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E-MAGIN GHANA

E- Waste Management in Ghana

From Grave To Cradle

Money Dey for Borla

Assessment of Ghana's E-Waste Value Chain

adelphi

Ghana National Cleaner Production Centre GNCPC

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EXECUTIVE SUMMARY

Through recent years, Agbogbloshie in Ghana's capital Accra has received increasing public attention for being the world's presumably largest dumpsite for waste from electrical and electronic equipment (WEEE or e-waste). While the environmental pollution and adverse health impacts of improper e-waste recycling are dire, crude recycling techniques are not solely restricted to the Old Fadama Scrap Yard in Agbogbloshie but can in fact be observed throughout the entire country. With the introduction of the Hazardous and Electronic Waste Control and Management Act, 917 as well as the corresponding Hazardous, Electronic and Other Wastes (Classification), Control and Management Regulations 2016, Legal Instrument (LI) 2250 in 2016, the Government of Ghana has made landmark achievements in curbing unsustainable e-waste management practices. More recently, the passing of the E-waste Management Guidelines has laid out the foundations to formalizing informal workers along the entire value chain. However, effective implementation will ultimately depend on the dissemination of knowledge amongst a wide range of actors.

In this light, the European Commission's SWITCH Africa Green program is funding a four-year project on E-waste Management in Ghana (E-MAGIN Ghana). Implemented by a consortium comprised of University of Cape Coast (lead), Ghana National Cleaner Production Centre, City Waste Recycling and adelphi between 2018 and 2021, the project supports the effective implementation of Act 917 by formalizing informal stakeholders, establishing a nation-wide collection mechanism, conducting trainings and capacity building programs and providing decision-support to decision makers through dialogue events, studies and policy briefs. This publication represents one of the first major outputs of the E-MAGIN project. Based on more than 120 data points from qualitative interviews and quantitative rapid assessments, the report delivers a brief synopsis of the current status of e-waste management in Ghana followed by a deep-dive of the value chain in qualitative and quantitative terms. This is complemented by a description of present challenges experienced by (primarily) Micro, Small and Medium-sized Enterprises (MSMEs) and suggestions for improvements.

Assessments of e-waste fractions and processed components indicate that there is a significant price gap between prices for items traded in the formal and the informal sector. Challenges commonly encountered by MSMEs working in the e-waste business include impacts on human health and the environment and a lack of awareness by MSMEs about the corresponding consequences. This is further aggravated by difficulties in gaining access to finance, the cost of logistics for transporting e-waste over larger distances. Moreover, respondents also highlighted that the informal nature of the e-waste business paired with the absence of a level regulatory playing field present challenges for upscaling environmentally sound e-waste recycling practices. Conversely, solutions to these challenges include public and private support for upgrading e-waste management infrastructure, facilitating access to finance and providing technical support for informal collectors and dismantlers. In addition, enforcement of laws and regulations and awareness creation were mentioned as important approaches to curbing harmful practices in e-waste processing.

Against this background and based on remarks received by interview partners during the data collection process, policy makers in Ghana make consider the following recommendations:

- upgrade infrastructure and allocate land to develop designated e-waste processing zones and streamline monitoring and enforcement;
- offer incentive schemes and provide monetary support to avoid cherry-picking of valuable fractions and promote expansion of collection infrastructure;
- foster formation of scrap dealer associations and streamline registration procedures to accelerate formalization and strengthen their bargaining power;
- create awareness and strengthen monitoring and enforcement of laws to create a level playing field amongst all actors in the e-waste value chain; and
- offer technical support in line with good business and e-waste management practices through provision of trainings by actively engaging scrap dealer associations.

For more information about the EU-funded E-MAGIN project implemented under the European Commission's SWITCH Africa Green program, please refer to https://e-magin-ghana.com/ or contact info@e-magin-ghana.com.

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ABBREVIATIONS

AC	Air-Conditioning
CRT	Cathode Ray-Tube
EEE	Electrical and Electronic Equipment
EPA	Environmental Protection Agency Ghana
EPR	Extended Producer Responsibility
GESTA	Ghana Electronic Services Technicians Association
GH₵	Ghanian Cedis
GPS	Global Positioning System
ICT	Information and Communications Technology
MESTI	Ministry of Environment, Science, Technology and Innovation
MMDA	Metropolitan and Municipal District Assemblies
MSMEs	Micro, Small and Medium Enterprises
PCB	Printed Circuit Board
SGS	Societe General De Surveillance SA
UEEE	Used Electrical and Electronic Equipment
WEEE or e-waste	Waste from Electrical and Electronic Equipment
WP	Work Package

1. INTRODUCTION

Electrical and electronic equipment (EEE) have become a mainstay of modern lives and are a vivid reflection of the accelerating pace of digitalization and the rise of a global middle-income class; yet, short cycles in innovation and product lifetime paired with the increasing market penetration of (consumer) electronics also give rise to a darker side of modernity: rapidly growing amounts of waste from electrical and electronic equipment (WEEE or e-waste) which need to be disposed of and recycled responsibly. According to the Global E-waste Monitor, a staggering 44.7 million tons of e-waste were generated in 2016 embedded with raw materials with an estimated value of 55 billion Euros (equivalent to some 327 billion GH₵[1]) (Balde et al., 2017). These numbers not only illustrate the amount of materials needed to sustain today's economies, but also highlight that "*money dey for borla*"[2], meaning that there is a strong economic case for establishing functioning e-waste management systems. (Hagelüken and Corti, 2010)

Having recognized the considerable economic value contained in e-waste, many economically advanced countries have taken action and implemented policies, which ensure collection of EEE at the end of life in order to recover the critical raw materials contained therein. However, the waste management systems of many emerging economies are often underequipped to handle the rising domestic generation of e-waste. In many cases – including Ghana – this situation is exacerbated by the influx of second-hand products, which become obsolete after a short period of time upon arrival in the country. In addition, some industrialized countries (including some member states of the European Union) fail to comply with the internationally binding *Basel Convention on Transboundary Movements of Hazardous Wastes and their Disposal* and illegally export e-waste to less developed countries, which lack adequate processing capacities to deal with these wastes.

[1] Currency Rate taken from: XE Currency Converter: 1 Euro = 5,94475 GH$; Date: 02.18.2019 09:35 GMT

[2] A creole expression which was frequently encountered by the E-MAGIN research team when speaking to stakeholder from the informal sector during the data collection for this report; it translates into "there is value in trash" and highlights that e-waste is seen as a valuable resource in Ghana.

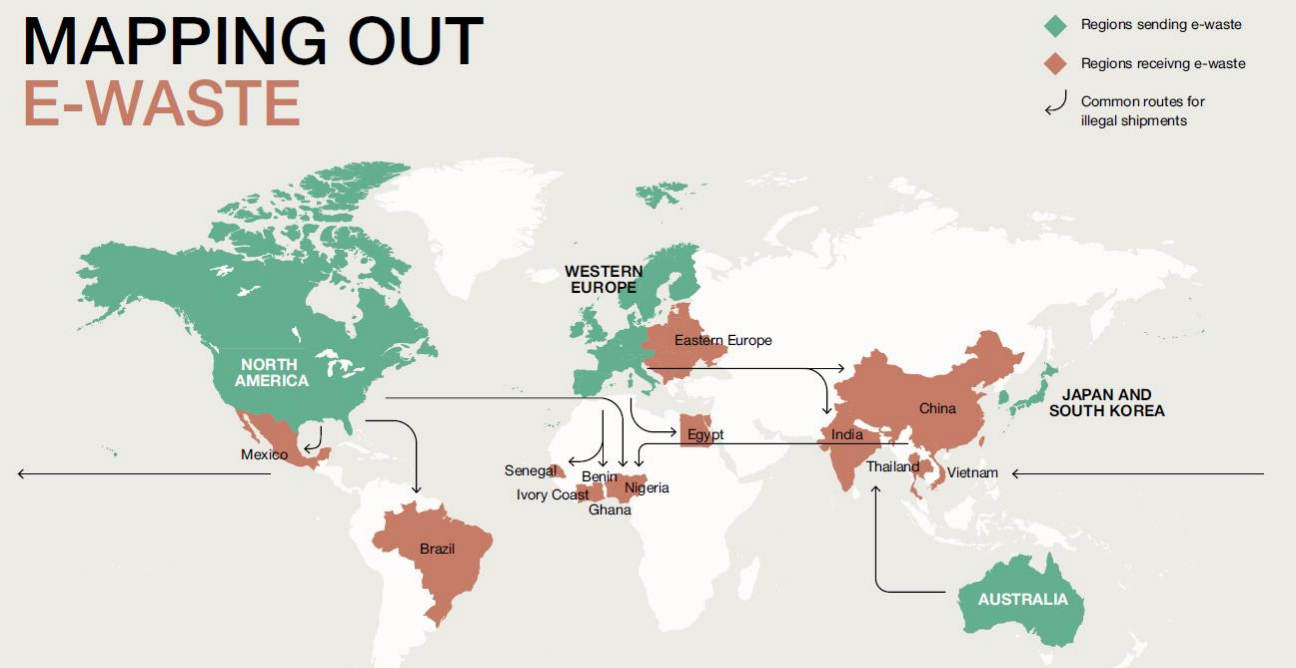

Figure 1: Mapping out global e-waste flows[3]

While illegal shipments of e-waste urgently need to be addressed by the international community, the magnitude of corresponding material flows remains largely unknown. Analyses by the EU-funded Countering WEEE Illegal Trade project indicate that some 1.3 MMt of discarded electronics left the EU in undocumented mixed exports. Thereof, an estimated 30% was e-waste whereas 70% was functioning equipment. Hence, it can be expected that a large parts of e-waste generation in low-income countries can be attributed to legal trade of near-end-of-life or second-hand EEE occurring due to the high demand for such equipment (Jaco Huisman et al.) .

In Ghana, the e-waste management sector consists of a wide-spread network of unlicensed collectors, intermediaries, scrap dealers and dismantlers specializing in manual disassembly and trading of post-consumer electronics. A lack of decent environment, health and safety safeguards among these actors results in massive environmental pollution and negatively affects the physical well-being of thousands of people. Open burning of cables and manual dismantling of lead-acid batteries present some of widely applied malpractices and can be observed throughout the entire country. Yet, it is widely accepted that incorporating the informal sector into formal e-waste management activities is of utmost importance if sound collection, dismantling and recycling of discarded EEE is to be ensured on a long-term basis. (Williams et al., 2013)

[3] Authors: Bel, van Brunschot et al. 2019; License: https://creativecommons.org/licenses/by-nc-nd/4.0/legalcode

THE PARADOX OF E-WASTE

According to the EU's definition, EEE refers to equipment which is dependent on electric currents or electromagnetic fields in order to work properly (European Union 2012). Once discarded or abandoned by its owners, this equipment becomes e-waste. In simple and less technical terms, one may describe e-waste as discarded items with a plug, electrical cord or battery and its components, thus including a wide range of products such as toasters, smartphones, fridges, laptops and television sets that have reached the end of its life.

E-waste contains high-value materials…

E-waste contains a plethora of high-value, scarce and recoverable materials such as gold, silver, copper, platinum, palladium, iron, aluminum and tin. It has been estimated that up to 12% of the world's annual mine production of gold is utilized for manufacturing EEE, signifying the potential material value of these products even at the end of life (UN Environment 2018)**.** Figure 2 further showcases the different contents embedded within a typical mobile phone, including significant fractions of metals such as copper, iron and palladium. Additionally, other precious metals such as neodymium (vital for magnets in motors), indium (used in flat panel TVs) and cobalt (for batteries) contained in e-waste hold a high economic value.

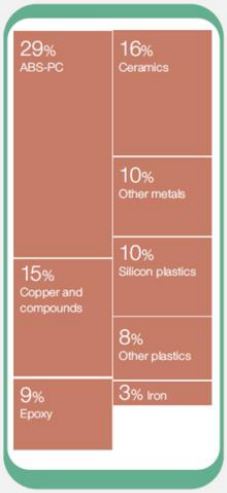

Figure 2: Contents of a mobile phone[4]

… but also, highly toxic compounds.

E-waste is not biodegradable, accumulates in the environment and releases toxic substances, such as lead, mercury, cadmium and flame retardants found in phones, laptops, fridges, sensors, TVs and other types of discarded items. Burning, melting or uncontrollably dumping these items poses a considerable environmental and health risks, as the pollutants leach into air, soil, or water bodies. Research suggests that e-waste represents the fastest growing waste stream globally; yet, only 66% of the global amount of e-waste is covered by legislative provisions (Balde et al. 2017).

On one side, the informal sector is highly important due to its scale, geographical spread and network-like structure which yield high collection rates; on the other side, informal collection, dismantling and recycling of e-waste has emerged as a major livelihood strategy among the local population and must not be neglected when fostering sustainable waste management practices in Ghana. In fact, it is estimated that between 20,000 and 35,000 people are directly employed by the e-waste sector, whereas more than 120,000 depend indirectly on the industry. Economic analyses conducted by Öko-Institut (Prakash and Manhart, 2010) suggest that on average, informal collectors earn as little as 2.3 to 4.6 USD (12 to 24 GH₵) per day whereas

[4] Authors: Bel, van Brunschot et al. 2019; License: https://creativecommons.org/licenses/by-nc-nd/4.0/legalcode; modified for own purposes

recyclers earn about 5.8 to 9.5 USD (30,4 to 49,8 GH₵[5]) on a daily basis. Despite these low income levels, the e-waste sector represents an important part of Ghana's economy: in 2015 it was estimated that the sector indirectly contributed 546 to 1,393 million GH₵[6] to the country's Gross Domestic Product (Oteng-Ababio et al., 2014).

In order to reduce the disastrous environmental and social impacts of current e-waste management practices, the Government of Ghana drafted the Hazardous and Electronic Waste Control and Management Bill in 2012 and transposed it into binding law (known as Act 917) in July 2016. At its core, it is based on the approach of Extended Producer Responsibility (EPR), an internationally applied policy principle for establishing structured waste management systems. To give effect to Act 917, Ghana has also passed a corresponding legal instrument (LI 2250) and recently published the Technical Guidelines on Environmentally Sound E-Waste Management, which came into effect January 2017 and February 2018 respectively.

