

Action plan for management of LHA in Kenya – Report on Activities 3 and 4: Identification and definition of activities for an improved circular waste management infrastructure for large household appliances



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Development of an action plan to improve the circularity of large household appliances in Kenya - Report on Activities 3 and 4: Identification and definition of activities for an improved circular waste management infrastructure for large household appliances

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Executive Summary

This sub-report presents the results for activity 3 and 4. The aim of these activities is to identify practices for value retention processes (circular processes) and for system structures from other countries. These best practices give input to give recommendations for handling LHHA's in Kenya.

The value retention practices are clustered in three groups: reuse, repair/refurbishment and recycling. The practice identified for re-use focuses on online platforms where households sell or offer LHHA's for free or low price to other households. Through such platforms a high level of interaction is reached, which also indicates the value of second-hand LHHA's. Repair activities are important for extending the lifetime of appliances and provides vivid economic activity in a country: many profitable initiatives are set up around repair worldwide. In France, Italy and Norway companies can be found that collect spare parts or whole appliances via online platforms and use this to repair LHHA's. After being repaired/refurbished, the appliances are sold or given back to the household that asked for repair and warranties can be given with this. Initiatives in Nigeria and Ghana focus on communicating how households can safely dismantle and repair their appliances by themselves, and if necessary, information on where the appliances can be handed in is provided. For recycling there are several common practices/technologies existing. In general treatment consists of the following steps: (1) pre-treatment, separation of components, often done manually; (2) automated treatment, shredding and further separation per material type. Proper treatment of cooling appliances and refrigerators is in particular important due to the ozone depletion potential and high greenhouse gas emissions (GHG) coming from those appliances. A step that needs to be added for cooling appliances is the recovery of refrigerants, the refrigerants have to be sucked out to prevent hazardous emissions of the gases into the environment. This step comes between step 1 and 2.

In terms of policy practices and systems structures, a few examples are explored in this report. To get a more holistic idea of practices of handling LHHA's, the Rwanda case is discussed. Rwanda has initiated e-waste handling practices, including LHHA's, which present many of the value retention processes discussed before. The country implemented supporting policies, funding schemes, collection infrastructure and capacity building for the (in)formal sector for both man and woman, to enhance proper management of e-waste. A key stakeholder in this management is Enviroserve Rwanda, which refurbishes and recycles the appliances. The combination of activities allows job creation, safe handling of appliances and larger volumes through collection. Enviroserve also keeps track of the appliances that arrive at the facility, they separate, weight and record them. However, the facility has high investment and operating costs which needs to be provided by funding. In other countries, such as the Netherlands, policy contributes to proper handling of LHHA's, regulations throughout the whole value chain are implemented and enforced, e.g.: Standards for processing are introduced, landfilling of e-waste is prohibited, EPR schemes are in place and new policies are still being developed such as the 'right to repair'. In Brazil efforts for regulating (e-)waste are also being made, mainly focusing on reversed logistics, implementation of collection centers, stimulating recycling and providing inclusive training. Inclusion of the informal sector is also a key element for handling LHHA's. In India examples are

seen where in collaboration with GIZ guidance is provided to increase trust and collaboration between the formal and informal sector. To enhance proper management, it is important to incentivize safe treatment and recovery of the whole appliances and not just the valuable parts. The hazardous substances in these appliances are a high risk for human health and the environment. Increasing collection and separation is important to allow proper management of the whole appliance. Incentives should be given on awareness creation about the hazardous nature of the appliances. Several practices are identified that do this via digital platforms.

The collection and study of the mentioned practices served as basis for developing recommendations to improve the management of LHHAs in Kenya. In several examples found in other countries the use of apps or digital platforms supported this proper handling through high level of interaction between stakeholders and knowledge sharing. Increasing connectivity between consumers, repair/refurbishment shops and recycling facilities, such as the WEEE center is important to improve LHHAs management. Additionally, training and education could be given to (in)formal workers to increase knowledge and safety in handling LHHAs. The last one also helps to create more standardization in the processes and improve material recovery. Some infrastructure for the activities mentioned already exists in Kenya: there is a good penetration of internet and easy access, there is already some level of interaction/trade of spare parts between repair/refurbishment shops and the WEEE center. Additionally, there are some collections points connected to the WEEE center in the country. An important further factor is the installation of EPR schemes which are currently being developed and will be installed in Kenya. The precise timeline and execution details of these schemes are valuable to develop suitable recommendations. Lastly, financial aspects are important for handling LHHAs. EPR schemes, as just discussed, are a very important aspect of this. Additionally, voluntary schemes could be available (e.g. NGO's), CO₂ emissions schemes, subsidies and get money from selling recovered materials and repaired appliances.

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1 Introduction

1.1 Objective of the study

The study aims to develop an action plan to improve the circularity of large household appliances (LHHA) in Kenya.

1.2 Scope of the study

The Technical Assistance Response Plan is clear about the broad scope concerning circularity: it stresses the importance of so-called Value Retention Processes (VRP's; see below) as an important driver for economic development and for prevention of environmental degradation. Therefore, the scope of this study explicitly extends beyond 'waste management' which is often regarded as the main activity when it comes to circular policies.

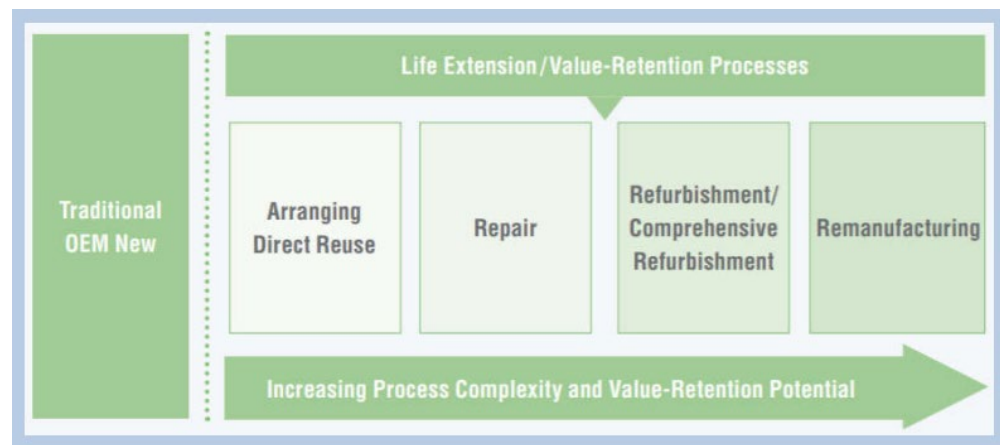


Figure 1 Overview of Value Retention Processes

The Technical Assistance Response Plan is also clear about the product scope, which concerns (primarily) only a part of the broad category of EEE (Electric and Electronic Equipment) i.c. Large Household Appliances which comprise¹: large cooling appliances, refrigerators, freezers, other large appliances used for refrigeration, conservation and storage of food, washing machines, clothes dryers, dish washing machines, electrical cooking equipment, electric stoves, electric hot plates, microwaves, other large appliances used for cooking and other food processors, electric heating appliances, electric radiators, other large appliances for heating rooms, beds, seating furniture, electric fans, air conditioner appliances and other fanning, exhaust ventilation and conditioning equipment.

In later parts of the study we will discuss this scope more in depth, especially where the differentiation between these categories and a broader category of electronic products becomes a potential barrier for further development.

¹ The categorization and composition is as per the stipulation of E-Waste Management Guidelines 2010.

1.3 Scope of this report

The terms of reference are documented in the Implementation plan (see Annex A). The implementation plan covers all activities up to the development of an action plan and conceptualization of a pilot project for an improved and circular waste management infrastructure for large household appliances.

This specific report concerns only the findings under Activity 3: Identification of opportunities for a circular waste management infrastructure for Large Households Appliances in Kenya, and Activity 4: Identification and definition of activities for an improved waste management infrastructure for large household appliances.

1.4 Methodology

This subchapter describes value retention practices in other countries, both in developed and developing countries. Combining the findings in other countries with the gaps and current status in Kenya as presented in report 2 allows to give some recommendations for the Kenya context on value retention practices of LHHA's and some system practices. The data was collected through qualitative and quantitative approaches: a desk research and stakeholder meeting.

1.4.1 *Practices in other countries*

Through a desk research literature and companies were found describing activities for value retention processes. Besides value retention processes, practices on policy and other system practices were included. The gap analysis in report 2 was used as starting point to search for relevant practices. Both for developing and developed countries there was searched for example practices, to give an extensive overview and to both include practices from different contexts. Therefore cases from a.o. Europe, Brazil and Rwanda were included. Additional information was gathered during a conference on sustainable e-waste management, which took place in December 2021.

1.4.2 *Recommendations*

The recommendations for system and value retention processes for Kenya are based on the information given in report 2 and the practices found in other countries. Additional information was gathered during the stakeholder meeting that took place in January 2022 in Kenya.

1.4.3 *Market analysis*

To assess some characteristics of the current infrastructure to see the market potential for the identified options, data was gathered by interviewing 5 repair shops, 4 distributors and sellers, 2 civil society organizations and the WEEE Centre from Nairobi, Kisumu, Mombasa and Meru Counties. Furthermore, data that was already found in report 2, describing the current situation in Kenya, is used to further assess the market analysis.

2 Examples of value retention activities aimed at large household appliances

In this activity some relevant practices for value retention processes, that are operational in other countries, are discussed. As can be seen in Figure 2 and Figure 3 that there are different strategies concerned with value retention processes. To structure this report, the different strategies are clustered into three practices: reuse, repair/refurbishment and recycling respectively. Additionally, practices that address the whole system of handling LHHAs (e.g. infrastructure) are discussed separately as well.

