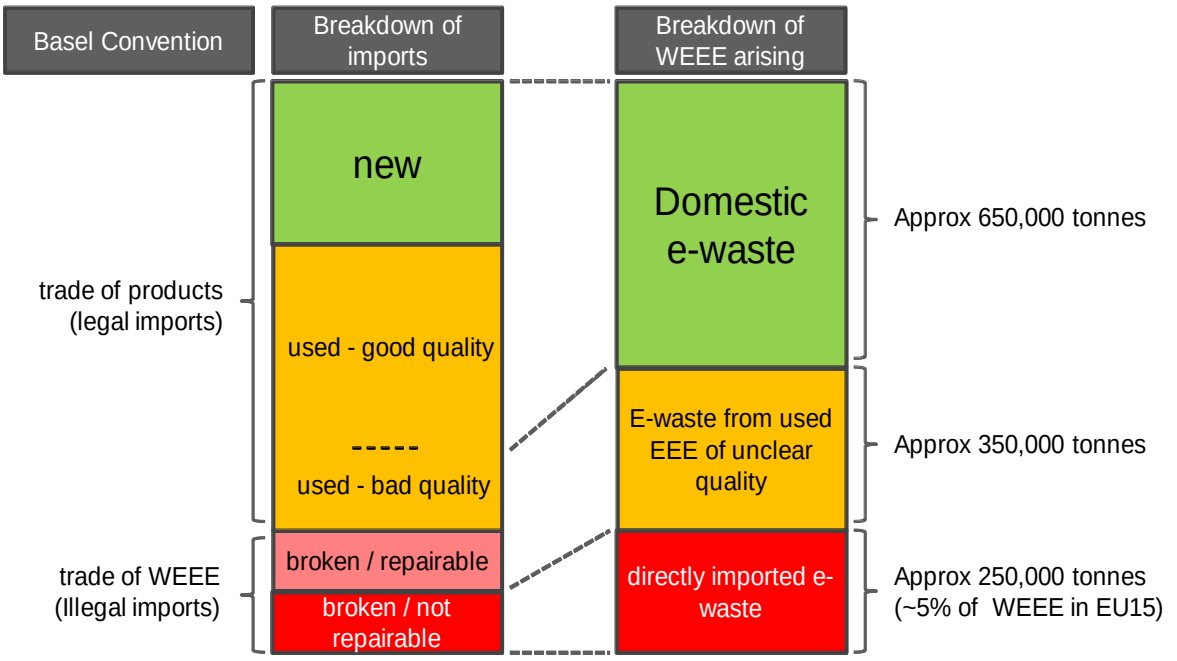

Figure 1: Estimated breakdown of EEE imports and e-waste (WEEE) generated for Ghana and Nigeria in 2009/2010

soldering of printed wiring boards (PWB) and subsequent leaching of gold. Open-dumping of residual fractions such as CRT-glass and plastics is evident in all countries.

Formalized processes in the e-waste recycling chain are only about to develop in the form of initial manual dismantling pilot projects (Ghana and Nigeria) or are planned (Benin and Côte d'Ivoire) through either private initiatives or development cooperation projects. All of them at least partially rely on financial start-up funding, which is not yet secured. More costly treatment processes, such as degassing CFCs and HCFCs from cooling and freezing appliances and CRT recycling are not available in West Africa. Only in Ghana there is a project commissioned by the United Nations Development Programme (UNDP) aiming to set up a refrigerator collection and recycling system to recover and destroy CFCs. In some countries, formal refining processes exist for metallic fractions like steel and aluminium. This ranges from rather simple re-melting operations to larger metal smelters and refineries. Metallic scraps from e-waste are usually treated in these facilities, together with mixed metal scraps from other sources.

3.2 Environmental impacts

Emissions from informal recycling activities have already been assessed in many studies [20] and their impacts on the environment and health are evident. Major impacts from current recycling practices in West Africa result mainly from the processes of dismantling, material recovery and final disposal. During collection as well as refurbishment or repair of EEE, negative impacts can partly occur, but are generally at a significantly lower level.

Recycling activities often take place on unfortified ground where harmful substances released during dismantling are directly discharged to the soil. Burning copper cables and wires, as well as monitor and TV casings, creates an accumulation of ash and partially burned materials at the burning sites. Insulating foam from dismantled refrigerators, primarily CFC-containing polyurethane, or old car tyres are often used as the main fuels for the fires, contributing to acute chemical hazards and long-term contamination at the burning sites, as well as emitting ozone depleting substances and greenhouse gases into the atmosphere.

The release of dioxins is the most relevant emission from the burning of plastics, especially PVC plastics and plastics containing polybrominated diphenyl ether (PBDE) flame retardants [21]. Dioxin emissions from cable burning in the greater Accra region, for instance, are estimated to correspond to about 0.3% of total dioxin emissions in Europe [13]. While that number may sound small, Accra's tiny proportion, when extrapolated to the whole continent, adds up to a substantial amount. Recent measurements in Accra indicate increasing levels of PBDEs in breastmilk associated with informal recycling of e-waste [22]. Recent studies from Europe [23] and Nigeria [24] suggest that especially plastic casings from CRTs are subject to high concentrations of PBDEs.