1.1. E-MAGIN Ghana: project background and objectives

While the introduction of Act 917, LI 2250 and the Technical Guidelines represent landmark achievements, their successful implementation will ultimately depend on the dissemination of knowledge among a wide range of stakeholders across the entire country. Previous projects sought to address e-waste management practices in selected regions across Ghana, especially those taking place at the Old Fadama Scrap Yard in Accra, an area also referred to as Agbogbloshie. This particular site has received considerable public attention as Africa's presumably largest dumping ground for e-waste. Few additional projects have addressed Kumasi and Tema as other focal points of e-waste processing (UN Environment, 2016). However, urgent actions need to be taken in other regions to achieve positive impact on a national scale and to create conducive conditions under which the informal sector can continue to pursue its livelihood whilst avoiding damages to human health and the environment.

Against this background, the European Union is funding a project on E-waste Management in Ghana (E-MAGIN Ghana). Being implemented under the EU's SWITCH Africa Green program (phase II), the project targets eight regions with seven lying beyond the metropolis of Accra where a considerable number of informal collectors, dismantlers and recyclers are located, namely Greater Accra, Ashanti, Brong Ahafo, Western, Eastern, Central, Northern and Volta Regions. The project is implemented by a consortium of University of Cape Coast, Ghana National Cleaner Production Centre, City Waste Recycling and adelphi over a period of four years (i.e. from January 2018 till December 2021).

E-MAGIN's overall objective is to improve management of e-waste in Ghana towards sustainable consumption and production through an integrated multi-stakeholder approach, thus promoting sustainable growth, alleviating

[5] Currency Rate taken from: XE Currency Converter: 1 USD = 5,24056 GH₵; Date: 02.18.2019 09:35 GMT

[6] Converted from US$ into GH₵. Original figure 105-268 million US$

poverty, increasing human well-being and preventing environmental pollution. More specifically, the project seeks to contribute to an effective implementation of the Ghana Hazardous and Electronic Waste Control and Management Act, Act 917 by implementing a number of integrated work packages (WPs:) WP1 seeks to improve the knowledge base on e-waste management in Ghana by taking a closer look at the sector's value chain; WP2 aims at fostering formalization of informal Micro, Small and Medium-sized Enterprises (MSMEs), thus enabling them to continue operating under the legal ambit of Act 917; WP3 seeks to establish a collection mechanism for e-waste at a national scale; WP4 disseminating best practices through capacity building and training of trainers; lastly, WP5 provides decision support for policy makers and creates awareness amongst consumers. This approach is presented in Figure 3 below.

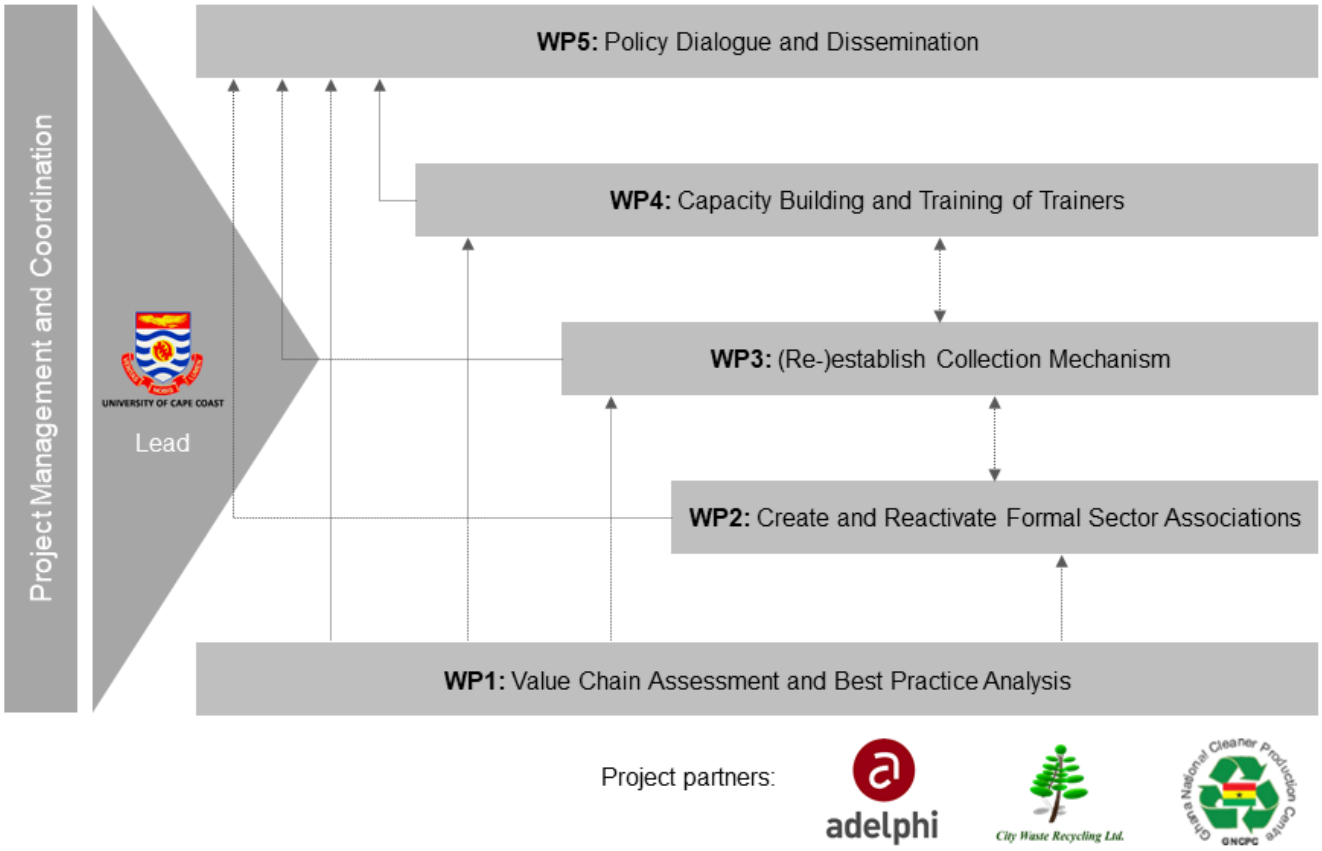

Figure 3: Structure of E-MAGIN Ghana project

Within this context, the value chain analysis presented in this study forms part of WP1 and presents one of the first major outputs of the E-MAGIN project. Drawing from extensive data collection, the purpose of this study is to deepen the knowledge about the overall situation on e-waste management in Ghana by:

1. identifying hotspots of informal e-waste processing;
2. describing the most prevalent techniques for collection, dismantling, recycling and disposal;
3. mapping out the most dominant stakeholders in the formal and informal sector;

4. understanding the market structure and business case for e-waste management, including (prices paid for) fractions collected and processed; and
5. outlining challenges and solutions to provide recommendations for the way forward.

The study presents a comprehensive assessment on this issue in Ghana and seeks to contribute towards the achievement of E-MAGIN's objectives.

1.2. Methodology

Methodologically, this study relies on triangulation of different data sources in order to provide robust insights on the key components and aspects of the Ghanaian e-waste value chain. Data was collected from February 2018 to November 2018. Starting with a comprehensive review of available literature (comprised of peer-reviewed papers, grey literature, legislative documents, websites and news articles), the study provides a written account on the baseline scenario of e-waste management in Ghana as well as an overview of the current legal framework.

As such, this review depicts the current situation on e-waste management (including historic developments and estimations for quantities) and summarizes prevalent processes, hazards and their occurrence throughout the country. However, as large parts of the value chain consist of informal MSMEs and go unaccounted for, historical data and written information are in most parts insufficient. Therefore, information gathered from literature had to be complemented with first-hand information collected in the field.

1.2.1. In-field data collection

In-field data collection was conducted in two distinctive forms: 1) rapid assessments with one-page data collection forms for quantification of amounts of collected e-waste and their corresponding prices from MSMEs; 2) qualitative in-depth interviews (at times conducted in focus group settings) with MSMEs and policy makers for identifying challenges and improvement options for e-waste management.

The rapid assessments covered mostly quantitative aspects regarding the collection of e-waste as sub-stream of general scrap generated in the country and the sales of components extracted from different e-waste fractions. E-waste types included devices or products commonly found in e-waste streams, such as fridges, televisions, batteries, while the components list comprised of the most significant material streams (aluminum, iron/steel, copper, printed circuit boards etc.).

To complement the quantitative aspect of the rapid assessments, the consortium also conducted qualitative in-depth interviews with stakeholders along the e-waste value chain. The stakeholders predominantly included informal MSMEs active in the collection and dismantling, refurbishment, repairs and/or recycling of e-waste fractions, importers of near-end-of-life EEE, bulk generators of e-waste as well as officials from governmental institutions.

1.2.2. Sample composition

Prior to the collection of data, an extensive contact data base for key stakeholders from the e-waste sector within the Ghana was formed. The aim was to include stakeholders (predominantly MSMEs) from all eight target regions. The stakeholders were deemed eligible for inclusion if they were actively involved in e-waste management and expressed willingness to share information. Per this approach, the contact database consisted of scrap dealers, e-waste recyclers/component exporters, electronic waste/repairers/importers, Ghana's Environmental Protection Agency (EPA) officers and municipal/district waste officers. A visual representation of the distribution of stakeholders across the different regions where interviews were conducted can be seen in the figure below. The map roughly indicates locations by using the Geographical Positioning Systems (GPS) for data collected during the rapid assessments and interviews. Upon examination of the data, stakeholders in close proximity were clustered together for illustrative purposes.

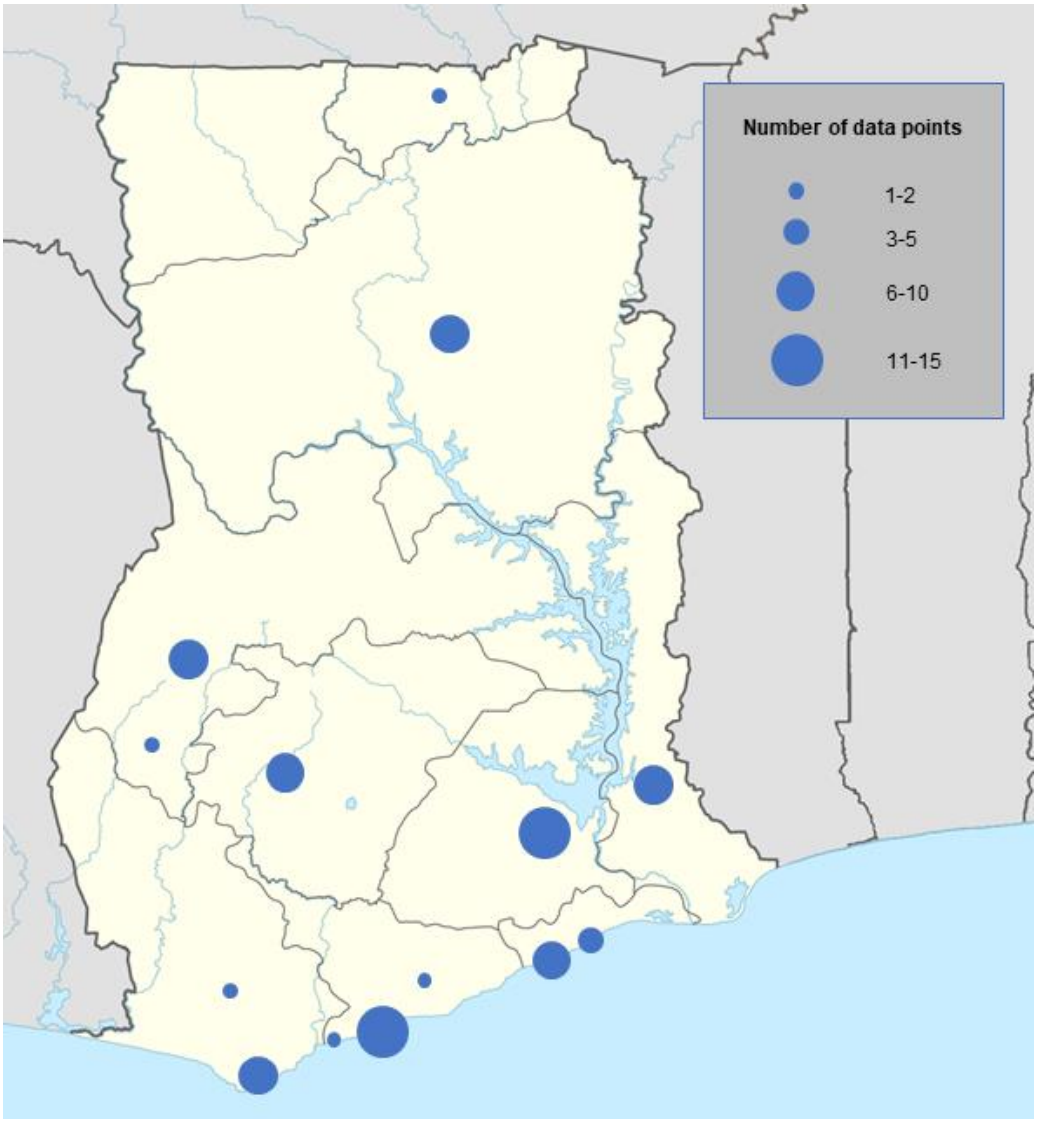

Figure 4: Visual representation of recorded data points within project surveys in Ghana[7]

During the data collection phase, a total of 64 in-depth interviews and 61 rapid assessments were conducted.[8] The sample composition for both in-depth interviews and rapid assessment is relatively similar. It consists of a total of 61 rapid assessments and is evenly distributed across the eight target regions. A summary of the distributions across the eight target regions for the in-depth interview and the rapid assessment can be seen in Figure 5.

[7] Author: NordNordWest License: https://creativecommons.org/licenses/by-sa/3.0/de/legalcode; modified for own purposes

[8] Initially, the project team sought to conduct 40 in-depth interviews and 80 rapid assessments; however, during the data collection phase, some of the interviewees could not produce quantifiable data but were only able to provide general, qualitative remarks regarding their business operations.