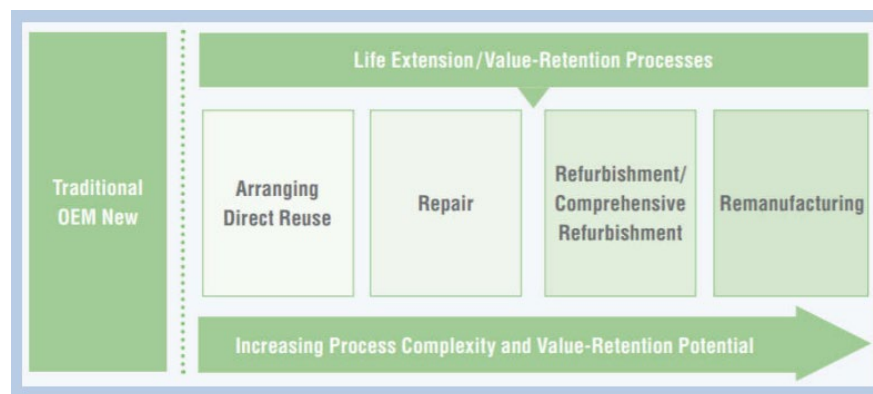


Figure 2 Broad overview of value retention processes

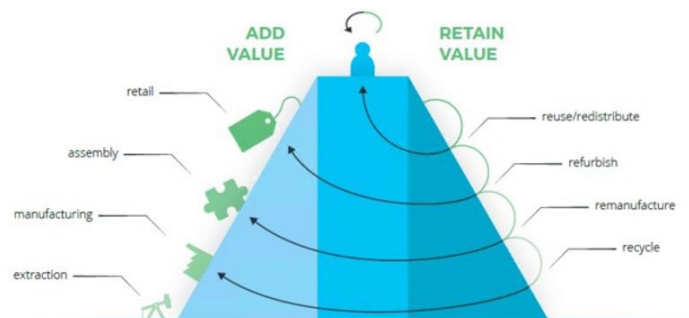


Figure 3 Overview of value retention processes

In Output 2, Development of an action plan to improve the circularity of large household appliances in Kenya, a gap analysis was made for current and future LHHAs management in Kenya. The value retention scheme as outlined in Figure 3 and which is further detailed in the proposed project pilot (Output 5), is a solution direction that we think will close some of the gaps.

These value retention processes are key for an improved handling of (end-of-life) LHHAs. In order to structure our assessment of relevant examples in other regions we have sketched a schematic overview of actors in the value chain of LHHAs (Figure 4). This overview presents the different actors and links between them, indicating both financial and material flows.

For the different value retention processes, different parts of this value chain are considered to be more/less relevant. The value chain overviews are used to understand which actors are relevant for a certain value retention process, which is explored in the coming paragraphs.

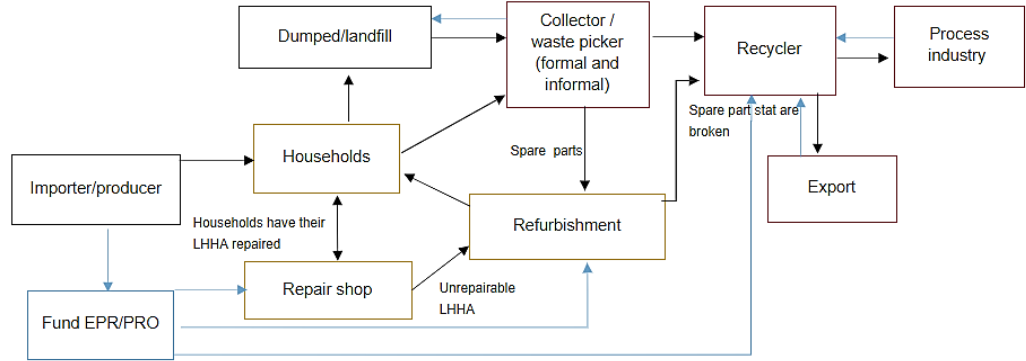
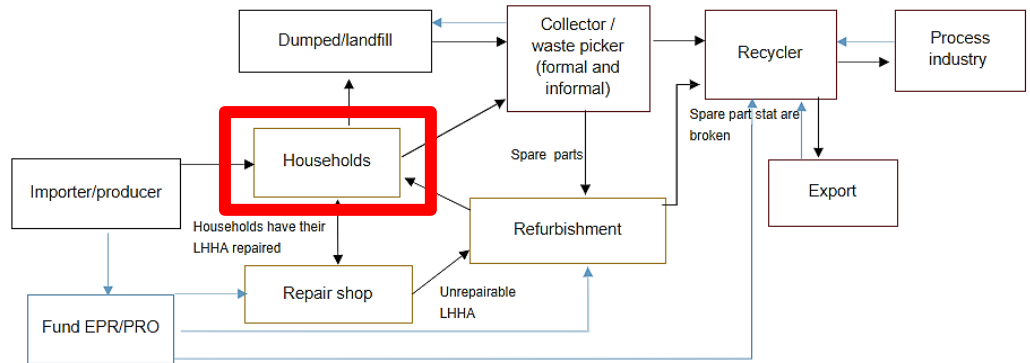


Figure 4 Value chain for LHHAs

2.1 Reuse practices



Practices of reuse (second hand market) have always been present in many countries, under which The Netherlands, for instance by setting up specific second hand shops. Goods in such shops are mostly donated by households for free, and re-sold for modest prices.

A drastic change in the re-use market is the development of online platforms where goods can be traded by consumers. Internationally, eBay is the most well-known example of such a platform. The Dutch subsidiary of eBay is called *marktplaats.com*. This platform is meant for all kinds of products, but also many LHHAs appear on the website. Interestingly, browsing such platforms reveals information on the actual prices of second-hand goods. A check on availability of used household appliances (in October 2021) shows that thousands of washing machines, air-co units, refrigerators are offered in used state (see Figure 5). Notably, many of these products are offered for free or with only marginal costs.

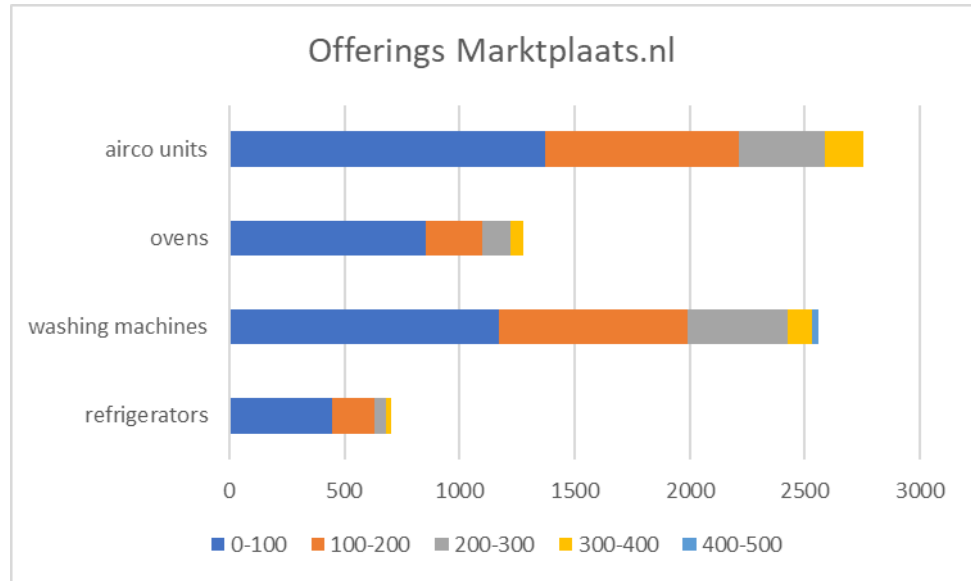
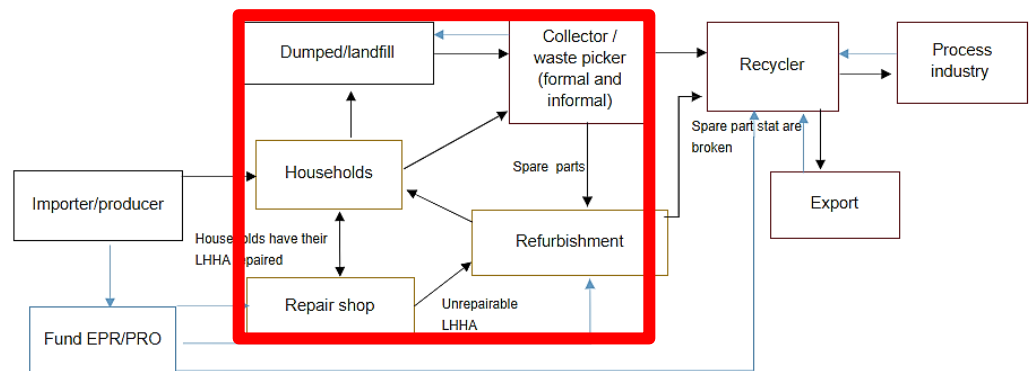


Figure 5 Offerings Marktplaats.nl (differentiation in price levels) (accessed in October 2021); numbers in the horizontal axis refer to units of offerings.

The situation for washing machines can be used as an example. An estimate of the number of sold items (based on the yearly trade volume and a unit price of 600 Euro) in The Netherlands is in the order of 1200 items per day. On any given day twice that number is being offered on Marktplaats.nl, which indicates that such web-based applications have a significant impact on the numbers of sold items. Furthermore, a transparency with respect to the value of second hand goods is obtained.