3.3 Socio-economic impacts

An in-depth socio-economic analysis was carried out in Ghana [25] and Nigeria [19]. In both countries, there is a well organized repair and refurbishing sector focusing on used equipment either from imports or from domestic sources such as businesses and households. These activities are only indirectly linked to the e-waste recycling sector, as the business outputs are functioning products rather than raw materials. Nevertheless, the sector produces significant amount of e-waste, as often old devices are used as sources of spare parts and later discarded.

In Accra (Ghana) and Lagos (Nigeria), this refurbishing sector provides income to more than 30,000 people. In particular in Lagos, two refurbishing clusters – Ikeja Computer Village and Alaba International Market – achieved high professionalism and gained regional importance by supplying refurbished equipment not only to Nigerian households, but also to other West and Central African countries. Together, these two markets feature about 5,500 small enterprises with around 15,000 technicians and sales personnel. Many of these workers have a comparably high education and most of them went through a sector-specific apprenticeship system lasting between two and five years. It is notable that many of these enterprises are registered with the local authorities and pay taxes to local and regional administrations. Therefore, the refurbishing sector operates partly under formal conditions.

In contrast, collection and recycling of e-waste is almost exclusively carried out by non-registered individuals widely referred to as "scavengers". These are mostly poor migrants from the rural areas in the north of the respective countries, where populations have few alternatives to small-scale agriculture and where rainfall variability cause food shortages. For these migrants, the scrap metal business is one of the few economic activities that can be taken up without prior training or investment. In addition, it enables rapid and regular access to cash, as the revenues from one day's work immediately materialize when the recycling products are sold to one of the local middlemen.

	Refurbishers	Collectors	Recyclers	Total
Remuneration per month (in US$ / person)	190–250	70–140	175–285	-
Remuneration per year (in US$ / person)	2,280–3,000	840–1,680	2,100–3,420	-
Number of people engaged in refurbishing and e-waste recycling sector in Ghana	14,000–24,000	6,300–9,600		-
Income of those engaged in the e-waste sector per year (in US$)	Remuneration per year (in US$) multiplied by the number of people employed in refurbishing and e-waste recycling sector in Ghana			110 – 270 million

Table 2: Annual income of people employed in the e-waste sector in Ghana.

However collection and recycling of e-waste is associated with severe health and safety risks for the engaged workers. These risks mainly stem from poor working conditions and the exposure to hazardous substances in and around dismantling sites. Working hours are particularly long in the informal collection and recycling of e-waste. While child labor is not common in the refurbishing sector, it is observed in the scrap metal business. Collection and dismantling activities are carried out by children from the age of 12, however younger children from the age of 5 are sometimes engaged in light work, including dismantling of small parts and sorting of materials.

A few numbers regarding estimated incomes in the business are summarized in table 2 for Ghana. Although part of these figures might give the impression that the scrap metal business and e-waste recycling is quite lucrative in Nigeria and Ghana, it has to be considered that these revenues mostly have to be shared with other family members and that income is only earned on economically active days and not during periods of sickness or other emergencies. Therefore, it is concluded that a significant portion of e-waste workers in Nigeria and Ghana live below the internationally defined poverty line of US$ 1.25 per day. Nevertheless value creation is significant. In Ghana, for example, it was estimated that countrywide activities in refurbishing and scrap metal collection and recycling (including e-waste) generate between US$ 110 and 270 million (see table 2).

4 Conclusions and outlook

One major challenge for West African countries is to avoid the import of e-waste and near-end-of-life equipment without hampering the meaningful and socio - economically valuable trade of used EEE of good quality. Refurbishing of EEE and the sales of used EEE is an important economic sector in some countries of West Africa (e.g. Ghana and Nigeria). It is a well-organized and a dynamic sector that holds the potential for further industrial development. Indirectly, the sector has another important economic role, as it supplies low and middle income households with affordable ICT equipment and other EEE. In the view of the sector's positive socio-economic performance, all policy measures aiming to improve e-waste management in West Africa should refrain from undifferentiated banning of second-hand imports and refurbishing activities and strive for a co-operative approach by including the market and sector associations.

In addition, high volumes of domestically generated e-waste require well-functioning local take-back and recycling systems. Challenges include the establishment of appropriate collection strategies, ensuring that high volumes of valuable and non-valuable waste fractions are collected equally and that those fractions reach appropriate treatment and disposal facilities. In addition, connecting informal collectors to a formal recycling structure is pivotal, along with appropriate capacity building and training. Recyclers in West Africa should make use of the abundant labor force, and concentrate on manual recycling techniques and only apply mechanical shredding and sorting technologies where unavoidable. In addition local recyclers need to connect to global players in countries with the best technologies for a maximum recovery of separated fractions and proper treatment of residual waste. A sustainable e-waste management system will also need an adequate financing scheme, a level playing field and appropriate market incentives. It is thought that similar to policies in OECD countries, e-waste recycling systems in Africa could be developed in line with the principle of Extended Producer Responsibility.

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5 Literature

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