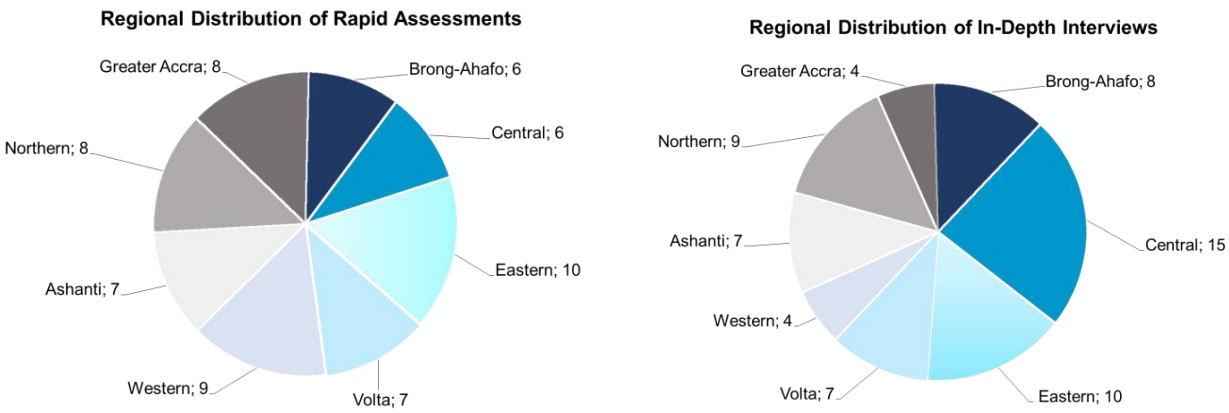

Figure 5: Regional distribution of data points

1.2.3. Data analysis

Due to the acquired data being both quantitative and qualitative in nature, different analytical techniques had to be applied in order to produce warranted findings. For the in-depth interviews, the analyses searched and clustered individual text strings and assigned these to thematic clusters. The categories were determined post data collection and emerged from the answers given during the interviews.

For the analysis of the data collected by the rapid assessments, quantitative analytical methods were applied. However, in order to employ these methods, the units given by the stakeholders had to be converted into standardized measurement units. Both quantities collected or purchased of different e-waste types and the quantities of fractions generated were scaled to tonnes per month, while the cost of purchase for fractions and the sales price of components were scaled to GH₵ per month. As most informal MSMEs do not deal with e-waste per ton, a large proportion of the answers were given in price per piece. To convert these into the required format, average weights for e-waste types and components were used as a basis of conversion calculations. The average weights were taken from a variety of sources (including internal assessments from previous projects and practical manual dismantling workshops of E-MAGIN project under WP2), as available databases generally do not include all e-waste types and components. For missing entries, publicly available references were used. This included (inter alia) publications on e-waste statistics by the United Nations University and the Re-Use Network in the United Kingdom.

Once the units had been converted to a standardized measurement scale, the quantitative analytical methods could be applied to the data. For data points with a sufficient number of entries[9], intraregional statistical means and ranges were calculated for both prices and quantities. Due to the sample size and some underlying limitations of the data, advanced quantitative methods (distributional analysis, cluster analysis etc.) were not employed.

[9] Number of entries to be considered for further evaluation: eight entries for Price Values, five entries for Quantity Values; related to both E-Waste Type and E-Waste Components

1.2.4. Limitations and scope

Due to the extensive involvement of actors from the informal sector, there is also an underlying reliability concern with the acquired information. At times it was unclear whether the provided information was fully robust. To deal with this uncertainty, the analysis cross-referenced the information with other records. However, this was not always possible, implying that an uncertainty issue of the data cannot entirely be ruled out. Furthermore, some informal MSMEs were either unable or unwilling to provide coherent data on their operational processes. Since they usually do not adhere to standard industry procedures, they do not have any formal register on business activities, such as the sales and collection of the respective e-waste quantities. This implies that some of the provided data is based on quantitative estimates of the MSMEs themselves and can merely serve as an approximate baseline, rather than a true representation of actual quantities. In addition, it should be noted that the data only covers a small sample of the entire e-waste value chain, which may compromise up to 20,000 to 35,000 individuals in Ghana.

Moreover, the estimates of the processed and collected quantities come with some inherent statistical limitations. As a majority of the measures were not provided in uniform units, conversions had to be applied. These conversions drew from certain assumptions regarding the average weight of certain e-waste types or components. This could potentially lead to systematic errors within the converted units. Furthermore, some of the e-waste streams did not have an inherent unison format. For example, batteries typically come in different shapes and sizes. Depending on the exact type of battery, they can be larger (e.g. car batteries) or smaller (motorbike and tricycle). Due to this difference in weight, prices per piece of a battery or pieces collected per month can be inflated or deflated as a result of conversions. Hence they could not be considered in the further statistical analysis.

1.3. Outline

The report sets out in Chapter 2 with a brief synopsis of the current status of e-waste management in Ghana by providing by a broad overview of existing literature and a subsequent examination of policy measures that have been implemented in the past and present. Chapter 3 continues with a comprehensive analysis of the e-waste value chain, which is based on the in-field data collection. In Chapter 4, the deep-dive of the value chain is complemented by a description of present challenges experienced and suggestions for improvements by the stakeholders taken from the survey. By reviewing the information provided by the stakeholders, recommendations for present and future e-waste management practices in Ghana are given in the conclusion in Chapter 5.

2. MANAGING E–WASTE IN GHANA

2.1. Outlook

As countries get richer, they create more waste. Economic growth in developing countries is raising living standards and reducing poverty, but there are also undesired side-effects, such as generation of more e-waste, which needs to be managed properly to reduce the risks to human and ecological health (Bel et al., 2019). In Ghana, e-waste management has over the years been in the hands of informal scrap dealers. However, in recent times, the government has increased measures to formalize the sector and integrate informal workers into the formal value chain. This chapter provides an overview regarding issues encountered along the e-waste value chain in Ghana, highlights previous and current policy interventions and points to potential areas of improvements.

2.1.1. A problematic 5%

Out of the world's 44.7 million tons of e-waste generated in 2016, only 5% (2.2 million tons) were generated in Africa. Thus, the continent ranks lowest with regards to e-waste generation at 1.9 kg/inhabitant. Yet, the management of this 5% has been problematic making the continent a significant contributor to the global e-waste problem. Indeed, out of the 2.2 million tons generated, only 4 kilotons (0.0004 million tons) were documented as collected and recycled via authorized organizations; this is less than 1% of the total generated. E-waste management in most African countries is dominated by unregulated informal sector collectors, dismantlers and recyclers with limited access to modern infrastructure for recycling and outside of government control (Balde et al., 2017).

Besides the importance of informal e-waste management as a livelihood strategy, common practices often involve the use of illicit methods (e.g. open burning of cables to retrieve copper) as well as a lack of personal protection equipment for the workers. Resulting from such practices is a severe pollution of the environment, poor efficiencies in recovery of expensive and precious components, and the exposure of workers' and the general populace to hazardous emissions (Amoyaw-Osei et al., 2011).

Frequently, Ghana's Old Fadama Scrap Yard (better known as Agbogbloshie) has been cited as epitomizing these informal practices in Africa and has received wide international attention and concern (Hector, n.d.). With the scrap yard housing a wide-spread network of licensed and unlicensed collectors, scrap dealers and dismantlers specializing in manual disassembly and trading in varied components of e-waste, a lack of decent environmental, health and safety safeguards has turned it into a massive pollution site that negatively affects the physical well-being of thousands of people.

2.1.2. How much e-waste?

Agbobgloshie Scrap Yard may epitomize informal e-waste management practices in Ghana, yet much of what happens in the e-waste value chain beyond Agbogbloshie remains unknown. Particularly quantities of e-

waste flows are not well documented, yet there have been recent efforts to quantify the importation e-waste and/or near end-of-life equipment as indicated in Table 1 below.

Table 1: Estimated quantities of WEEE generation (MT) from 2010 to 2016 in tonnes; source: Switch Africa Green (Phase I) Ghana E-Waste Model baseline studies report 2016

	ICT Equipment	**Consumer Electronics**	**Large Household Appliances**	**Small Household Appliances**	**Total**
EEE in use	100,009.700	48,640.00	110,330.20	4,178.29	663,158.19
WEEE stored	280,731.98	6,221.92	30,934.00	158.71	318,046.61
WEEE to recycling	80,101.01	7, 377.17	74,222.04	5,000.05	166,700.27
WEEE re-exported illegally*	10,900.00	4,500.00	6,308.00	88.00	21,796.00

** Mostly UEEE/WEEE re-exported to Europe/origin*

It is understood that the expanding e-waste sector is due to Ghana's economic strategy enabled by Information & Communications Technology (ICT). In 2003, the Government of Ghana articulated an ICT for Accelerated Development Policy to "transform Ghana into an information-rich knowledge-based society and economy, through the development, deployment and exploitation of ICTs within the economy and society" (The Republic of Ghana, 2003). To ensure affordable access to ICT products and promote usage, government issued a tax-free import of computers and computer accessories in 2004. This heavily affected the number of imported computers, which can be seen in Figure 6. By 2011 the imported gross mass of computers was recorded at 10,300 tonnes, which is sevenfold the import mass of 2004. More recent estimates on the amount of EEE imported are currently not available.

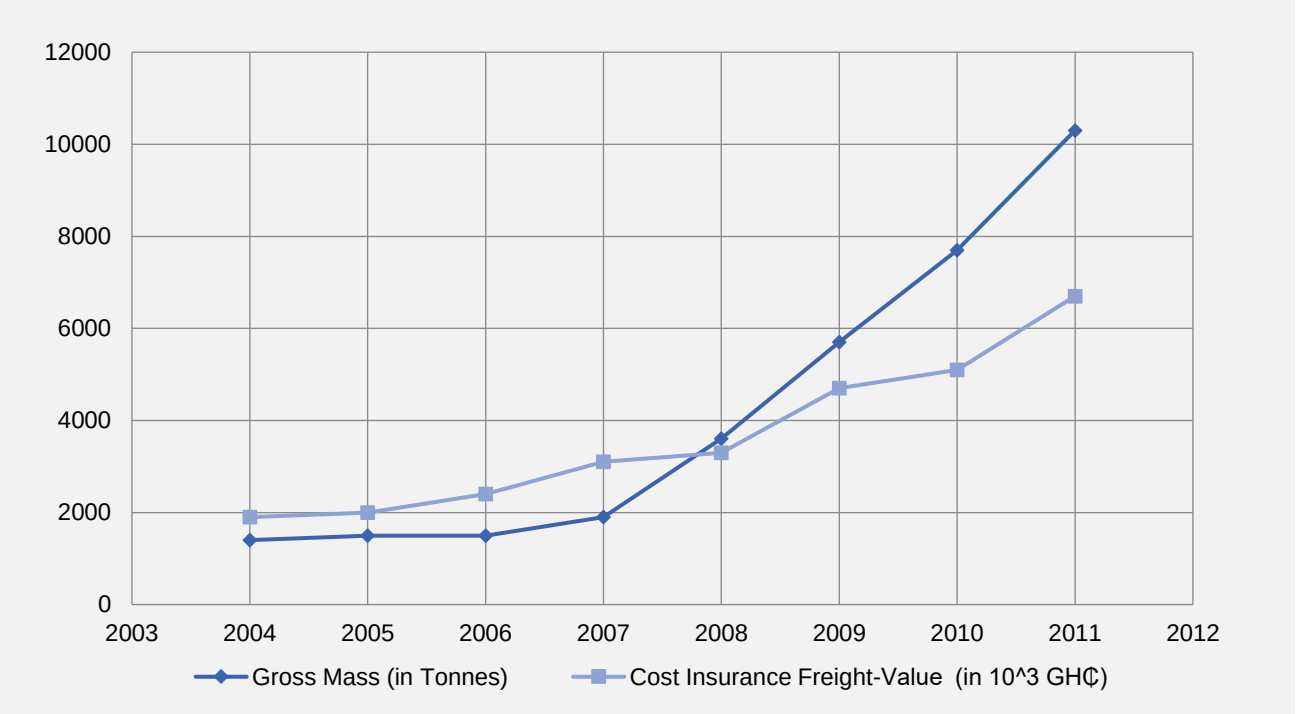

Figure 6: Import of used computers into Ghana from 2004-2011; source: data taken from (Grant and Oteng-Ababio, 2012; Oteng-Ababio, 2012)

Besides computers, the growing Ghanaian economy and the associated emergence of middle-income class consumers has increased the demand for both new and used electronics. In 2009 the EPA estimated imports of EEE at 215,000 tons made up of 30 % new equipment (65,500 tons) and 70 % used ones (150,500 tons). The EPA also estimated that in the same year of 2009, 280,000 tons of e-waste were generated in Ghana, out of which 57% were repaired, 8% were stored, 34% were collected through informal collection mechanisms, and 1% collected by formal companies (Amoyaw-Osei et al., 2011). More recent estimates indicate that some 350,000 tons of EEE are imported per year. For more information, please refer to flow chart in Annex 3. Particularly, used electronics locally known as "second hand" electronics have become a major import fraction due to their comparatively affordable prices. In Ghana, about 20% of imported second hand EEE have been estimated to have a short life span of less than two years, while another 10% to 20% of these imports are expected to be virtually non-functional upon arrival (Amoyaw-Osei et al., 2011).

At times, exporters in industrialized countries illegally ship obsolete EEE to low-income countries, which lack adequate treatment facilities, by "labelling" them as second-hand goods. This effectively exploits a loop-hole in the internationally binding *Basel Convention on Transboundary Movements of Hazardous Wastes and their Disposal* which was introduced in 1989 (Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1992). Readily available and affordable ICT products in conjunction with the significantly lower life span of second hand EEE have led to an overall increase of WEEE generated. Upon arrival, used electronics are sorted with non-repairable items, sold directly to scrap dealers or dumped at disposal sites (Hoeltl et al., 2017).

2.1.3. Hazardous jobs

The vast majority of e-waste in Ghana is managed under improper environment, health and safety conditions. Open burning of cables and manual dismantling of lead-acid batteries are common practices and result in significant environmental pollution and damage to human health. Due to improper processing of e-waste, workers are commonly exposed to the toxic chemicals contained within and often show acute symptoms of heavy metal poisoning. For instance, a study by Lomotey examined 20 informal workers and found that 19 had dangerously elevated blood-lead concentrations (40 >µg/dl). Such concentrations have detrimental consequences for human health and correlate with symptoms of weakness, headache, pain in arms and legs, memory loss, slow reaction times and – in more extreme cases – can lead to acute poisoning or death. These health hazards are even more dramatic as they often affect the most vulnerable, particularly due to the prevalence of child labor. Among the informal workers who dismantle or recycle e-waste are often barely 14 years old and even younger children, sometimes just under the age of ten, who forage e-waste dumping sites or sell water to the informal workers. In this, they are being exposed to toxins at an age which is most crucial to their long-term physical and mental development. (Lomotey, 2010)

Over the past few years, the e-waste sector has gained a substantial increase in international media coverage, particularly the Agbogbloshie recycling site (Balde et al., 2017). The site has been rated as "among the top ten most toxic sites in the world" Blacksmith Institute in 2013 (renamed to Pure Earth in 2015) (Blacksmith Institute and Green Cross Switzerland, 2013). Other times, it has exaggeratedly been referred to as the "world's largest e-waste dump" by mainstream media (The Guardian, 2014), the pollution induced by the unsafe dismantling and recycling practices at the site are living testaments of the challenges associated with establishing a functioning e-waste management system across the country. Despite these hazards, many have pointed out that the e-waste economy can and is already creating many jobs and supporting livelihoods. Oteng-Ababio & Grant estimate that about 4,500 to 6,000 recycling workers are active at Agbogbloshie alone (Grant and Oteng-Ababio, 2012). Nationally, annual revenue generated by recycling activities is estimated to be between 546 to 1,393 million GH₵, supporting the livelihood of around 200,000 people (Oteng-Ababio, 2012). Other accounts suggest that the employment infrastructure of Agbogbloshie already provides means of subsistence for around half a million people within the country (Masoom and Toufique, 2016).