The mentioned platforms demonstrate that the use of internet plays an important role in establishing circular practices.

2.2 Repair and refurbishment practices



Of course repair activities are a vivid and economically sound element of each economy. National statistics can be used to identify the size of the economic activity directly related to repair of industrial and household equipment. In The Netherlands the number of companies explicitly registered as companies in the repair sector is

relatively small: only 625 companies are registered as 'repair of electrical household appliances', of which 505 are registered as self-employed. Translating that to employment, it shows that almost 5,000 people are employed in the sector of repair of electric household appliances, which is more than in the retail sector on whole goods.

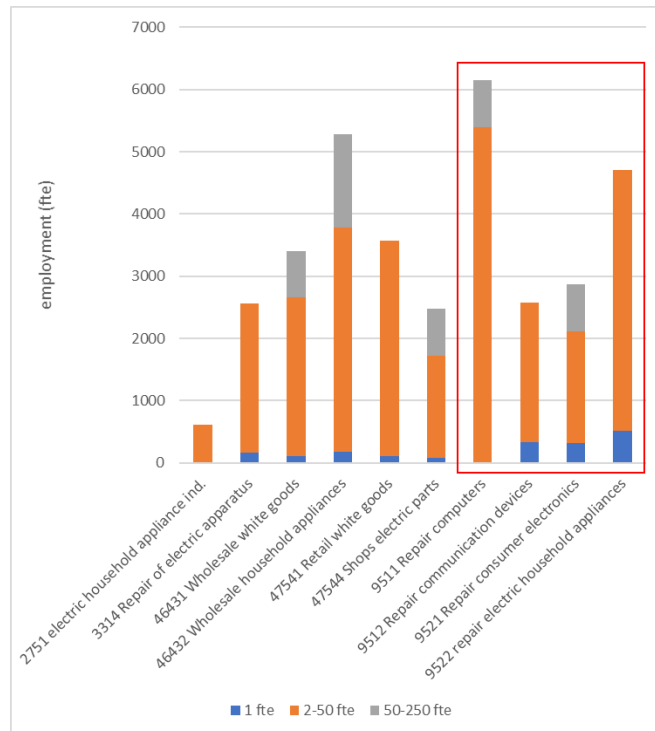


Figure 6 Employment in the household appliances sector in The Netherlands (source: CBS Statline)

Undoubtedly, many repair activities are carried out by retailers (or importers) as part of warranty systems. Repair activities of such kind will not be registered separately. As was already observed in a previous report² (focussing on the current status of LHHA management), the number of small repair shops in an economy characterized by a smaller GDP is much larger. Getting insight in these figures may help in establishing the potential for facilitating repair in the Kenyan context; the large informal part of this sector may obscure these data.

The introduction of digital technologies and the increasing attention for sustainability has resulted in new initiatives in the field of repairing and refurbishment. Besides examples in The Netherlands, we will present some examples from other countries in the next paragraphs.

SOS *Accessoire*³ is a French company founded in 2008 that aims to give autonomy to customers to repair their household appliances. The company offers a digital platform where customers can look for spare parts for their household appliances

² TNO 2021 P11318 CTCN Technical Assistance - Development of an action plan to improve the circularity of large household appliances in Kenya – WP2 Current Status, issued in final draft in December 2021

³ <https://www.sos-parts.com/about-us.html>

and order them online. It also presents tutorial videos and instructions on how to repair the appliances.

Another example is the Italian company *Astelav*⁴. The company has both an online website and a physical distribution centre. The company manages the supply of spare parts for household appliances. *Astelav* can provide spare parts to repair shops directly or to distributors and orders can be done online. The company employs 60 people and in 2018 recorded sales of 13 million euros. This indicates the value that can occur from these activities.

Norsk Ombruk is a Norwegian company founded in 2013 with the aim to give a new life to household electrical goods (such as fridges, freezers, stoves and washing machines). The company collects old devices and repairs and remanufactures them. There are approximately 25 people employed in this company and the annual turnover is around 1.8 million euro (2016). The remanufactured products are designed to last another 5 years. *Norsk Ombruk* gives warranties for 6 months to the stores who resell the products. Those stores give a warranty of 2 years to the end customers.⁵

In Ghana easy deconstruction manuals are distributed with the appliances, indicating how you can handle LHHA's in a safe way, both for human health and environment⁶.

A start up in Nigeria developed an App, called Craftly, for households which helps them to understand what their product is still worth and where they can sell it or what can be repaired by the households⁷. This tool is mainly aimed at discovering value in fast moving electronic goods such as smartphones.

⁴ <https://www.astelav.com/en/>

⁵ Norsk Ombruk (n.d.) [Norsk Ombruk Final.pdf \(earthshine-group.com\)](#)

⁶ [Washing machines – AMP \(qamp.net\)](#)

⁷ [Team Craftly: eWaste in Rwanda EDIT - Google Presentaties](#)

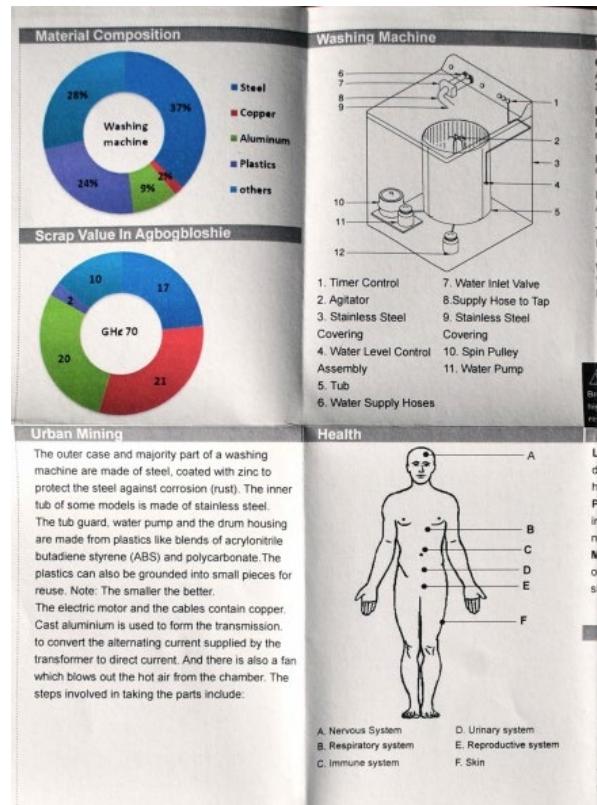
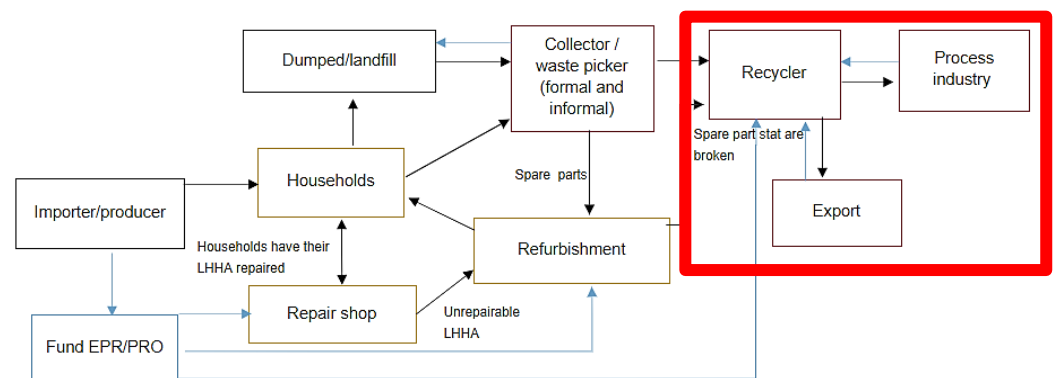


Figure 7 Example of a manual for disassembly of household goods in Ghana

2.3 Recycling and component harvesting practices



Recycling processes focus mainly on the materials recovering from used LHHAs that no longer can be repaired. Different techniques can be used for recycling of LHHAs, however, there are common steps that are applied for distinct appliances. A summary of the main recycling processes found in the literature for the appliances that are most commonly used in Kenya (refrigerator, washing machine and air conditioners) are described in the next paragraphs. This overview indicates common practices for recycling of LHHAs's.

Refrigerators

In general, the recycling processes for refrigerators are highly regulated because of the ozone depletion potential of the cooling agents. Therefore, the recycling processes are well established in the market and can be defined by the following steps:

- 1 Pre-treatment: this is normally a manual operation in which the separation of specific components takes place such as lamps, glass shelves, electronic boards and wooden parts.
- 2 Securing or recovery of refrigerant circuits: the compressor and the refrigerant circuit are prepared for suction. This step removes safely both the refrigerant and the oil from the motor. The refrigerant suction occurs with the assistance of specific machinery. Refrigerants can be recycled, though they should be *cleaned* first. The cleaning process removes moisture and toxic particles. After the cleaning process, the refrigerant can be used in a new system. This cleaning process can be done outside the recycling facility. However, the transport of these materials should be done safely. After the suction, both the compressor and the refrigerant circuit are removed for further recycling or disposal.
- 3 Automated treatment: the refrigerator passes through shredding steps that are responsible for delivering pieces of material between 40-60 mm. Following the shredding, the materials are separated per type. Aluminum, iron, plastic, copper and polyurethane (containing flame retardant agents) can be recovered via different machines: zig-zag for polyurethane, magnetic separator for the iron and densiometric separator for the other materials. Because the polyurethane usually keeps traces of gases internally, it should be treated to remove the remaining gases (via pressing). This is the most machinery intense step. All these operations should be carried out in a controlled atmosphere and with safety systems, in order to avoid that polluting gases are dispersed in the environment or that there are excessive concentrations of gas in the working areas. Figure 8 gives an impression of the type of materials that compose refrigerators and Figure 9 illustrates the recycling process described above.