Apart from these estimations, very little is known with regards to the economic relevance of e-waste management beyond Agbogbloshie. However, since the vast majority of e-waste management remains in the hands of the informal sector, which is present throughout the entire country, it can be expected that it represents a major livelihood strategy for the Ghanaian population as a whole. Aside the informal sector, formal collection and recycling companies are scarce, and consequently existing recycling facilities are largely inadequate.

2.2. Policy framework

Since the 1990's, Ghana has been signatory to regional and international agreements, such as the *Bamako Convention* and the above-mentioned *Basel Convention*. Yet this has not stopped the importation of obsolete and near end-of-life EEE, thus compounding the problem of improper e-waste management. Responding to the disastrous environmental and social impacts of current e-waste management practices in Ghana and the notoriety gained by Agbogbloshie worldwide, the Government passed the *Hazardous and Electronic Waste Control and Management Act, 917* as well as the corresponding *Hazardous, Electronic and Other Wastes (Classification), Control and Management Regulations 2016*, *Legal Instrument (LI) 2250* in July 2016.

2.2.1. Act 917 and LI 2250

Act 917 seeks to address the issue of improper e-waste management, placing stricter regulation on imported goods by assigning a higher responsibility to producers and private importers of EEE and thereby harnessing the principle of EPR. As an internationally recognized principle, EPR can be defined as an "environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle" (Organisation for Economic Co-operation and development).

Since Ghana relies mainly on imports of EEE, most EPR obligations rest with importers as the primary entities putting electrical and electronic goods onto the Ghanaian market. First and foremost, importers are required to register with the EPA and pay an Advance Eco Levy to a designated External Service Provider at the exporting country for goods processed or imported. These levies are then pooled in a fund. Managed by an Administrator appointed by the Ministry of Environment, Science, Technology and Innovation (MESTI) in consultation with the Ministry of Finance, the Administrator shall disburse the funds as per the stipulations of Article 21 and Article 28 of Act 917. Details for shares of disbursement are displayed in the figure below.

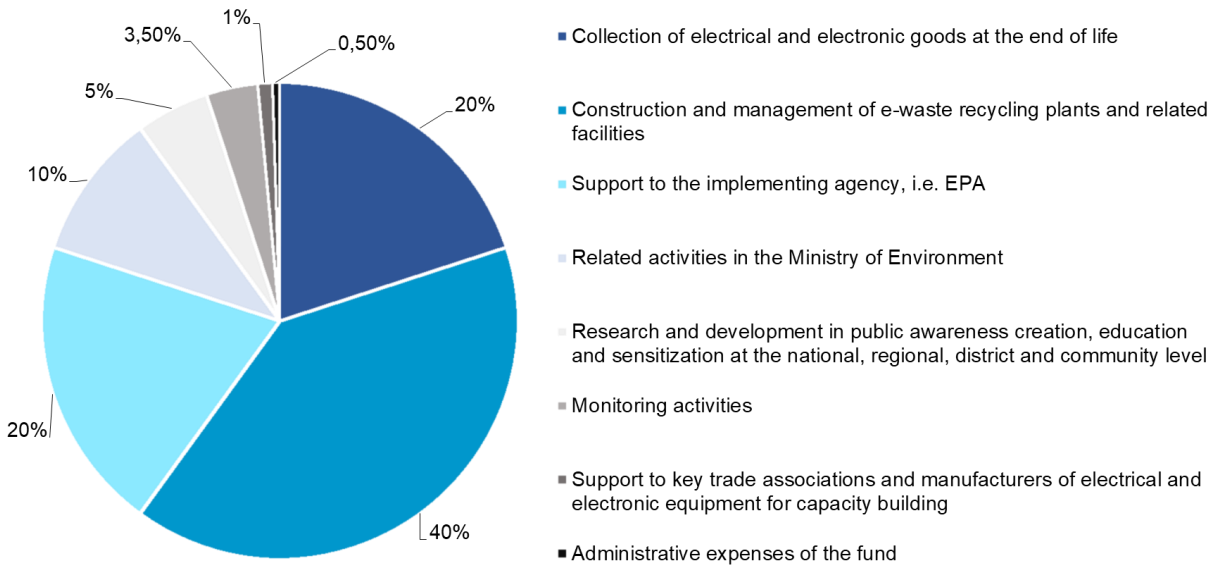

Figure 7: Intended disbursement of funds generated under Act 917

Additionally, those convicted of disregarding the Act would be held accountable by an imposed fine or even imprisonment, with a maximum sentence of 20 years. Some of the offences listed in the Act include "the disposal of hazardous wastes on unauthorized landfills and territorial waters" (Hector, n.d.) and unregistered import and export of hazardous waste. Further, the Act outlines requirements for developing the e-waste sector by advocating collection incentives, establishment of recycling plants, awareness, educational and research programs.

To give effect to Act 917, a corresponding legal instrument LI 2250 was passed and came into effect in 2017. It regulates classification, control and management of waste, establishes a mechanism for listing of waste management activities that do not need official waste management permits, prescribes requirements for the establishment of take-back systems, and outlines general duties of waste generators, transporters and waste managers, amongst other things. Furthermore, it includes a waste catalogue as well as a list of hazardous waste types that serve as a classification system in Ghana and provide a basis for all national and international waste reporting obligations.

To further implement provisions laid out in Act 917 and LI 2250, the President of Ghana announced the beginning of the construction of an integrated e-waste management facility at Agbogbloshie in August 2018. He also highlighted that the Advance Eco Levy will be collected by *Societe General De Surveillance SA (SGS)*, a Swiss inspection, verification, testing and certification company, which has been selected and designated as the External Service Provider as provided by Article 21 of Act 917 (Environmental Protection Agency Ghana, 2018).

The agreement implemented under *SGS Renovo™* program involves the carrying out of physical inspection and verification at the country of export of EEE and tyres for shipments to Ghana from November 1, 2018. The Government of Ghana acting through MESTI and the EPA will ensure confirmation by the Customs Division of the Ghana Revenue Authority of the Advance Eco Levy payment for all applicable products subject to the SGS Renovo program. This will be done prior to the release of the products from customs control.

From November 1, 2018, therefore, all EEE and tyres exported to Ghana have to be registered on an e-environmental platform deployed by SGS. This will enable exporters to create an e-environmental declaration form, listing the goods to be supplied under a specific consignment and to make the Advance Eco Levy payment.

2.2.2. E-waste Management Guidelines

To further develop a structured approach to e-waste management, the EPA in cooperation with Sustainable Recycling Industries project, completed the development of *Technical Guidelines on Environmentally Sound E-Waste Management for Collectors, Collection Centers, Transporters, Treatment Facilities and Final Disposal in Ghana* in February 2018. The guidelines are mandatory in compliance with Act 917 and LI 2250 with respect to every undertaking operating in the field of collection, storage, transport, treatment and final disposal of e-waste in Ghana. The guidelines specifically address target stakeholders of the value chain,

placing them into five groups. The central obligations for each stakeholder group are summarized in the text box below. (Environmental Protection Agency Ghana and Sustainable Recycling Industries, 2018)

SELECTED OBLIGATIONS UNDER GHANA E-WASTE MANAGEMENT GUIDELINES

Tier 1: collectors

Shall

- register with the relevant Metropolitan and Municipal District Assemblies (MMDA) and, where in an association, with the EPA
- manage e-waste in a way that prevents releases of gases, liquids or solid particles from any e-waste, or component, to the environment
- are prohibited from engaging in any treatment activities of e-waste (such as dismantling)
- prohibited from delivering whole or components of e-waste to a collection center that is not permitted by EPA

Tier 2: collection centers/buy back centers

Shall

- register with EPA and other relevant body (such as district assemblies) by completing and submitting the required forms in line with LI 1652 and LI 2250. Also, the number and Ghana Post GPS location of collection points shall be documented at the registration
- be prohibited from engage in any treatment activities of e-waste (such as dismantling) unless permitted by EPA
- be prohibited from disposing any negative value fractions of e-waste. All unusable fractions shall be sent to a tier 5 facility

Tier 3: transporters

Shall

- transport reusable electric and electronic devices in a transportation unit that is purposely prescribed.
- ensure that the transport capacities comply with the road traffic regulation of Ghana
- ensure that all fractions containing hazardous substances are stored in a manner that prevents dispersal of hazardous materials to the environment

Tier 4: treatment facilities/recyclers

Shall

- register with EPA by completing the relevant form and with other relevant bodies
- not dispose any e-waste inappropriately
- only initiate a shipment of parts to a facility that is permitted or certified to accept those materials and that is registered under Act 917 or internationally
- document the treatment process to separate material streams. Removed substances, mixtures and components (and fractions containing those substances, mixtures and components) shall be kept separate and shall be clearly and identifiable labelled (as stated in Act 917, section 13, subsection 3(a).
- report to EPA the quantities of incoming and outgoing e-waste

Tier 5: final disposal of certain hazardous fractions

- Owners and operators of disposal sites shall be licensed by Ghana EPA and the MMDAs
- Burying and open burning is strictly prohibited as contaminants may easily leach into the soil and pollute both soil and groundwater resources and lead to considerable air pollution.
- Owners and operators should be trained by competent institutions in collaboration with EPA with regards to technical knowledge and understanding of the hazardous nature of e-waste.

3. FROM TEMA TO TEMA – the E-Waste Value Chain in Ghana

Drawing from the information collected throughout the in-field survey process, the following chapter provides a detailed description of the activities undergone in each step of the value chain and a comprehensive account of the key actors involved. A wide range of stakeholders are involved along the value chain of EEE and e-waste. An overview is presented in the figure below. Although this visualization depicts the value chain in a linear fashion, it should be highlighted that its components are interconnected and consists of numerous feedback loops. For instance, collectors may at times sell directly to end processors whereas recyclers may engage in end-processing as well as recovery of selected e-waste components.

Without a vibrant EEE manufacturing or assembling facilities, EEE is mainly imported from other countries (mostly from Europe, Asia and North America) into Ghana through the ports of Tema, Takoradi and other entry points (e.g. Aflao border via the port of Lomé, Togo) by individual, bulk and institutional importers (Interpol, 2017).

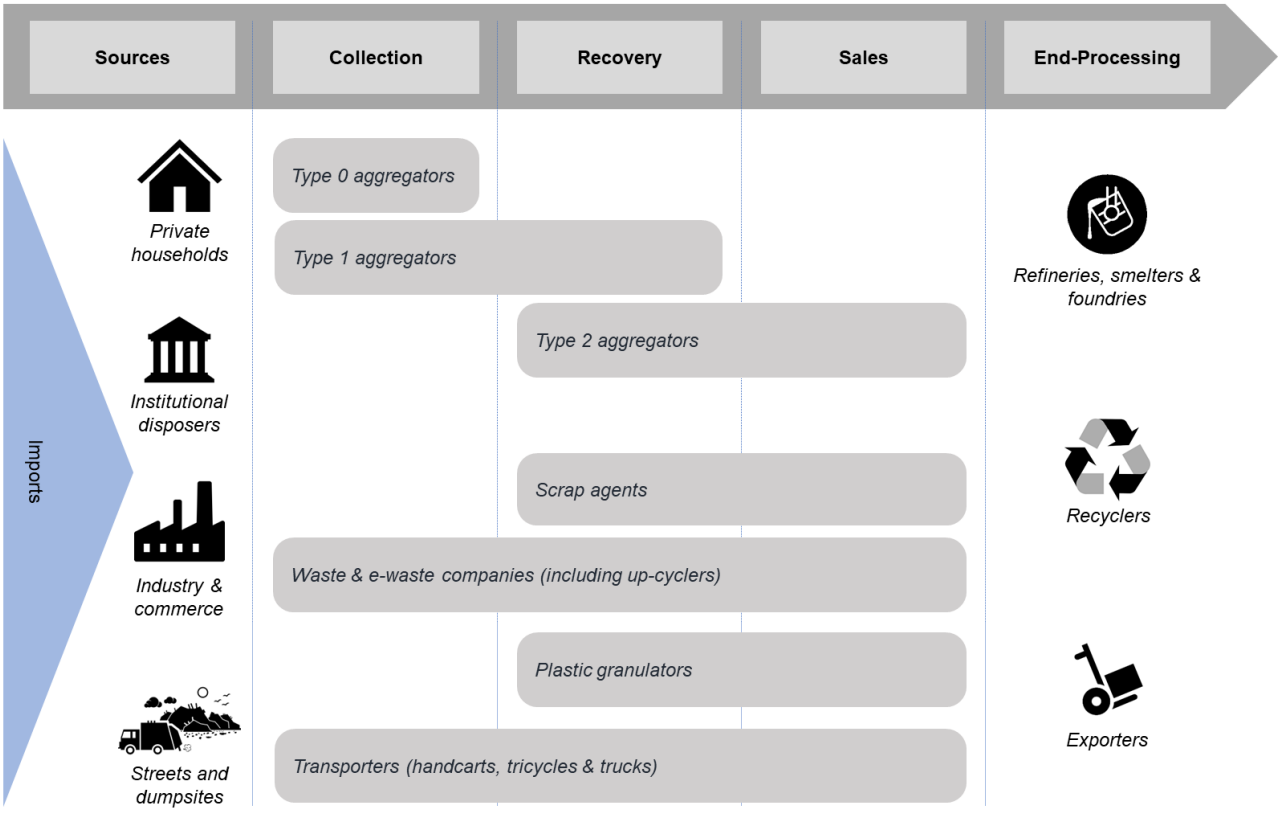

Figure 8: Overview of stakeholders involved along the e-waste value chain

3.1. Sources

Sources of e-waste can be clustered into four major categories. The graph below displays the distribution of the collection sources referred to by the MSMEs in the in-depth interview. Figures on top of the bar charts represent the number of interviewees who explicitly referred to the respective source. Most frequently mentioned were households as a source of e-waste, highlighting the presence of the informal sector within residential areas, followed by institutions, industry & commerce and dumping sites/streets being the least mentioned.