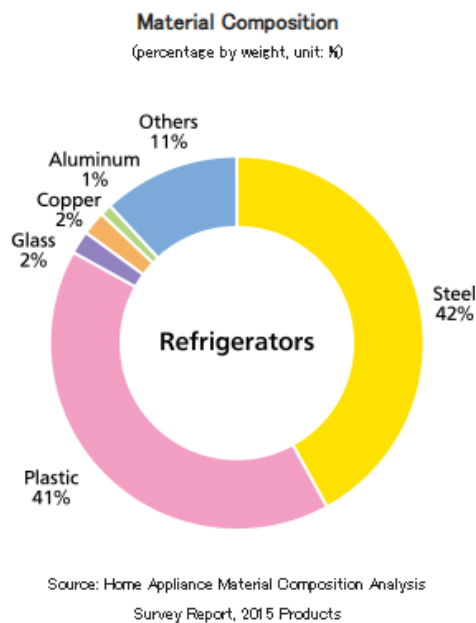


Figure 8 Typical material composition of refrigerators (Source: <https://panasonic.net/eco/petec/process/>)

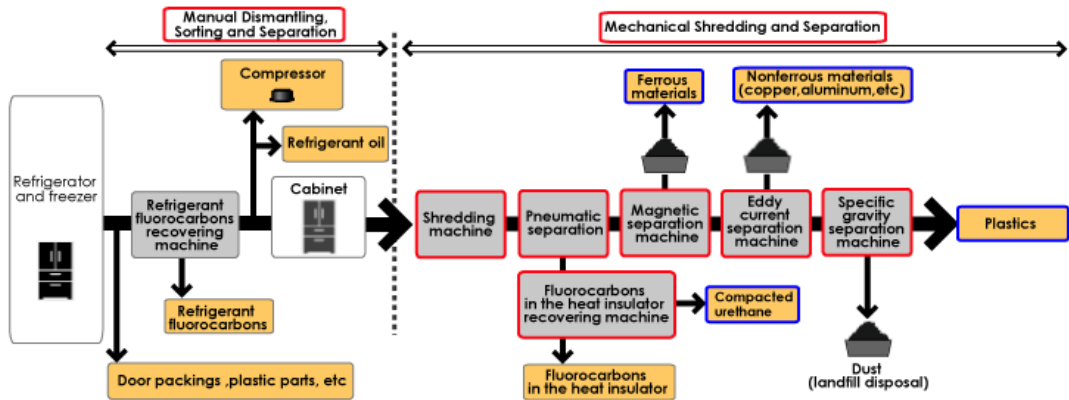


Figure 9 Recycling process of refrigerators (Source: https://www.aeha.or.jp/assessment/en/english_flame_rp.html)

Washing machines

The recycling method of washing machines is similar to the one used for refrigerators, though of course no cooling agents are used. At the first station, the metal cover is removed, followed by the removal of the circuit board and motor. Manual disassembly of washing machines is preferred, according to Baylakoglu & Yüksel (Baylakoglu & Yüksel, 2007). However, the authors state that the best results can be obtained by developing optimization of automatic-manual methods. Figure 10 shows a typical recycling process of washing machines and Figure 11 present the most common material composition of these appliances.

The most valuable parts of the washing machines are the metal components and the PCB's (printed circuit board) (Kaya, 2016), see Table 1.

Also, the engine can be valuable and is easy to remove (Ilgin & Gupta, 2011). To remove these components no high technical skills are needed and they do not contain hazardous material.

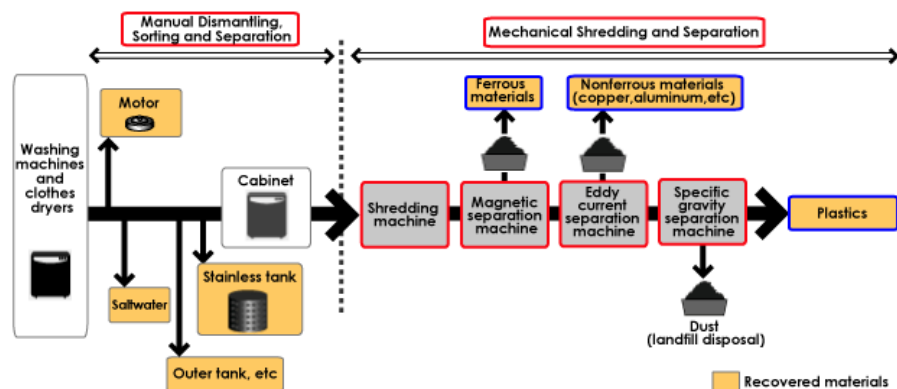


Figure 10 Recycling process of washing machines
Source: https://www.aeha.or.jp/assessment/en/english_flame_rp.html

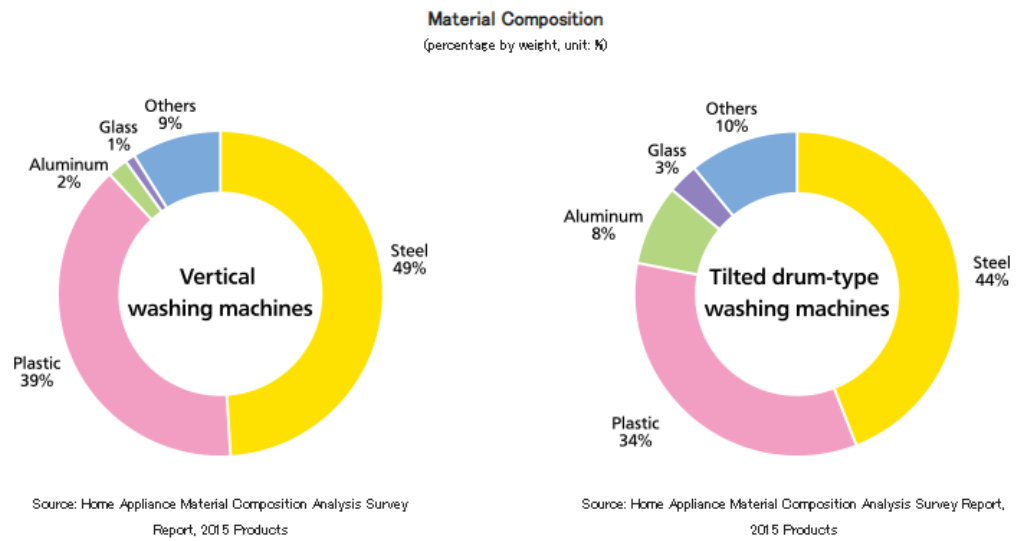


Figure 11 Typical material composition of washing machines (source: <https://panasonic.net/eco/petec/process/>)

Table 1 - Typical market prices for materials recovered from washing machine recycling

Materials recovered	Weight (kg)	Market price (2017) EUR
Metal cover	4 to 7	0,67
Printed circuit board	0,2-0,7	32,23
Engine	2 to 7	2,45
Scrap	45 to 63	4,99
	TOTAL	40,34

Source: (ILGIN & GUPTA, 2011) (MRF, 2016)

Air conditioners

Air conditioners also present similar recycling process as refrigerators, especially since they also contain refrigerants that need to be carefully removed. Refrigerant fluorocarbons are recovered by specific equipment and those gases should be destroyed at dedicated treatment facilities. Once the refrigerant has been properly removed the manual dismantling of the AC unit occurs and scrap metals can be collected. The aluminum coils, the motor, and the radiator are the most valuable parts of the unit. Figure 12 shows the recycling process and Figure 13 presents the material composition for AC units.

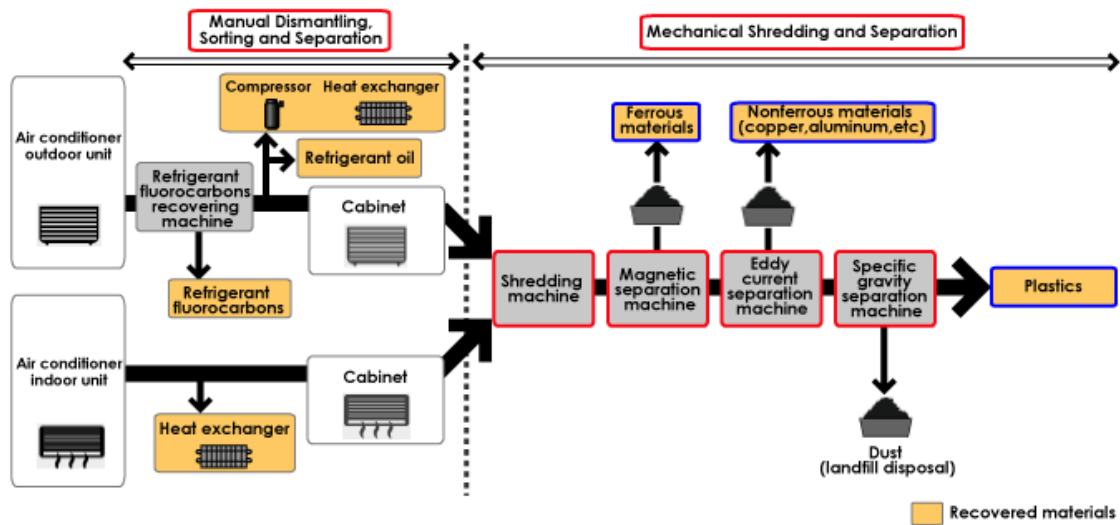
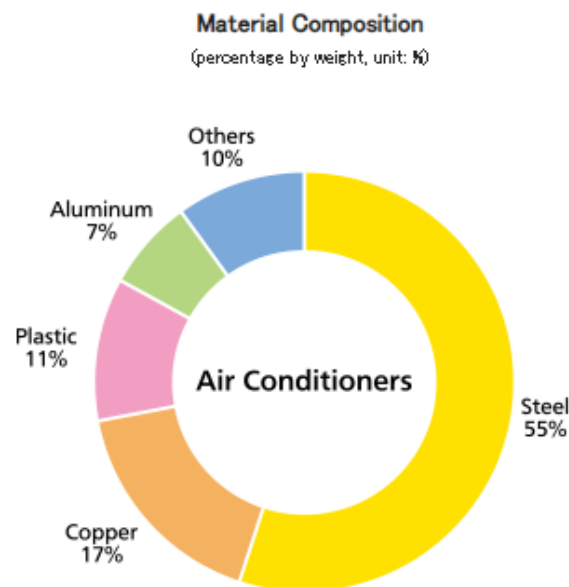


Figure 12 Recycling process for air conditioners (source: https://www.aeha.or.jp/assessment/en/english_flame_rp.html#Refrigerator)



Source: Data for 1982 Products, Association for Electric Home Appliances

Figure 13 Typical material composition of air conditioners (source: <https://panasonic.net/eco/petec/process/>)

Manual disassembly is a common step for all the mentioned recycling processes and similar machinery is required (e.g. shredding and magnetic separation). This is a positive factor for the recycling activity which could allow different LHHAs to be recycled in a shared facility. However, for refrigerators, freezers and air conditioners, extra investments are required due to the removal of the cooling agents.

Another complication of the recycling of LHHAs is the presence of various forms of flame retardants in the plastics used. Figure 14 shows an overview of a number of bromine flame retardants present in cooling and freezing appliances (CFA) and Large household appliances (LHHA). The presence of such material prevents commercial re-use and recycling of such plastics, and presents an environmental and thus a cost burden to the operation. They are considered Substances of Very High Concern and are generally treated under specific rulings and in incineration ovens with dedicated environmental measures.

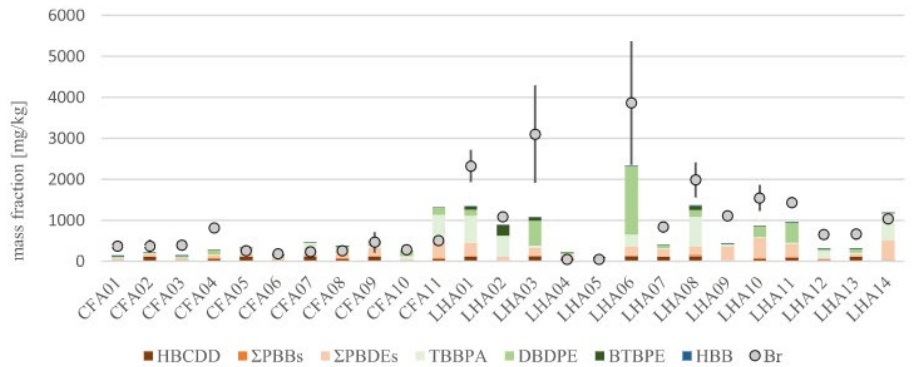
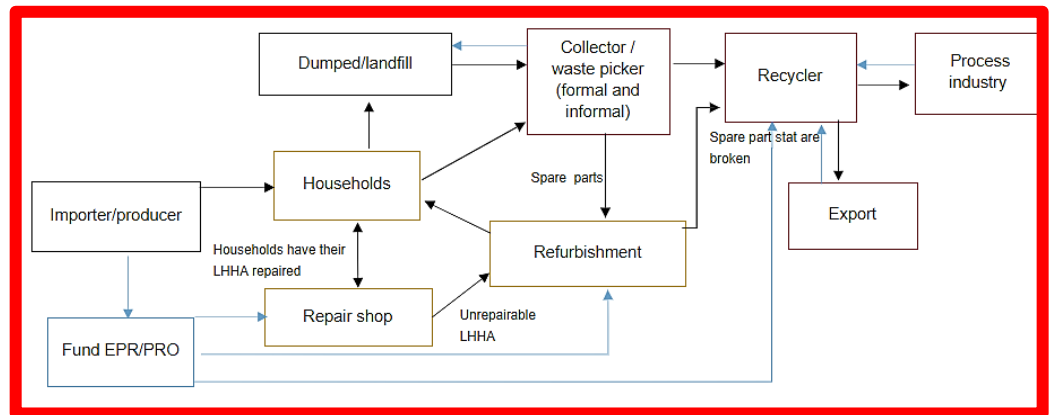


Figure 14 Average level of bromide and bromine flame retardants in a number of large household appliances (LHA) and Cooling and freezing appliances (CFA) (source : see footnote⁸)

2.4 Activities on a system level: examples of policies



2.4.1 Integral e-waste management in Rwanda

Rwanda has initiated e-waste handling practices including many of the value retention processes discussed before. This section provides an overview of the way Rwanda organizes e-waste handling and what the opportunities and barriers are.

⁸ Bill, A., Haarman, A., Gasser, M., Böni, H., Rösslein, M., & Wäger, P. A. (2022). Characterizing plastics from large household appliances: Brominated flame retardants, other additives and density profiles. Resources, Conservation and Recycling, 177, 105956.

The Ministry of Trade in Rwanda invested 1.5 million dollar in an e-waste handling facility through the Green Fund of Rwanda (FONERWA) in 2014. The facility is a subsidiary of a Dubai based company called Enviroserve and focuses on recycling and refurbishing of e-waste. It is Africa's second largest facility for handling e-waste⁹. There are supporting policies in place to ensure the facility operates properly. An overview of Rwanda's institutional framework can be seen in Table 2.

Table 2 Overview of Rwanda's institutional framework (Source: [RW-04 National E waste Policy 2018 Revision.pdf \(eaco.int\)](#))

Ministry / Agency / Authority	Options implemented by different stakeholders
Ministry of ICT	Lead the development of ICT Bill and E-waste management policy Established guidelines in collaboration with Rwanda Standards Board (RSB)
Ministry of Infrastructure	Lead the development of the National sanitation policy which is an umbrella policy for all waste management aspects in Rwanda
Ministry of Environment	Revision of Environment law and policy to cater for e-waste management Currently leading the development of a Ministerial order for e-waste management
Ministry of Trade and Industry (MINICOM)	Lead the establishment of e-waste recycling and dismantling facility and signed a PPP agreement with the private investor to manage and operate the facility
Rwanda Standards Board (RSB)	Developed standards on e-waste handling, storage, transportation, collection, treatment and disposal
Rwanda Utilities Regulatory Authority (RURA)	Developed E-waste regulations and licensing framework for operators in e-waste management sector
Rwanda Environment Management Authority (REMA)	Enforcement of environmental laws and regulations Conducted initial assessment of e-waste quantities in Kigali
Rwanda Green Fund (FONERWA)	Funded the establishment of e-waste facility, assessment and development of legal instruments for e-waste management

Enviroserve Rwanda has installed collection points specifically for e-waste where households can bring their appliances to. From these collection points, the e-waste is transported to Enviroserve. The collection points are spread over the country (see Figure 15). This helps to collect meaningful volumes of e-waste, (around 3.000 tonnes per year) however there is still room for improvement. The following strategies aim to increase proper separation and collection:

⁹ Twagirayezu, G., Irumva, O., Uwimana, A., Nizeyimana, J. C., & Nkundabose, J. P. (2021). Current Status of E-waste and Future Perspective in Developing Countries: Benchmark Rwanda. *Energy and Environmental Engineering*, 8(1), 1-12.

- Increase the number of collection points and the spreading of the points towards all districts and border posts¹⁰.
- Increasing involvement of households through awareness programs. These programs focus on informing households where they can hand in their appliances (what are the nearest collection points) and providing information on the hazardous nature of the appliances and thus the importance of proper disposal¹¹.
- Enviroserve also collaborates with general waste companies and gives training to the employees at these companies to separate e-waste. After the e-waste is separated it is brought to the Enviroserve Rwanda facility. This is necessary since at the moment a large amount of the e-waste is mixed with general waste¹².



Figure 15 Collection points Enviroserve Rwanda Green Park. Source: [Collection Points – Enviroserve](#)

With these strategies the government hopes to reach a collection rate of 10,000 tonnes of e-waste per year, which is the full capacity of Enviroserve Rwanda. It is important to highlight that LHHAs from households only form a small part of the total volume of e-waste handled at Enviroserve. Other types of e-waste, such as ICT equipment, are handled in the facility as well. Furthermore, e-waste is not solely collected from households, but also from governmental institutions and private companies. The broader scope that Enviroserve uses helps to reach a larger volume of waste.