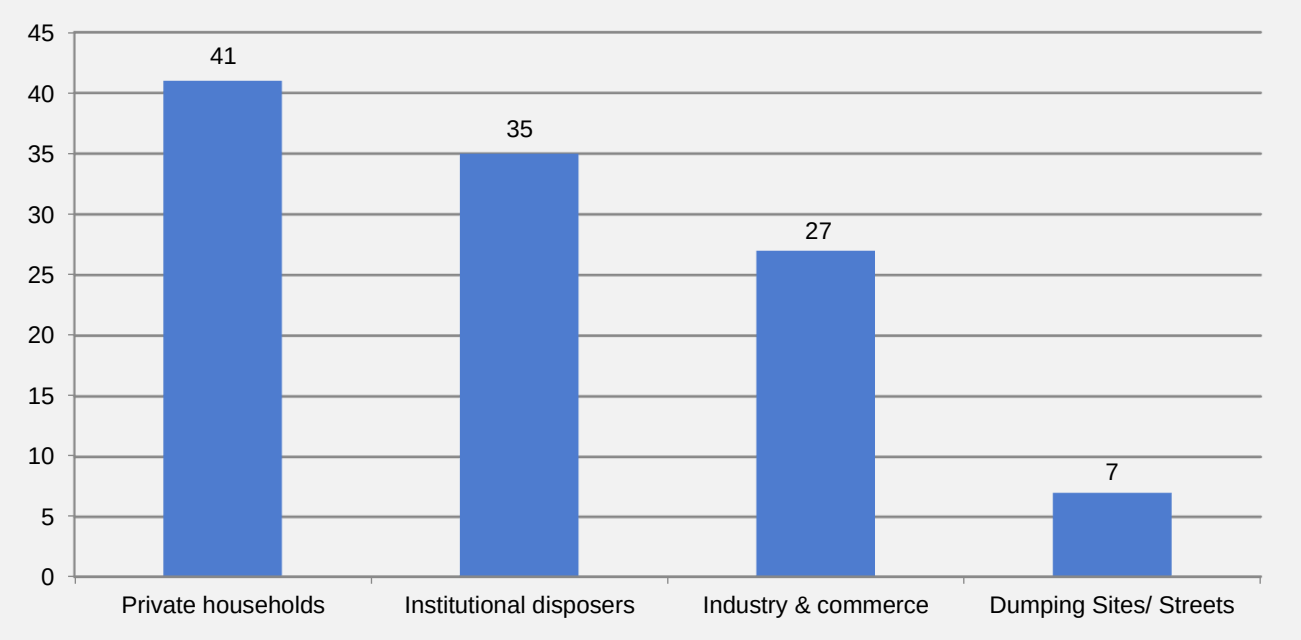

Figure 9: Sources for collection of e-waste mentioned during interviews

Private households

A wide range of e-waste items are collected from homes located in Ghana's residential areas. With many households unaware of the value of e-waste, they store, burn or sell (near-)end-of-life EEE to informal collectors. However, some households add their e-waste to the general solid waste stream in waste-bins to be collected by waste companies or sent to dumpsite. Since private households were mentioned most frequently during the interviews, it can be assumed that they represent the most significant source of e-waste in Ghana.

Institutional disposers

E-waste is collected from institutional disposers such as schools, churches, hospitals, corporate offices, educational institutions (universities), hospitals, police stations, government agencies and non-governmental organizations. Specific institutions were frequently mentioned amongst the interviewed participants. These include Ghana Highways Authority, Electricity Company of Ghana, Ghana Water Company Limited, Ghana

Investment for Electronic Communication, technical universities, Ghana Ports and Harbor. Some of the institutions have established procedures for disposing off their e-waste including auctioning[10]; where waste management companies and scrap dealers are invited to bid for e-waste. Other institutions auction e-waste together with discarded cars, vans and trucks.

Industry and commerce

A significant amount of e-waste is collected from industry and commerce. These include bulk importers of EEE such as malls (Melcom, West Hills, Accra, Nungua) but also smaller shops, restaurants, EEE repairers and various garages in the country. In addition, industries active in the saw milling and agro-processing sector were mentioned as suppliers of e-waste. Notably, small-scale mining companies were also mentioned as suppliers of e-waste, although materials from these sources appear to be mixed up with end of life vehicles (e.g. excavators and related equipment). Another source of e-waste is importers of UEEE, which were mentioned 7 out of 27 times. This comparatively low frequency indicates that most EEE does indeed enter the country as second-hand equipment and goes through another use-phase before finally becoming e-waste.

Streets and dumpsites

Some types of e-waste are disposed of together with other solid waste streams and dumped at unapproved landfill sites. Informal collectors frequently forage these sites for valuable e-waste items, which are subsequently sold to aggregators higher up the value chain. In addition, respondents mentioned that some EEE is abandoned and left to be collected on public streets.

[10] Interestingly, many of the goods auctioned are given to Type 2 aggregators who may have registered their business but may not have EPA permit. Others who have a permit also do not strictly adhere to approved recycling methods, but these institutions do not follow up to see the end of life of their waste: many are burnt and disposed of crudely after valuable fractions are extracted.

GARAGES: MAJOR E-WASTE HOTSPOTS AND THE DIFFICULTY OF DIFFERENTIATING E-WASTE AND SCRAP DEALERS IN GHANA

During the field studies, the research team observed that the various garages in regional capitals represent typical hotspots for processing and trading of e-waste. This is primarily owed to the intermingled nature of the e-waste and scraps business in Ghana: majority of scrap dealers, who mostly deal in items with metallic components, are also involved in trading a wide range of different types of e-waste and typically use basic tools for dismantling both vehicle/car scraps and e-waste. These dealers are concentrated in the various garages and source car, vehicle and other scraps from mechanics as well as used or non-functional EEE from bulk importers.

Figure 10: Typical garage dealing with e-waste and other scraps in Ghana; © Ebenezer Kumi

3.2. Collection

With regards to the specific collection mechanisms, the E-waste Management Guidelines distinguish between tier 1 and tier 2 collectors (aggregation points/buy back centers). During the in-field data collection, the E-MAGIN project team gained the impression that such distinction may be suitable for defining legal responsibilities but does not provide an adequate reflection of informal collection networks. Often times, it appears difficult to distinguish between tier 1 and tier 2 collectors, especially since formalization of the sector is still in an early stage of development and most collectors are not (yet) formally registered. Hence, this study

proposes a three-fold classification system (see text box below), which hopes to produce a more fine-grained illustration of prevalent informal collection mechanisms in Ghana.[11]

The amount of e-waste collected or aggregated by informal MSMEs varies significantly and largely depends on their position in the value chains as well as the collection systems employed. During the rapid assessments, refrigerators (2.3 tons), Personal Computing units (2.2 tons) and Air-Conditioning (AC) appliances (1.6 tons) were found to account for the largest volumes per month (see figure below).

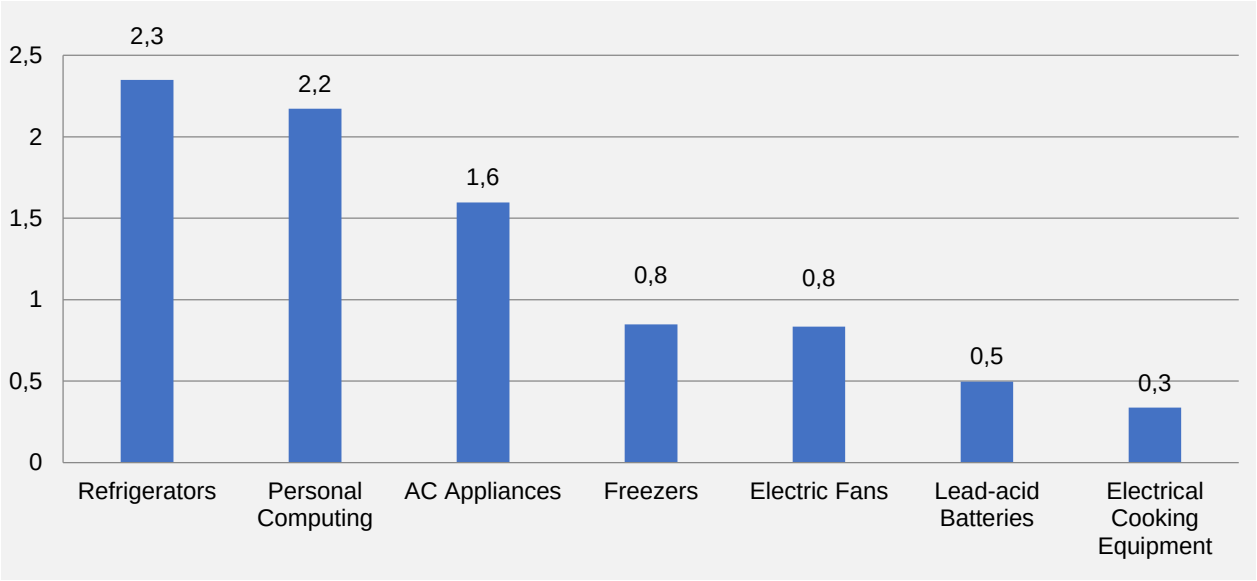

Figure 11: Average amounts of e-waste collected by informal workers (tonnes/month)

Although the major incentive used by most e-waste collectors is monetary, some respondents mentioned that informal relations and trust play a key role; in fact, many households and institutions prefer to reserve their e-waste for a handful of loyal collectors. Scrap dealers highlighted that there are no fixed prices for e-waste items, but prices are negotiated depending on the owners bargaining power and knowledge of the valuable fractions contained therein. The assessment of price structures for selected e-waste types was a central part of the in-field data collection. The findings can be seen in Table 2. The price ranges support the notion of heterogeneous price determination, as a wide spread can be observed within the values. Furthermore, the varying conditions that the e-waste types are found in also affect the pricing range, as interviewees at times gave price ranges depending on the state of the collected e-waste (e.g. fridges with or without motor). The table below displays prices in the formal sector, which are derived from the accounts of one of the E-MAGIN consortium members, City Waste Recycling. A comparison of both tables reveals that prices for e-waste in the informal sector tend to be higher than in the formal sector.

[11] A similar typology was originally developed and proposed by Kabdadiwalla Connect, an Indian social enterprise, which seeks to empower collectors of the informal sector through a data-driven approach; for more information, please refer to https://www.kabadiwallaconnect.in/

Table 2: Prices of common e-waste types in Ghana traded in the formal and informal sector

E-waste type	**Informal sector**			**Formal sector**		
	Price range per piece (GH₵)		*Average price per piece (GH₵)*	Price range per piece (GH₵)		*Average price per piece (GH₵)*
	Min	Max		Min	Max	
Fridge	10	100	*27*	2	20	*11*
Freezers	20	100	*49*	6	20	*13*
Cooking equipment	10	45	*15*	1	4	*2.5*
Electric fans	1	50	*8*	0.5	2	*1.25*
AC appliances	50	200	*105*	12	20	*16*
TV sets	5	50	*8*	1	2	*1.5*
Personal computing	5	30	*15*	5	20	*12.5*
Washing machine	7	70	*26*	5	12	*8.5*
Microwaves	3	15	*8*	1.5	2.5	*2*
Cellular telephones	0.3	3	*1*	1	2	*1.5*
CRT Monitors	3.5	20	*8*	0.5	1	*0.75*

Another important aspect of the e-waste collection process is the dynamic relationship between EEE repairers and aggregators. Aware of each other's works, aggregators constantly visit repair shops to enquire about non-repairable gadgets. Repairers on the other hand regularly visit scrap yards in search of valuable parts of gadgets that can be used to repair other machines. Besides those visits, repairers or refurbishers are also key players in determining the price of different e-waste components as they create demand for spare parts. Notably, most representatives from informal MSMEs (mainly type 1 and type 2 aggregators) belong to some loose scrap dealers' association with few registered as a company, partnership or sole proprietorship with the registrar general. Moreover, few keep records with many mentioning that they keep waybills and receipts of sales made in Tema and Accra.

TOWARDS A TYPOLOGY OF INFORMAL STAKEHOLDERS IN GHANA

Type 0 Aggregators – *Condemn*: These are informal collectors popularly known as *"condemn"* (owing to the way they attract attention vocally by shouting "condemn!") who wear simple clothing and move around residential and commercial areas with handcarts in order to purchase or pick up idle scraps and e-waste. The may work individually or in pairs, visiting dumpsites and sifting through waste with sticks and metal rods to find valuable e-waste. Mostly travelling to outskirts of towns, they aggregate purchased or collected e-waste and transport them by handcarts to a scrap yard for dismantling. In other cases, when the e-waste aggregated cannot be transported by their handcarts due to the quantities involved, tricycles and mini-trucks are hired to collect waste on behalf of Type 1 or 2 Aggregator. Characteristically, many informal e-waste collectors are youthful migrant men (emigrating from Northern Ghana, Burkina Faso, Niger and beyond) with low formal education seeking better job opportunities. Often, they enter the e-waste business as collectors due to its relatively low capital requirement – an average locally made handcart costs approximately GH₵ 400.

Figure 12: Type 0 Aggregator in Accra; © Ebenezer Kumi

Type 1 Aggregators – *Small, small*: This group may be termed "*small, small"* (reflecting their ambition to start small and grow large over time) and represent former Type 0 Aggregators who have substantially increased their capital base and grown their business to become aggregators of larger quantities over time. These aggregators have temporal arrangements with few collectors who supply them with e-waste. At their relatively small yards (typically makeshift sheds) they engage in and oversee manual dismantling of e-waste using basic tools such as chisel, hammer and screwdrivers, and regularly burn cables to recover vital fractions. They typically focus on handling few vital fractions such as aluminum, iron or may focus exclusively on dismantling and recovering printed circuits boards (PCBs) from computers, laptops and DVDs. Valuable fractions are typically sold to Type 2 Aggregators or plastics granulators within close vicinity.

Figure 13: Type 1 Aggregator in Cape Coast; © Ebenezer Kumi

Type 2 Aggregators – *By his Grace*: These informal stakeholders may be termed "*By His Grace"* (after a name of an aggregator in Volta Region who epitomizes this group) and typically have well-constructed or established workshops as a base of operations. They are comparatively large scrap dealers who have a sizeable number of collectors under their supervision from whom they source e-waste in large amounts. In addition, they bid for scraps during auctions from (for instance) Electricity Company of Ghana, Ghana Water Company, schools and other formal institutions. Just as Type 1 Aggregators, Type 2 Aggregators mainly dismantle through basic tools such as chisel, hammer, and screwdrivers. However, since their capital base is larger, many Type 2 Aggregators buy and dismantle larger varieties of waste types, including scraps of car, vehicle and heavy-duty construction machines such as excavators. In such cases, Type 2 Aggregators hire and use more advanced technologies such as laser cutting machines for dismantling. Some Type 2 Aggregators are formally registered businesses and do adhere to certain (informal) safety standards (e.g. simple protective equipment) but commonly apply malpractices such as open burning of cables.

Figure 14: Type 2 Aggregator in Ho; © Ebenezer Kumi

3.3. Recovery

When e-waste is collected, it is sent to a scrap yard or e-waste company for recovery and further processing. In Ghana, several methods – from basic to advanced recovery processes – are used to recover vital fractions from e-waste. Both Type 1 and 2 Aggregators hardly adhere to safety standards in the recovery processes and frequently burn indiscriminately to retrieve copper and other valuable metals. Moreover, their workspaces are often unplanned, crowded and unhygienic with virtually all their dismantling techniques and procedures self-taught. Without any formal training or apprenticeship, scrap dealers hardly wear protective clothing, gloves and boots, thus exposing themselves to various hazards and dangers.

In addition, during the recovery process, e-waste is not treated in any significant way with some interviewee's describing their experiences with dangerous explosions from e-waste and scraps they had less knowledge of. To reduce this danger, some aggregators mention that they have resolved to dismantle only electronics that they are familiar with or only burn e-waste fractions at specific times of the day to supposedly avoid environmental hazards. Nonetheless, many dismantlers have passed on crude techniques to their apprentices over time. Among such techniques include basic methods used to detect and separate different metal types. For instance, one aggregator mentioned that he taught all his apprentices how to identify metals by using simple techniques: steel when it attracts a magnet; copper when a scratch reveals red color, aluminum when a scratch reveals whitish color; and brass if the color beneath the scratch is yellow.

"I burn at night to minimize pollution."
- Informal scrap dealer in Koforidua

Aside Type 1 and 2 aggregators, there are few registered waste or e-waste companies such as Zoomlion Ghana Limited (and its 10 regional subsidiaries); City Waste Recycling, Presank, Blancomet, Atlantic Holding, Zoil Ghana who engage in different recovery process such as manual and technical dismantling, cable shredding or stripping, fridge degassing, and plastic granulation. Such companies have relatively clean and structured workspaces and adhere to some health and safety standards. They also have EPA permits to recover and process different waste types. But just as Type 1 and 2 Aggregators, many companies struggle with disposing problematic and invaluable fractions such as glass, television plastic casing, and fridge foams among others.

3.4. Sales

The figure below displays the final off-takers of processed fractions which were explicitly referred to during the interviews. The size of the blocks is proportionate to the number of interviewees who mentioned the company listed during the conversations. Tema Steel Co. Ltd. was the company most often referred to as a destination of collected e-scraps of the MSMEs, followed by Ferro Fabrik. Notably all of these companies are listed to operate within Tema and if not, they are situated in the Greater Accra region, showcasing the relevance of the

region in the value chain. Notably, these off-takers are mainly active in the processing of steel and iron, while processors of other components were generally not named by the interviewees.

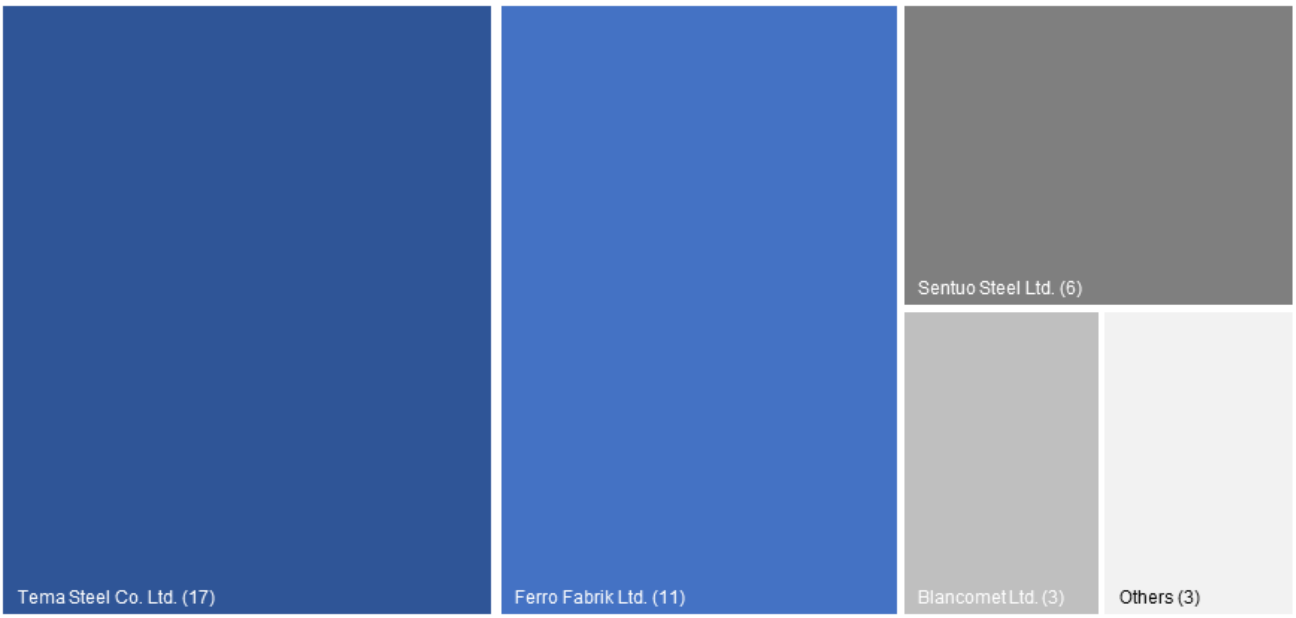

Figure 15: Off-takers of e-waste mentioned by MSMEs

Other stakeholders in the e-waste recovery process are plastics granulators. Many plastic granulators may originally be Type 2 aggregators, who have accumulated enough capital to purchase a plastic granulation/ crushing machine. They sort out valuable plastics that come with e-waste for crushing. Other popular valuable plastics from other sources such as plastic chairs, bowls, and drink crates are also crushed and added. Crushed and granulated plastic is sent to plastic recyclers for recycling to secondary raw materials such as construction materials (fencing and plastic posts) and other plastic products including chairs and benches.

The amounts of e-waste fractions sold per month by MSMEs vary significantly across the data sample, depending on their position in the value chain and the specific activities carried out for dismantling and (pre-) processing. During the rapid assessments, iron/steel, aluminum and copper were found to account for the largest volumes sold per month. For more information, please refer to the subsequent figure below.

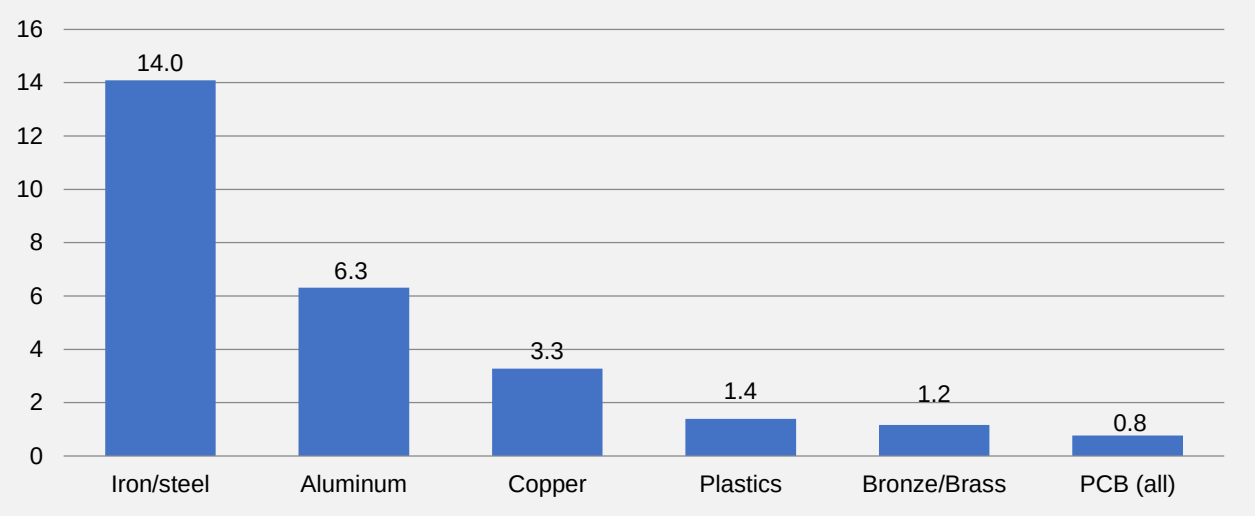

Figure 16: Average amount of e-waste components sold by scrap dealers (tonnes/month)

Processed e-waste in the form of different recovered valuable fractions is either sold locally or exported to foreign or parent companies of recyclers abroad. An overview of prices for the components can be seen in the table below. The data suggests a high variance in sales prices for e-waste components recorded by MSMEs. It should be noted that prices of components are given in different units and quantitative references, influencing the price variance of (e.g.) aluminum, copper or plastics. Hence, sales prices for e-waste across the MSMEs are rather heterogeneous along the value chain, depending on size and bargaining power of the enterprise. When compared to prices for processed e-waste components in the formal sector, prices in the informal sector are usually higher, the sole exception being copper. Moreover, price ranges tend to be larger, suggesting higher qualitative differences in the components sold on the informal market.

Table 3: Prices of processed e-waste components in Ghana in the informal and formal sector

E-waste component	Informal sector			Formal sector		
	Price range per kg (GH₵)		*Average price per kg (GH₵)*	Price range per kg (GH₵)		*Average price per kg (GH₵)*
	Min	Max		Min	Max	
Aluminum	2.2	18	*4.20*	1.5	3.8	*2.65*
Iron/steel	0.14	10	*1.50*	0.2	1.2	*0.70*
Copper	16	25	*21.60*	20	24	*22.00*
Plastics	0.6	1.8	*1.15*	-	-	-
Bronze/ Brass	2.5	20	*14.00*	6	7	*6.50*
Stainless steel	0.7	5	*2.9*	n/a	n/a	*n/a*
PCB Type 1 (DVD)	8	16	*9.40*	n/a	n/a	*n/a*
PCB Type 2 (PC)	12	40	*20.00*	n/a	n/a	*n/a*
PCB Type 3 (Mobile phone)	18	60	*35.00*	n/a	n/a	*n/a*

When analyzing sales data on revenues generated by different fractions, it can be observed that the e-waste business roughly follows the 80-20 rule: about 20% of fractions constitute 80% of the MSMEs business by turnover. This can be attributed to the fact that those fractions, which were the most frequently mentioned for sales (including aluminum, iron, copper, bronze/brass, stainless steel, PCBs and batteries), have a proportional share of roughly 80% of all the entries recorded. This emphasizes a focus on valuable fractions, while neglecting other fractions. Scrap dealers thus go after the 20% of vital fractions which often leaves the remaining 80% packed, dumped or burnt (see figure 17 below).

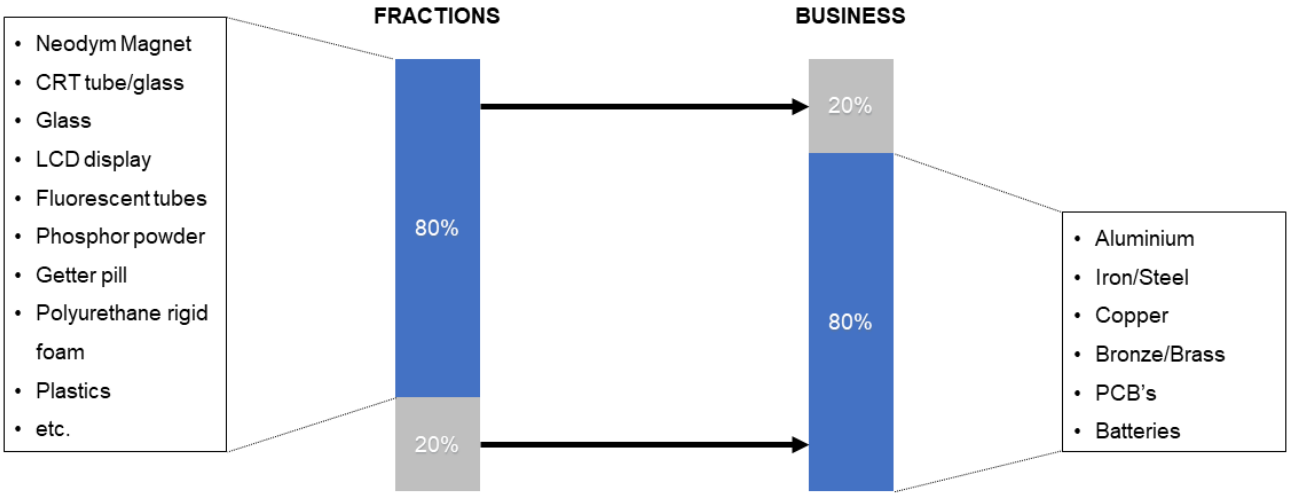

Figure 17: 80-20 principle of e-waste business in Ghana

3.5. End-processing

All vital fractions recovered by aggregators are sorted, weighed, packed or transported for sale to e-waste companies, recyclers, foundries, smelters or exporters. Subsequent unwanted components are disposed mainly in two ways:

1) **Dumping**: Waste that is dumped mainly consists of unwanted metal components that cannot be burnt easily. Scrap dealers gather these components and send them to municipal waste bins, authorized or unauthorized dumpsites nearby. Small amounts of GH$ 10-50 are occasionally paid at dumpsites to caretakers. Many companies on the other hand send their unwanted fractions to authorized and engineered landfill sites at outskirts of towns and cities.

2) **Burning:** Flammable unwanted fractions such as plastics, wood, paper, foams and cartoons are regularly burnt in areas close to scrap yards, at the roadsides or in the middle of residential areas. Burning mainly serves the purpose of retrieving valuable components (e.g. copper from cables) while also reducing the physical volumes and space required for final disposal.