Further separation takes place upon arrival at the facility itself. There the e-waste is separated, weighed and recorded¹³. Enviroserve Rwanda can collect, sort, decontaminate, dismantle and recover components and materials that can either be further recycled or re-used. In first instance these materials are used locally. When

¹⁰ Kovacevic, M. (2020). [Rwanda setting example for electronic waste recycling | Trade 4 Dev News \(enhancedif.org\)](#)

¹¹ Kovacevic, M. (2020). [Rwanda setting example for electronic waste recycling | Trade 4 Dev News \(enhancedif.org\)](#)

¹² Kovacevic, M. (2020). [Rwanda setting example for electronic waste recycling | Trade 4 Dev News \(enhancedif.org\)](#)

¹³ Kovacevic, M. (2020). [Rwanda setting example for electronic waste recycling | Trade 4 Dev News \(enhancedif.org\)](#)

this is not possible they are transported to international smelters that further treat them. The facility includes a Metal Baler and Plastic crushing and washing line. Such machinery would also be suitable for treating end-of-life LHHAs.¹⁴

Rwanda's Utilities Regulatory Authority (RURA) together with Enviroserve Rwanda and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) have developed a program to create awareness and they give technical training to the informal workers on e-waste in different districts¹⁵. In 2020, 265 workers both in the informal and formal sector were trained, of whom 47 women, to increase the knowledge on safely handling e-waste. Furthermore training informal employers increases formal employment. The targeted groups for this activity were young people, women and people with disability¹⁶.

s gives an overview of the financial and product/material flow. Besides the funding from FONERWA it is important that producers and importers pay according to an EPR scheme and that revenues of the e-waste facility end up in this fund as well. The EPR scheme as it is currently present in Rwanda alone is not strong enough to fund these activities, so support from FONERWA is a must.

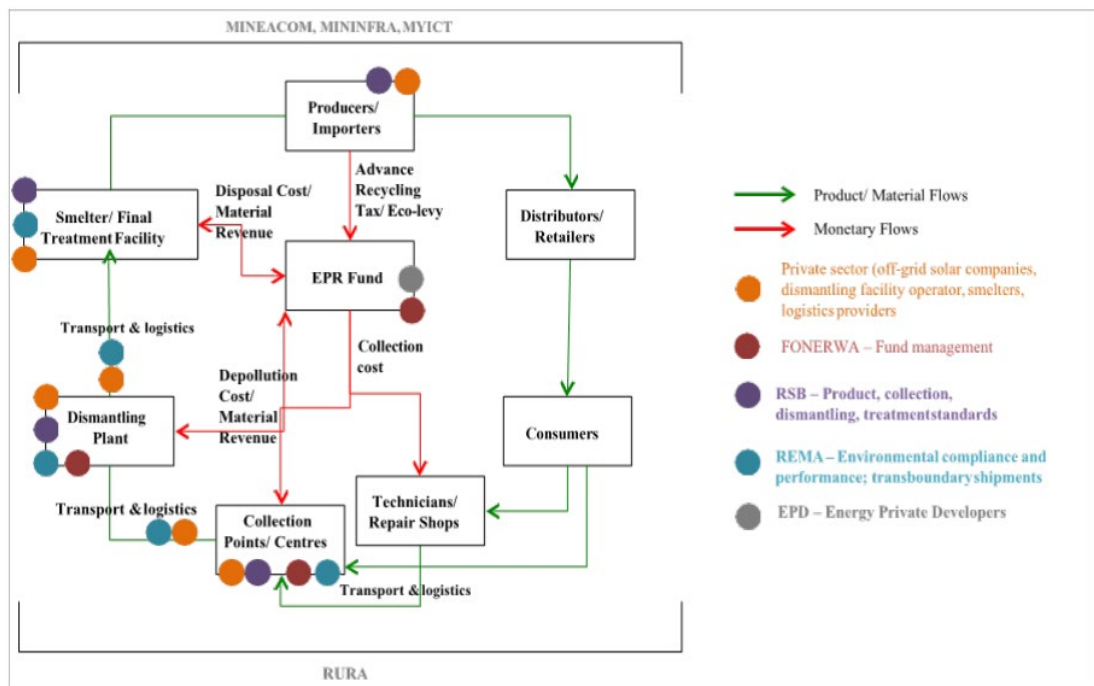


Figure 16 Government-private recycling scheme Rwanda¹⁷.

Some of the benefits and the opportunities that Enviroserve Rwanda bring are:

- the facility is able to create more than a 1000 jobs, both for men and woman;
- it allows the disposal of hazardous e-waste in a safe manner, both for human and environment;

¹⁴ EACO. (n.d.) *Country status on e-waste management (Rwanda)*. [Diapositive 1 \(eaco.int\)](#)

¹⁵ RURA (2020). [Creating a safe environment and job opportunities for Rwanda through Sustainable E-waste Management \(rura.rw\)](#)

¹⁶ GIZ. (221). [Promoting the economy and employment in Rwanda \(giz.de\)](#)

¹⁷ Twagirayezu, G., Irumva, O., Uwimana, A., Nizeyimana, J. C., & Nkundabose, J. P. (2021). Current Status of E-waste and Future Perspective in Developing Countries: Benchmark Rwanda. *Energy and Environmental Engineering*, 8(1), 1-12.

- the facility allows multiple value retention processes such as repair and refurbishment, besides recycling;
- a large volume of e-waste is treated in the plant due to the multiple collection points and the flexibility of handling all types of e-waste.

Nevertheless, the facility deals with some conditions and limitations. High investment costs are needed upfront and financing is also needed to keep the operation running. For the facility to run efficiently, proper supporting regulations have to be in place. Furthermore, awareness programs are needed to reach a critical e-waste volume. Lastly, the centralized nature of this facility requires a very well developed infrastructure for safe transportation, collection and storage of the used appliances.

2.4.2 *Dutch policy on household appliances*

The Dutch policy in discarded electric and electronic equipment (WEEE) is highly detailed and highly regulated. As are most of the regulations on other waste streams. The way how to deal with all waste streams is described in the LAP3, the 3rd version of the National Waste Management Plan (Landelijk Afvalbeheer Plan)¹⁸. The regulation with respect to WEEE is described in sector plan 71. A corresponding sector plan (sector plan 70) describes the management of regulated substances (such as CFKs and HCFKs) which are important ingredients of refrigerators.

The scope of the WEEE regulation is not confined to the processing of the discarded product, but extends to the whole chain (collection, transport) and to the potential re-use of components that are harvested during dismantling. Crucial in the Dutch waste management system is the definition of so-called minimum standards for the management of specific waste streams.

The minimum standard stimulates the re-use of products and components: preparation for re-use is mentioned as the first step to consider. A further element of the minimum standard is that processors of WEEE are required to be certified (WEEELABEX Treatment Standards). The following aspects are described as the minimum standard for WEEE processing:

- The waste processing needs to be carried out using the best available technologies (BAT)
- Several materials and components need to be isolated from the waste stream including CFK, HCFKs and HFKs, batteries

The sector plan states that landfilling of WEEE is under no circumstances permitted.

An important aspect in the management and financing of the waste processing of WEEE is the extended producers responsibility (EPR): in an EPR producers, importers and distributors are held responsible for the management of waste at the end of (first) life including the financial aspects of it. Part of this EPR is the mandatory evidence by producers that environmental considerations were applied during design of equipment. Future demand by the European Commission may extend towards a mandatory 'right to repair' and availability of spare parts.

¹⁸ https://weee.nl/nl/vragen-graag; ap3_sp71_afgedankte_eeea

Furthermore, the European Commission demands from its member states that 45% (which will grow towards 65%) of the volume of EEE brought on the market will be processed towards 'useful application'. For cooling appliances the demands even exceed this: 85% needs to find a useful application.

In an EPR producers (importers and distributors) can decide whether they want to take on this responsibility collectively (through a PRO, a producer responsibility organization). Either collectively or individually, a mandatory reporting is produced annually that reports the volume of goods brought on the market and the volume of discarded products collected and recycled. Collection of WEEE from companies is organised by companies themselves; municipalities are responsible for organizing the collection of WEEE at households. Companies are obliged to collect old equipment upon delivery of new equipment to a household.

The costs in the EPR are not determined by the authorities but by the organizing body (in The Netherlands the foundation OPEN), that acts in the name of the producers. Producers (or their subsidiaries who bring the goods on the national market) are obliged to become a member of this foundation. OPEN organizes the collection and the annual reporting.

Companies who are active in refurbishment of goods that were previously seen as WEEE need to be registered too. This does not apply to activities that involve the direct repair or re-sell of used goods, that never reached the waste status.

2.4.3 *Brazilian policy on solid waste treatment*

In 2010, the National Solid Waste Policy, or PNRS, was published, regulating the proper treatment of waste in general. Although it does not specify a standard for electric and electronic waste, most of it can be applied to this type of material. Brazil is one of the few countries in Latin America that has regulations that are somehow applied to the treatment of e-waste.

The PNRS states that every institution and organization is responsible for separating and discarding the waste they are responsible for. The PNRS is applicable to industry, commerce, municipalities and consumers. As a consequence, companies are investing in reverse logistics in order to collect their products at the end of their life cycle. Consumers must participate in the process, separating the waste and bring it to authorized delivery points.

According to the PNRS, the responsibility is divided between manufacturers, distributors and resellers, who take the products to the market. The Policy also made the return of electronic packaging and its components mandatory. It is estimated that each ton of electronic waste processed can generate around \$500. A small e-waste recycling company can earn around R\$500,000 annually, however, there is no specific data for LHHAs. This type of recycling is present throughout the country and is usually specialized in processing material fractions, which have greater added value.

The industries in the reverse logistics chain for the reuse of products in Brazil are spread throughout the country, and are mostly composed of micro and small companies, which use low technology in recycling. The country still cannot process the capacity stipulated by the PNRS, and most recycling procedures are not yet

available in Brazil, such as the processing of printed circuit boards and plastic housings for televisions.

The Brazilian Ministry of Environment published the Call to Sector Agreement on Developing the Logistics System for the Reverse Deployment of Electronic Products and components in 2013. The main aspects of this document, which proposes that the manufacturers and/or importers of electrical and electronic equipment establish a reverse logistics system for their products, are:

- the operation of collection centers in cities with fewer than 25,000 inhabitants;
- the operation of screening centers in cities of over 25,000 inhabitants;
- encouraging the operation of waste of electrical and electronic equipment recycling industries;
- the establishment of organizations for logistics management of products, with social inclusion and training; and
- the possibility of compensation for the products obtained for all stakeholders in the process.