Different companies have specialized in buying different components based on the technology they possess for end-processing. This includes local smelters, foundries and plastic recyclers, which are concentrated in Tema due to the cluster of both light and heavy industries in that city. Common components (e.g. iron) are used by these local smelters, foundries and recyclers for making iron rods, corn mill plates and several other steel-based items. Recovered aluminum is recycled into aluminum sheets, gate designs, cooking pots, cook stoves and other aluminum-based household items. Crushed and granulated plastic is used by local plastic recyclers in making plastic chairs, bows etc. by using simple extrusion machinery. In addition, more valuable components (e.g. PCBs, capacitors and batteries) are exported due to the lack of technology in recycling such fractions in Ghana. Again, with Tema boasting of the biggest harbor, most of the companies purchasing fractions that are exported are found in Tema, with others in Takoradi and Accra.

Interestingly, key actors mediating between scrap dealers and end-processors (local buyers and exporters) are "***scrap agents"***. In all regions, respondents mention that scrap agents have been appointed by some companies to facilitate the sale process. Without agents, many scrap dealers mention that it is impossible to sell directly to companies. Yet, agents were derided by scrap dealers as profiting unduly from the scrap business. As many exporting companies are hesitant to conduct interviews it was difficult to ascertain the real motivations for engaging agents. Nonetheless, one agent mentions that with a multitude of informal scrap dealers, most foreign companies prefer to deal with agents who can communicate and simplify the trading process.

4. IMPROVING THE VALUE CHAIN

4.1. Challenges

Impacts on human health and the environment

During data collection, respondents mentioned several challenges encountered in the e-waste business. While there is a basic level of awareness amongst scrap dealers and local policy makers regarding the negative impact of crude e-waste handling on human and environmental health, malpractices continue to be widely present. MSMEs mentioned the physical injuries associated with manual stripping of cables and other scraps without wearing personal protective equipment, handling of lead acid from car batteries and inhaling toxic fumes from open burning of e-waste fractions. Moreover, the responses indicated that the burning of certain plastics with hazardous chemicals is observed to cause respiratory diseases and skin deformities, thus negatively impacting the health of the scrap dealers. From the environmental perspective, some scrap dealers are also aware of the negative impacts of disposal of harmful components into water bodies and dumpsites resulting in water and air pollution.

Lack of awareness by MSMEs

However, some responses also indicate that the understanding of such polluting practices and knowledge about mitigation strategies is still very limited. For instance, one respondent explicitly referred to the hazardous nature of "inhaling copper substances". Other MSMEs mentioned that in order to avoid pollution they have chosen to burn at specific off-peak days and times, e.g. on Sundays or at midnight. Few respondents even admitted engaging in extremely hazardous processing practices dismantling e-waste/scraps with dynamite; in addition, they may be exposed to pesticides, which are applied as insect repellants around their workshops. Notably, even though some MSMEs reported to engage in dismantling of cathode-ray tube (CRT) monitors and fluorescent tubes, none of the respondents mentioned exposure to toxic substances such as lead, cadmium, barium or fluorescent powders.

Although Act 917 has been passed two years before the field study, the majority of scrap dealers interviewed were not aware of any e-waste laws and regulations, except for few who have participated in other donor-funded e-waste projects. Local policy makers on the other hand are very aware of waste laws and regulations both nationally and locally and the informal e-waste practices in their municipality such as burning; yet in all regions, there are few local government initiatives aimed at addressing the challenge of e-waste.

"Boss, the business is good, but the problem is the 'make ready – money'."

- Informal scrap dealer in Bolgatanga

Difficulties in gaining access to finance

Various MSMEs reported that they are constrained by their small capital base and lack of access to financing support. Type 2 aggregators particularly explained that the nature of the scrap business – paying cash

instantly to suppliers of e-waste – means that they always must have larger sums of money readily available. Aside the working capital, some respondents mention that they are seeking capital to expand their business or purchase vehicles and machinery. Others need capital to rent or buy larger lands or to build more durable and spacious workshops. Required capital investments in the range of GH₵ 20,000 to 60,000 were mentioned. Many agreed that the challenge of access to financing for scrap dealers is compounded by the fragmented and informal nature of their businesses which is perceived as highly risky by lending institutions. In addition, virtually all scrap dealer associations do not only lack financial resources but also lack proper organization and credibility to negotiate with financial institutions for loans on behalf of their members.

SAMPLE TRANSPORTATION COST

Double-axle truck carrying scraps (39 tonnes max.) from Tamale to Tema as given by a scrap dealer in Tamale

ITEM	COST (GH₵)
Transportation	3,500
Waybill from Tamale Municipal Assembly	20
Boankra scale	300
Yape scale	100
Offinso scale	200
Bribes	200
TOTAL	**4,320**

Cost of logistics

A frequent challenge mentioned is the cost of transportation. In all regions (except Accra) respondents complained about the cost of transporting waste to scrap yard and the cost of transporting processed waste to buyers mostly in Accra and Tema. Many mentioned that transportation cost constitutes up to 50% or more of their operating expenses. They repeatedly mentioned that in addition to the high costs for logistics, bribes and intimidation by police and customs on their way drastically reduces their profit. In addition, many interviewees identified an emerging problem of third-party agents at many recycling and processing companies who buy valuable components. Accordingly, scrap dealers need an "agent" to complete the sale of their goods or are otherwise unable to conduct business.

Informal nature of the e-waste business

Another major challenge mentioned is the low level of organization and documentation of the scrap business. Many respondents pointed out that due to the loose and informal nature in which the scrap business is conducted, local government authorities mainly perceive them as nuisance. For instance, e-waste dealers hardly keep proper documentation on inflows and outflows of e-waste and revenues. Although the majority of them have a rough sense of what they make in the business, they do not keep consistent records. This worsens the already bureaucratic registration procedures meant to streamline their activities. They add that they lack coherent technical, business and safety training, which hinders an understanding for formal documentation processes. Notably, many agreed that due to the informal nature of the e-waste business, they struggle to identify unscrupulous e-waste dealers who engage in selling and buying of stolen WEEE.

"In this scrap business, you must be suspicious of items, they are mostly stolen."

- Informal scrap dealer in Koforidua

Absence of a level playing field

In all regions, a problem commonly mentioned by informal scrap dealers was the growing unfair competition in the scrap's trades from third-party middle men and involvement of non-Ghanaian stakeholders. According to the interviewees, actors from nearby states enter the scrap business sector with significantly higher capital assets, giving them an upper hand over local stakeholders. Moreover, they are not part of any of the regional scrap dealer associations and therefore do not adhere to any standards postulated by these associations onto their members. Formal recyclers on the other hand complain about the lack of treatment of e-waste by informal scrap dealers during processing which puts them in an uneven playing field; with cost favoring the informal sector.

4.2. Solutions

Upgrading infrastructure for e-waste management

Respondents also enumerated the possible solutions for some of the challenges mentioned above. With regards to the hazardous nature of the business, upgrading the infrastructure in the e-waste sector was one of the most often mentioned solutions. In particular, the establishment of various recycling and processing facilities in the different municipalities was seen as a key objective in adjusting regional capacity discrepancies. Most end-of processing units are situated in Greater Accra, which implies a dependence of regionally operating stakeholders on longer transportation routes to financially benefit from collected e-waste materials. To counteract this effect, interviewees suggested the creation of e-waste buy-back centers in different municipalities. Furthermore, some stakeholders also recommended the provision of safety equipment and collection vehicles and called for the free allocation of land for regionally operating scrap dealers associations. Some also advocated for building more engineered dumpsites, which would allow for safe long-term disposal of unwanted e-waste fractions.

Facilitating access to finance

Another frequently mentioned request for support was to improve access to financial capital for stakeholders operating in the e-waste sector. For example, respondents would often call for the provision of loans with lower interest rates for recycling companies. Such ideas were elaborated on by other respondents, which suggested access to government facilitated loans from the private sector for investments into capital goods such as a scrap compressing machine. Large industrial recycling machinery is highly capital intensive but entails a range of benefits for the overall recycling process. Moreover, respondents also expressed the need for financial incentives and standardized pricing for e-waste items and fractions to allow for more sustainable practices. In one specific case, a respondent recommended the establishment and coordination of a trading scheme for dismantled and recovered fractions similar to the model of cocoa beans trading in Ghana where there are recognized buyers who offer producers standardized prices.

Technical support for informal collectors and dismantlers

Provision of technical training was another frequently mentioned support component. In this context, respondents called for training sessions for informal collectors on e-waste dismantling by experienced electronic gadget repairers or glass manufacturing companies. This would also entail basic occupational health and safety procedures to prevent injuries, e.g. by demonstrating the use of safe dismantling techniques, improving the practices of hand washing for hygienic purposes and the application of personal protective equipment (e.g. safety boots).

Enforcement of laws and regulations

A lot of respondents reported that their operations would benefit greatly from creating a level playing field across the e-waste sector by enforcing laws equally amongst all stakeholders. First and foremost, formalization procedures and registration processes should be simplified to assist scrap dealers in avoiding challenges associated with informality (e.g. potential handling of illegal/stolen e-waste and issues with local authorities). This could be complemented by the provision of technical support from local authorities or educational institutions (e.g. universities) to clearly outline the requirements of the registration process. Further support could be provided by facilitating the set-up of formal scrap dealer associations and the designation of "formal scrap agents" to create transparency and facilitate transactions with recyclers and end-processors. In one particular instance an interview candidate called for the development and implementation of a material recovery and recycling policy.

Awareness creation and education

Some interview candidates highlighted the importance of awareness creation and education of the public to change the general attitude on waste segregation and disposal. Segregation at the source was perceived as a key solution to avoid mixing e-waste with general household waste stream to aid effective recovery. In one case, a respondent referred to disposal practices by hospitals which indiscriminately mix and burn e-waste together with other types of waste, thus making recovery of valuable components difficult. Looking at the business of scrap dealers, respondents called for practical public education on the dangers of e-waste processing by using promotional films, drama and other creative media. This should also engage a wide range of actors, such as schools, universities and government agencies to increase both outreach and effectiveness.

5. CONCLUSIONS AND RECOMMENDATIONS

Drawing from the numerous discussions with MSMEs and policy makers dealing with the e-waste sector, a number of conclusions and action points for improving the Ghanaian e-waste value chain may be considered.

Upgrade infrastructure and allocate land to develop designated e-waste processing zones and streamline monitoring and enforcement.

In the view of policy makers and government representatives responsible for implementation, monitoring and enforcement, the provision of permits was often perceived as a key stepping stone for formalization; however, it merely presents one part of the solution. During the field studies, it was observed that more than 90% of informal scrap dealers currently live in makeshift and unauthorized sheds which lack space to safely dismantle and store e-waste upon processing. Upgrading such facilities by providing adequate technical structural specifications and financial support is an important prerequisite for formalization.

The first step in formalizing the operations of informal scrap dealers could begin by facilitating the acquisition of land for scrap dealers by local authorities. Providing access to land would encourage informal scrap dealers to set up spacious and improved facilities for their business. Such facilities could be developed by scrap dealers in collaboration with local authorities and designated as "e-waste industrial zones" or "e-waste processing hubs". Centralizing e-waste business to designated localities would simplify and streamline monitoring and enforcement and further aid in taxation purposes. For instance, the Koforidua Scrap Dealers Association has been allocated land by the New Juabeng Municipal Assembly. Other municipalities can follow suit and develop similar approaches for areas falling under their legal responsibility.

Offer incentive schemes and provide monetary support to avoid cherry-picking of valuable fractions and promote expansion of collection infrastructure.

The evaluation of rapid assessments suggests that roughly 20% of vital fractions make up 80% of what is traded in the e-waste business (see chapter 3.4) This means scrap dealers mostly go after the 20% of vital fractions which often leaves the remaining 80% packed, dumped or burnt. Efforts to boost and expand the e-waste business in Ghana should therefore focus on addressing the 80% of non-vital or negative fractions and provide the technical and financial support/incentive for their management. To address this, MESTI and local municipalities may promote innovative business solutions that use 80% of negative fractions for valuable inputs and products. For instance, since CRT's and plastic cases from televisions sets are currently deemed non-vital, the Eco Levy and other incentive schemes (tax breaks, business awards etc.) could be used to support businesses that innovatively use fractions for useful products. Focusing on this 80% so-called negative fractions and turning them into useful products will not only increase the profitability of the e-waste business but also reduce burning and pollution.

Yet, some e-waste fractions have a negative economic value and cannot be recycled at a profit. In such cases, the Eco Levy should be fully applied in order to finance processing operations and/or allow shipments of such

fractions to foreign treatment facilities. One option is to use funds from the collection of the Advance Eco Levy of which 5% is to be dedicated to innovative research projects rolled out via universities and research institutions. This emphasizes the importance of due diligence for a structured disbursement of the Advance Eco-Levy in order to support MSMEs in growing their business and advancing the treatment capacities of the sector as a whole. In any case, equitable disbursement of the Advance Eco Levy will be paramount and needs to follow transparent criteria.

All local regulators (either regional EPA directors or municipal/metropolitan waste officers) interviewed are aware of informal e-waste dealers and their practices such as collection, crude processing and burning of unwanted fractions, yet, none of the local authorities has initiated an intervention to address the challenge. Meanwhile, local authorities have been empowered under L.I. 2250 to begin local initiatives. Sub-regulation 9(4) of L.I.2250 states that *"A District Assembly may establish or facilitate the establishment of collection center and a take-back system".* This presents a clear opportunity for local authorities to initiate their own innovative municipal/community e-waste programs and take-back centers.

Foster formation of scrap dealer associations and streamline registration procedures to accelerate formalization and strengthen their bargaining power.

Interactions with informal scrap dealers often demonstrated that many are hesitant to take the initiative in registering with their respective local assemblies. Many complain of lengthy and bureaucratic procedures in attempting to register their business at the local level. To this effect, MMDA's could simplify registration and documentation procedures and encourage the scrap dealers to join formal sector associations for better and collective service. To do this, Waste Management Departments in MMDA's could form "E-Waste Teams" made up of national service personnel who could be deployed to various locations with simple forms to register and collect informal waste collectors' data at their places of work. For such an exercise to be successful, assemblies must work and collaborate with leaders of existing scrap associations to ensure inclusiveness and ownership.

Create awareness and strengthen monitoring and enforcement of laws to create a level playing field amongst all actors in the e-waste value chain.

Majority of scrap dealers interviewed were unaware of Act 917 and LI 2250 and their responsibilities thereunder. As the key government agencies for the implementation of Act 917 and LI 2250, MESTI and EPA hold the responsibilities for supervising, certifying, monitoring and enforcing different stipulations. To ensure effectiveness of these tasks, working together and creating awareness on the roles and responsibilities of various e-waste stakeholders will be key success factors. These awareness raising events can take the form of workshops, trainings and roadshows for importers, consumers, e-waste MSME, transporters and other stakeholders along the e-waste value chain.

Scrap dealers also perceived unfair foreign competition as a major threat to their business. To promote healthy competition that opens the e-waste sector for innovation while promoting the creation of local jobs, existing guidelines need to be communicated more clearly to both Ghanaians and non-Ghanaians who seek to enter the

e-waste business in Ghana. Enforcement of applicable laws needs to be ensured so that all entrepreneurs and MSMEs operate within the legal ambit of Act 917 and LI 2250. This will create a level playing field and deter informal MSMEs from applying malpractices, such as open burning of cables or draining lead acid batteries.

During the data collection, it was observed that garages are major hotspot of e-waste with many dealers in car/vehicle scraps doubling as e-waste dealers. With such interconnected nature of the car scraps[12] and e-waste business, approaches to regulating the management of these two waste streams needs to be addressed in a holistic fashion, e.g. by also incorporating EPR approaches for the management of end-of-life cars/vehicles.

Offer technical support in line with good business and e-waste management practices through provision of trainings by actively engaging scrap dealer associations.

Data collection revealed that very few e-waste MSMEs keep consistent records of their business. Yet, to register their business and improve on their processes, scrap dealers must begin to develop the culture of keeping simple business records. These records are key in accurately determining their inflows and outflows and identify profit potential in a structured manner. Keeping company records would also allow scrap dealers to access finance and benefit from government programs as they can enable MSMEs to verify their profitability and convince lending institutions to provide loans where they would otherwise be risk-averse. To this effect, scrap dealer associations can be employed and transformed into "knowledge centers" for good business practices. They can educate their members and encourage them to keep records. With the help of local authorities or donor and private projects, scrap associations could design simple record keeping forms for their members, train members on how to use them and monitor usage.

"I have trained and worked with over 10 people who have set up their own scrap yards now."

Scrap dealer in Tamale

Most scrap dealers expose themselves to hazards during collection, processing and disposal of e-waste. Beyond record keeping, scrap associations need to promote fundamental environment, health and safety practices among their members such as wearing of protective and durable clothes, gloves and goggles during work. Associations could also prescribe specific clothing for their members to aid identification and improve their legitimacy. Moreover, as was evident from responses of scrap dealers, many hold misconceptions about the danger of some e-waste components and lack a basic understanding of what constitutes environmental and human dangers. For instance, a significant proportion of scrap dealers believe that burning waste on Sundays at midnight or places far from human habituation have no negative effect. Such misconceptions need to be corrected by associations through training programs for their members and potentially by their members.

Members of the Ghana Electronic Services Technicians Association (GESTA) mentioned that due to the falling prices of both new and imported EEE, consumers increasingly prefer to buy new items instead of repairing old

[12] Vehicle components such as interior electronics, wires, catalytic converters and battery components are all considered e-waste in Ghana

ones. Rather frequently, consumers do not come back for their repaired items and instead choose to buy new ones, thus leaving repair shops with discarded items some of which are repaired but have not been paid for. As a consequence, repairers run out of space for storing uncollected discarded items and become the final point of disposal for EEE consumers. To free up their storage space and improve their income simultaneously, GESTA could encourage those members who possess technical dismantling skills already to set up "apprentice dismantling programs" where apprentices spend a percentage of their time every week dismantling e-waste. The revenue that is generated from selling e-waste components could boost GESTA member's profitability and drive the development of the association as a whole.

ANNEX 1: Interview Guide

E-MAGIN Ghana: SWITCH Africa Green Project – 2018

Questionnaire for MSMEs (Collectors, Refurbishes & Recyclers)

Date:	Location:	Survey No.

Note to the interviewer: Please be encouraged to take notes of your observations during your visit at the respective enterprise. Especially of interest is the section of human and environmental health (2.2 & 2.3) to see if safeguards are in place.

INTRODUCTION
We are collecting data for e-waste Value Chain Assessment in Ghana as part of the E-MAGIN Project funded by the European Union. The project supports MSMEs to improve management of e-waste in Ghana. **All collected information will be treated confidentially and the results will be published in a way that cannot be traced back to your person/ business.**

GENERAL INFORMATION about Enterprise	
Name of Enterprise/ Organisation	
Location/ Address	
Number of employees	
Year established	
Name and function of contact person	
Telephone	
E-mail	
Main activity	
Age range	
Hometown	

DEFINING E- WASTE
What types of e-waste is your enterprise dealing with? How would you describe your area of work? List the types of e-waste activity you are engaged in?

1	COLLECTION of Waste Electrical and Electronic Equipment	
1.1	**Where do you get your e-waste from?**	☐ Households ☐ Institutions (schools, churches, offices etc.) ☐ From the street ☐ Dumpsite ☐ Other(s) Please specify.....
1.2	**Is there a specific location where you collect e-waste from?** *Are there hotspots for collection of e-waste?* *Have you arranged your target area with other companies?* *Note to interviewer: Indicate collection/ operating area on map.*	
1.3	**How does your enterprise collect e-waste?** *Which stakeholders are involved?*	
1.4	**Which strategies do you use?** *What incentives do you use in collecting e-waste?*	
1.5	**Do you cooperate with other companies/ authorities for collection purposes?** *If yes: please name them and their function*	☐ YES ☐ NO
1.6	**Is there competition with other companies for the collection of e-waste?**	☐ YES ☐ NO
1.7	**Are there other initiatives in your area that focus on e – waste you know of?** *If yes: Is there any cooperation with these initiatives?*	☐ YES ☐ NO
1.8	**How do you transport collected e-waste to your site?**	

2	PROCESSING of Waste Electric and Electronic Equipment	
2.1	**Which processes does your enterprise carry out?**	☐ Refurbishment ☐ Sorting of products ☐ Manual dismantling ☐ Shredding ☐ Separation of (shredded) fractions ☐ Cable stripping/granulation ☐ Burning (e.g. cables, cases) ☐ Leaching (e.g. printed wiring boards) ☐ Other(s) Please specify:
2.2	**Does your enterprise cooperate with other enterprises in the processing of Waste?** *If yes: Please name them and their field of operation*	☐ YES ☐ NO

2.3	**Is there competition with other enterprises?** *If yes: Please name them and their field of operation*	☐ YES ☐ NO
2.4	**Are you aware of any impacts on human health from the work with electronic waste?** *If yes: Do you take actions to prevent them?*	☐ YES ☐ NO
2.5	**List any sickness /ailment that you or any other person might have contracted on the job (related to e-waste)**	
2.6	**Are you aware of any environmental impact caused by the work of your enterprise?** *If yes: What actions do you take to prevent/ minimize them?*	☐ YES ☐ NO

3	SALES of treated/ processed E-waste	
3.1	**To whom do you sell your finished products (raw materials, refurbished appliances etc.)?**	
3.2	**What do you do with other parts of e-waste that cannot be refurbished or sold?**	
3.3	**Are there costs for the disposal of these parts?** *If yes:* *1. Please state the types disposed off* *2. The estimated cost associated with disposal.*	☐ YES ☐ NO

4¤	GENERAL·information¤	
4.1¤	**Apart·from·e-waste,·which· other·materials·is·your· enterprise·working·with?¶** *e.g.·scrap·metals,·paper,·plastic,· etc.¤*	¤
4.2¶ ¤	**Do·you·keep·records·of·your· activities?¶** *If·yes:·How·do·you·do·it?¤*	☐···YES¶ ☐···NO¶ ¤
4.3·¤	**Is·your·business·registered· with·the·registrar·general's· department?¤**	☐···YES¶ ☐···NO¶ ¤
4.5¤	**Is·your·business·registered· with·the·EPA?¶** *If·yes:·Could·you·explain·the· registration·process?¶* ¤	☐···YES¶ ☐···NO¶ ¤
4.6¤	**Is·your·enterprise·a·member·of· any·association·or·body·of· recyclers·or·collectors?¶** *if·yes:·name·of·body/association?¶* *If·yes:·what·are·the·benefits·of·this· membership?¶* ¤	☐···YES¶ ☐···NO¶ ¤
4.7¤	**Are·you·aware·of·any·national· laws/·regulations·that·are· important·for·your·business?·¶** *If·yes:·does·the·law/·regulation· have·any·effect·on·your·business?¶* *Have·you·been·in·contact·with·law· enforcement·about·it?¶* *Have·you·benefited·from·the·law· in·any·way?¤*	☐···YES¶ ☐···NO¶ ¤

4.8	**What should be done to improve e-waste management in Ghana?**	
4.9	**General Remarks** ⬇	

Interview closure
Thank you for participating in this survey
Notes/ Observation

ANNEX 2: Rapid Assessment Form

E-MAGIN: a SWITCH AFRICA GREEN PROJECT-2018
Sample Record Form for Micro, Small and Medium E-Waste Enterprises

Name of the Enterprise: **Contact Person:** **Date:**

Location/ Adress: **Main activity:**

GPS Location: **No. of employees:**

Annual turnover (est.):

Which processes does the enterprise carry out?

- ☐ Refurbishment
- ☐ Sorting of products
- ☐ Manual dismantling
- ☐ Shredding
- ☐ Separation of (shredded) fractions
- ☐ Cable stripping/ granulation
- ☐ Burning (e.g. cables, cases)
- ☐ Leaching (e.g. printed wiring boards)
- ☐ other

COMPONENTS HARVESTED	EXTRACTION *How much of the listed components does your enterprise generate from the waste?* (tonnes/ month)	SALES *For how much does your enterprise sell the components?* (GHS/ tonne)	COSTS *How much does you enterprise pay for disposal of unwanted fractions?* (GHS/ tonne)
Aluminum			
Iron/steel			
Copper			
Neodym magnet			
Bronze/ Brass			
Stainless steel			
Plastics			
Wood			
Cable with plugs			
Cable witout plugs			
Processors			
HDD with PCB			
HDD without PCB			
Power supply			
Drives			
PCB Type 1			
PCB Type 2			
PCB Type 3			
Motors/inductors/transformers			
Deflection coil			
Getterpill			
Mixed Scrap			
Glass			
Batteries			
Capacitators			
LCD-displays			
Flourescent Tubes			
CRT tubes			
CRT glass			
Phosphor powder			
Other:			
Other:			
Other:			
Other:			
TOTAL			

Remarks:

ANNEX 3: E-waste flow chart showcasing estimated quantities in tonnes per year in Ghana

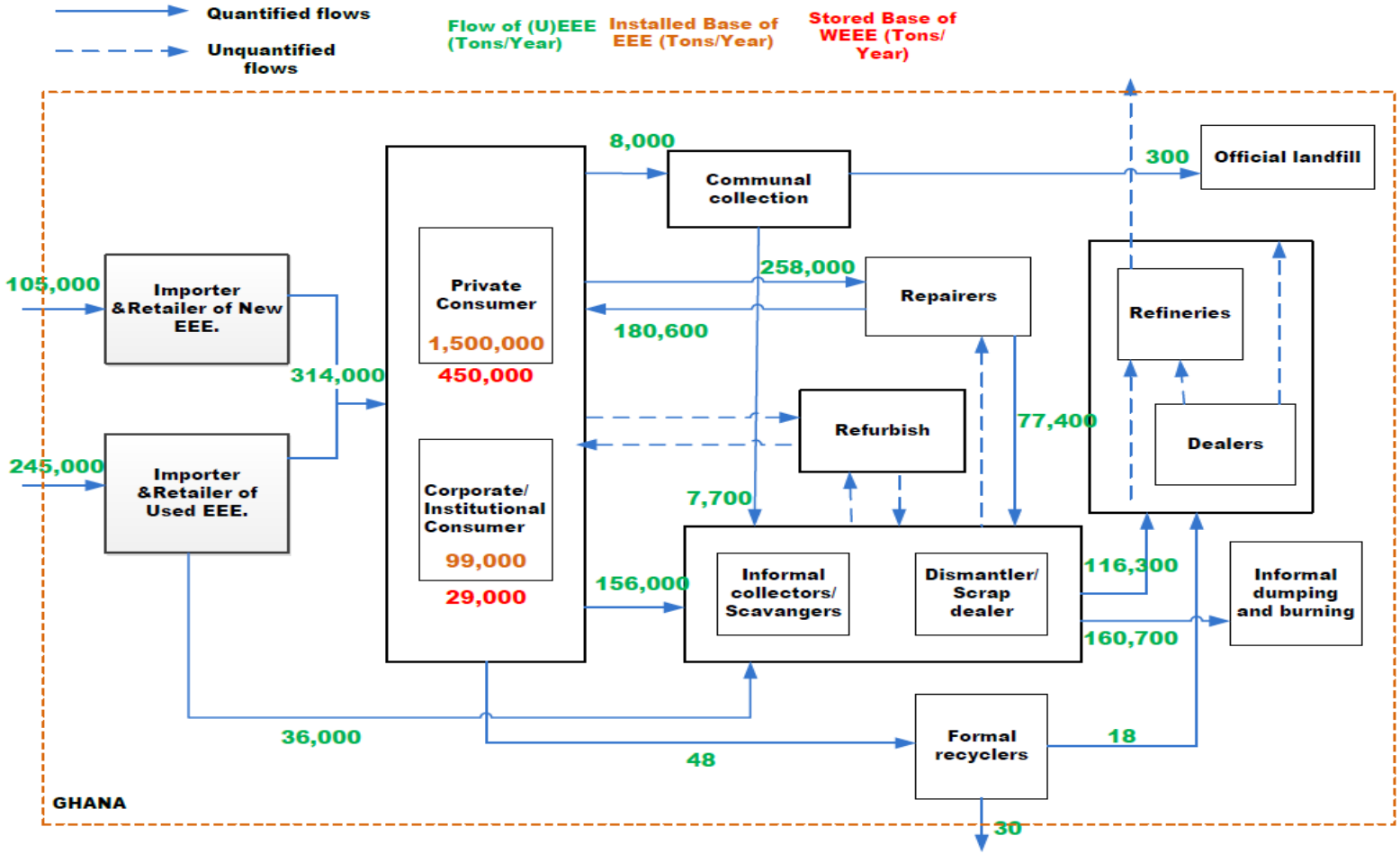

Figure 18: E-waste flow chart showcasing estimated quantities in tonnes per year in Ghana, Source: (EPA/CEPS Joint Port Control Unit inventory, 20

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