The model proposed by the Brazilian government for reverse logistics of e-waste divides responsibilities between consumers (primary logistics), merchants (receiving points and primary freight), and the manufacturer/importer (primary freight, packaging, secondary freight, packaging, and transport to processing end). This takes into account the full service of shared responsibility guidelines placed by the laws (Ministry of the Environment 2013).

More recently, the Decree No. 10,240 on reverse logistics for companies was approved in February 2020 by the Brazilian Ministry of the Environment. The document is a complement to the National Solid Waste Policy and establishes guidelines for the control of electronic waste in Brazil. The Decree defines some objectives that must be met by manufacturers, importers, distributors and retailers, who in turn are responsible for collecting, transporting and recycling products. Decree No. 10,240 only contemplates the recycling of household products, such as computers, printers, refrigerators, air conditioners, etc.

To carry out this work, from 2021 onwards, companies can choose a collective or individual reverse logistics model. In the individual model, the manufacturer or importer assumes responsibility for installing Voluntary Delivery Points (PEVs) in cities with more than 80,000 inhabitants and informing the consumer of the opportunity for responsible disposal, in addition to ensuring that the collected materials will be handled and transported to a recycler in a controlled manner, ensuring the tracking of all stages of the process. The collective system has the same implications, but the costs are shared among the companies involved in the process and it is up to the contracted waste management organization/company to guarantee the recycling of the material.

According to Decree No. 10,240, small, medium and large companies that import, manufacture, distribute or market household appliances, such as computers, small appliances, cell phones, televisions, etc., need to implement a reverse logistics system.

It is noteworthy that the simple hiring of a waste management company, or the common practice of selling (through auctions) the company's old equipment, does

not exempt the manufacturer from possible damage that any improper final destination of this waste may cause. That is why it is crucial that companies are aware of who they are hiring or which waste organization/company they are associating with, to ensure the safety and traceability of the entire reverse logistics process.

Retailers, in turn, can enter into partnerships with reverse logistics management entities to enable the installation of collection points in strategically located stores, such as in establishments with large circulation and easy access for people. In addition, it is also retail's role to publicize the reverse logistics system, making the consumer aware of and part of this dynamic.

The Decree also requires companies to present an annual schedule, detailing their reverse logistics implementation plans, as well as their communication and environmental education plans. Anyone who fails to comply with these guidelines can be fined and fines may be imposed, which vary with the seriousness of the negligence.

2.4.4 *Partnerships with informal sector in India*¹⁹

Organizations such as GIZ have developed alternative business models in guiding the informal sector association with formal authorities. These business models promote a city-wide collection system feeding the manual dismantling facility and a strategy towards best available technology facilities to yield higher revenue.

The partnership model they developed consists of the following elements:

- The organizational structure of partnerships should be designed in such a way that they respect the entrepreneurial character of informal collectors
- To increase the success of formal-informal partnerships, key individuals within a particular community and the e-waste value chain should be identified, approached and included. The analysis suggests that trust is an important pre-condition for the creation of formal-informal relationships and should be seen as a valuable resource when connecting to informal collectors. Integrating key stakeholders which are perceived as reputable and reliable business partners within the target community is necessary to render the partnership trustworthy.
- Civil society organizations can be useful interfaces for connecting to informal actors and should be included in partnerships. These organizations often work for the public benefit of the community, thus enjoying a strong standing and good reputation among local stakeholders.
- Agreements between formal and informal actors need to provide some degree of flexibility in order to adapt to changing local conditions. The e-waste sector is characterized by a highly dynamic market environment and consists of a wide range of heterogeneous stakeholders with diverse socio-cultural backgrounds. The relationships between those stakeholders are predominantly based on trust. These characteristics need to be mirrored by agreements between formal and informal actors. More specifically, including legally binding provisions may hamper formalization because it induces transaction costs for negotiation of contractual details and may even repel workers from signing such agreements in the first place.
- Producers should offer long-term support and technical assistance to partnering institutions. Producers should provide long-term support to

¹⁹ Building the Link: Leveraging Formal-Informal Partnerships in the Indian E-Waste Sector, GIZ, 2017

partnering organizations as part of the Extended Producer Responsibility (EPR) regime.

- The analysis suggests that providing additional benefits and establishing trust to informal actors can help offsetting the price gap between formal and informal transactions. Depending on the set-up of partnership models, these could either be directly provided by producers or by the collection agency itself. Additional benefits can materialize in the form of trainings for proper handling and/or dismantling of WEEE or by offering social securities and paying fixed salaries to employees.
- Diversifying the activities of interface agencies beyond mere collection (to include, for instance, refurbishment) can contribute to sustainably linking informal stakeholders to formal value chains.
- Collection agencies essentially act as intermediaries between formal and informal actors and the largest revenue potential lies within other parts of the e-waste value chain, such as recovery of precious resources and/or refurbishing of used equipment. Hence, diversifying the range of activities beyond collection of WEEE may be considered to create additional value, e.g. by offering waste management, consulting or recycling services. Alternatively, additional financial resources from producers need to support collection agencies in bridging the formal-informal price gap and acquiring sufficient amounts of e-waste.
- Producers and policy makers should offer entrepreneurial and organizational-development training and capacity building to formal organizations. Based on the analysed set of case studies, it appears that entrepreneurial and innovative thinking within partnering institutions is a key success factor for long-term existence of partnerships.

2.5 EU Policy in the making: the right to repair

In terms of establishing a more profound 'circular economy', the European Commission has initiated the Circular Economy Action Plan. As an element of this CEAP, the Commission has described the ambition to stimulate activities aimed at extending the lifetime of products through repair. The CEAP introduces the right-to-repair ambitions as follows: *"Empowering consumers and providing them with cost-saving opportunities is a key building block of the sustainable product policy framework. To enhance the participation of consumers in the circular economy, the Commission will propose a revision of EU consumer law to ensure that consumers receive trustworthy and relevant information on products at the point of sale, including on their lifespan and on the availability of repair services, spare parts and repair manuals. The Commission will also consider further strengthening consumer protection against green washing and premature obsolescence, setting minimum requirements for sustainability labels/logos and for information tools. In addition, the Commission will work towards establishing a new 'right to repair' and consider new horizontal material rights for consumers for instance as regards availability of spare parts or access to repair and, in the case of ICT and electronics, to upgrading services. Regarding the role that guarantees can play in providing more circular products, the Commission will explore possible changes also in the context of the review of Directive 2019/77115".*

Although the right-to-repair seems to focus on ICT related equipment primarily, electric household appliances may also become the target of this envisioned regulation. The market power of the EU may indeed lead to a global attention for

this aspect of lifetime extension. Other countries outside the EU may benefit from this regulation, or may employ the results of this. Local repairing activities might be stimulated upon implementation of this regulation.

2.6 Insights from E-waste World conference

In the context of this project, a conference on e-waste in the developing world was attended in November 2021. The conference covered insights in e-waste handling from developed and developing including insights on collection, financing options and informal sector inclusion. The information provided in the following sections is derived from this conference.

2.6.1 *Collection and separation*

Developing countries often deal with a low volume of e-waste, which makes processing difficult: the number of people that owns LHHAs is quite low. When LHHAs appliances are not collected or end up in the general waste stream, the volume that can be used for value retention processes is very low. In order to increase waste volumes and ensure proper handling the focus is on effective collection and separation of e-waste.

An incentive is needed to stimulate households to bring their appliances to qualified collection points, including all its valuable parts and materials. It is attractive for people to take these valuable materials out, but the hazardous nature of some of these appliances causes health risks. It is especially dangerous since an often used technique to recover these valuable materials is by open burning of the other parts of the appliances. This activity is considered very dangerous for human health and the environment. Such activities lower the business case for the qualified collection points to handle the appliance. Incentives can be given to households through payment for the complete products. Furthermore, awareness creation of the hazardous nature of the product for the environment and human health can increase the willingness of households to hand in their products at qualified collection points.

Different practices were suggested that could help to increase the collection rate. These practices mainly proposed the use of Apps where households could register their LHHAs so that waste collectors were informed and could go to the households and collect the appliances. In such an App it is possible to indicate the remaining value of the registered appliance to the consumer, the consumer gets this amount paid when the appliance is collected. This gives an incentive to the consumer to register the LHHAs for collection. Possibly, this could also work at company level, when repairers could register spare parts on an online platform for further commercial activities. This would help other repairers to find the needed spare parts. Other practices are to increase awareness of the value and hazardous nature of the LHHAs through awareness programs to increase collection rate (which also occurs in an earlier section that discusses the Rwanda case).

2.6.2 *Financing options/business case*

Another topic that is important to address is financing and business case development of a more circular way of handling LHHAs. Especially for recycling the business case is less straightforward: some materials in the LHHAs have a very high value, however other materials are worth little to nothing. Proper recycling means

recycling the whole product, so all parts and materials and not only the valuable parts. Recycling these complete products in a non-toxic and environmentally safe manner costs money. Therefore, it is important to understand which options there are for financing this process. The options are listed below:

1. EPR schemes. The establishment of an EPR scheme helps to collect financing from producers that can be used for proper handling of the products after disposal by customers. For this it is important to clearly identify to whom the term producer applies in the context of the country e.g. when the product is imported, who is defined as the 'producer'. Furthermore, it is important to include all actors that are involved with the LHHA's (or in more general e-waste). So also including the informal sector.

Example of EPR scheme in Nigeria:

There is now a kind of EPR existing in Nigeria. EPR scheme is slowly becoming operational but does not address all wastes, e.g., batteries are left out. (there are more pressing issues to address in the country such as poverty, so there is not the highest urgency for establishing such a scheme). Also PROs are just starting, they are doing a good job, but using the EPR scheme is complex. It is not realistic to expect from the PROs that they can in short term bring in finances. Maybe in the future, but at the moment recyclers do not yet profit from these systems. So companies are still struggling.

2. Voluntary initiatives. E.g., NGO's could help to pay for certificates of recycling.
3. Closing the Loop. This Dutch-oriented company collects money from customers and companies that are willing to pay some extra money that can be used for proper handling a similar product in a different country. So, this initiative collects money for example from customers in the Netherlands and this can be used for handling of disposal waste in Kenya.
4. CO₂ emission trade schemes. Mainly for refrigerators improper handling of this product when it is disposed leads to very high CO₂ eq emissions, due to the hydrofluorocarbons (HFCs) and hydrochlorofluorocarbons (HCFCs) present in cooling appliances. A typical fridge can contain 0.05-0.25 kg of such substances, resulting in CO₂ eq emissions ranging between 1660 kg and 6500 kg per refrigerator²⁰. Avoiding these emissions by proper disposal thus saves CO₂ emissions. The avoidance of this CO₂ eq can be traded and sold to companies.
5. Market based approach. Covering some of the costs for collection, transportation and processing by the profits of selling the scrap material or using it directly as input in a processing company. LHHA's contain precious metals that can be recollected and sold again. Also the other material fractions, such as (some, but not all) plastics can be sold. The cleaner the recycling process the higher the value of the stream.
6. Subsidies. If there is a compensation (subsidies) scheme in place it is more attractive for businesses to properly recycle and it could also be an incentive to become formal.

2.6.3 *Informal sector inclusion*

An additional point of discussion at the e-waste conference was the important role of the informal sector for proper handling e-waste in developing countries. Mentioned as a reason for the attractiveness of the informal sector is that the costs of compliance with all regulations are much higher. The informal sector is seen as a very competitive player that can keep big companies away. Different strategies for

²⁰ Gerretsen, I. (2020) [How your fridge is heating up the planet - BBC Future](#)

working with the informal sector can apply, e.g. formalizing the informal sector or strengthen the collaboration between the formal and informal sector.

The German institute for international cooperation (GIZ) is active in developing countries where it gives, among others, training to people in the informal sector to increase formal employment. For example, in Rwanda they have a project running from 2020-2022 to promote the economy and employment, including training of informal workers in the e-waste sector²¹. PREVENT waste alliance is another organization that is concerned with all types of waste and aims to connect actors from all parts of the value chain to each other to find a solution together. This organization furthermore provides online training on handling different types of waste. They share this knowledge around the world in online trainings and in different languages. Furthermore, they support pilots in developing countries e.g. in Nigeria the pilot *E-waste Compensation as an international financing mechanism in Nigeria* and a pilot in Serbia and Bosnia Herzegovina on *Enhancing awareness & employment through recycling*. Both pilots aim to include the informal sector as well, by giving them training and including the informal sector in collection processes to increase local value²².

²¹ GIZ. (2021). [Promoting the economy and employment in Rwanda \(giz.de\)](https://www.giz.de)

²² PREVENT. (n.d.) [Pilot projects for a circular economy - PREVENT Waste Alliance \(prevent-waste.net\)](https://prevent-waste.net)

3 Recommendations for value retention activities and system supporting activities for large household appliances

In a report on WP2 of this project an overview of the current status of LHHAs in Kenya was given, including an overview of trade volumes and policies and an analysis of surveys that were held to get an understanding of the current handling of LHHAs by consumers, repairers and distributors. In this section the insights obtained from the current situation in Kenya are linked to the practices found in other countries (report in this report) and to the discussions from the stakeholder meeting that was held in January 2022. Combining this knowledge allows to prepare draft recommendations for a Kenyan roadmap on LHHAs end-of-life handling and a blueprint for a pilot activity.

3.1 Recommendations for reuse practices for Kenya

During the stakeholder meeting a strength of reuse was indicated to be the lower price of secondhand appliances. The threat/weakness mentioned was the risk of retaining old technologies, while technology is rapidly changing and leading to improved products. To which extent this holds for all LHHAs was not discussed in detail. An additional threat is that people might be more reluctant to buy used appliances, since they might perceive the product as less valuable. However, from the findings of the WP2 report it is also possible to notice that the ownership of LHHAs is low in the Kenyan society, especially in rural areas.

Earlier in this report initiatives to resell LHHAs from one household to another via an online platform were shown. Such a platform facilitates sellers and buyers to find each other. Furthermore, it provides geographical information about the vicinity of offer and demand.

The design of an online platform aimed at re-use of LHHAs either on local scale or more centralized scale depending on the needs in the country can be recommended.

3.1.1 *Impact*

Besides the obvious benefits of reducing net consumption of materials upon re-use, a possible negative consequence of (re-)using older appliances, is prolonging the life equipment with higher energy consumption and thus resulting in higher emissions of GHG's and higher costs for households in the use phase of the product. However, there are economic benefits from reuse, since selling the used products can generate monetary gain to the sellers and the consumers that buy the products can do this for a relatively low price.

No large institutional changes are needed for reuse, since the appliances are sold from household to household.

3.2 Recommendations for repair/refurbishment practices for Kenya

The status report (WP2 of this study) showed that consumers are willing to buy refurbished products since they cost less money. Besides price, a warranty indicating that the appliance works properly is an important criterion for consumers to be willing to buy a refurbished appliance in order to build trust between consumers and repair shops.

For repair, it was indicated that there is a great willingness of consumers to have their products repaired if it is still worth the repair price. Identified gaps for repair and refurbishment are the lack of standardization, insufficient capacity building and knowledge sharing on how to repair and refurbish LHHAs, the lack of spare part availability. It is difficult to import or get hold of the needed spare parts. Increasing this availability is crucial for evolving the repair and refurbishment activities in the country.

During the stakeholder meeting the lack of technical experience on how to repair and refurbish LHHAs was discussed. Further discussion points from the stakeholder meeting are the competition from newer (maybe cheaper) products and the health impact of working with these hazardous appliances.

Practices found in other countries indicate that through education and by providing safety equipment it is possible to secure safety while working with hazardous materials. Giving training to (in)formal workers in repair and refurbishment shops can be a solution for this. Another option is providing clear information handbooks about hazardous components and how to properly dismantle the products when refurbishing LHHAs. These two practices would furthermore address the issue of the current lack of standardization. A more standardized way for repair and refurbishment may also lead to the warranties that consumers require to build trust that the appliance works properly again.

Practices in other countries showed that the availability of spare parts can be improved by the collection of old devices from households and creating an online inventory of spare parts. These practices were identified for quite large companies employing 25 to 60 workers. In Kenya there are several repair/refurbishment shops, but operating on smaller scale (many companies are one-person companies or employ around 1-10 workers) compared to the referred company practice.

Collecting many old LHHAs is difficult for small companies: there is too little storage room for LHHAs and buying many old LHHAs can be too expensive. The WEEE center currently presents partnerships with some repair and refurbishment shops from which they receive used (and dysfunctional) LHHAs. Therefore, increasing connectivity between and among repairers and refurbishment shops might increase trading and thus the availability of spare parts: a larger pool of spare parts and products becomes available. For this a platform has to be created and trust between the shops needs to be established.

Summarizing, the recommendation is to increase the connectivity between and among repair and refurbish shops and spare parts manufactures to share materials and exchange knowledge. Additionally, training and education could be given to

(in)formal workers to increase knowledge and safety in handling LHHAs. This helps to create more standardization in the processes.

3.2.1 *Impact*

Repairing and refurbishing of appliances extends the lifespan of the appliances and therefore reduce environmental damage, material consumption and related GHG emissions.

Supporting repair and refurbish activities creates jobs and there is a learning opportunity for the (in)formal sector. Both contribute to the social welfare of the country.

3.3 **Recommendations for recycling practices for Kenya**

In the WP2 report, the gap analysis identified the following for recycling: lack of institutional arrangements to collect and treat LHHAs waste and higher costs for recycling compared to the value of the possible recovered materials, especially for environmentally hazardous materials. The exposure to hazardous materials that threatens the human health was emphasized during the stakeholder meeting. The lack of a proper infrastructure makes it difficult to change this way of operating. In particular, the long distance transportation of LHHAs in combination with the low volumes was also highlighted as a barrier towards recycling operations during the meeting. The infrastructure that is proposed to benefit the reuse of LHHAs is further discussed in Output 5.

Proper recycling of all components from LHHAs requires significant investments. Considering the low volume of waste from LHHAs such an investment requires contributions from distributors and importers through an EPR. Recycling enabled by an EPR should be organized centrally and maybe combined with other recycling activities, such as recycling of electronic waste. However, different types of LHHAs share similar recycling steps, specially the manual dismantling, therefore, one possibility could be to focus on recycling facilities that can handle a wide range of appliances. The dismantled parts could be exported to nearby countries that already present the machinery required to recover materials such as metals.

3.4 **System recommendations**

Besides recommendations in particular for the value retention processes some supporting recommendations that apply to the whole system can be given. These recommendations are based on the gap analysis in WP2 report. In the paragraphs below these gaps are linked with the system practices found in other countries: collection, policies, informal sector inclusion and business case. Finally, recommendations on how different practices can be linked is given.

3.4.1 *Collection*

To increase collection rate and thus (to some extent) the volumes of LHHAs, practices focused on awareness creation and on motivating consumers to hand in their used appliances have a significant impact. Some recommendations related to the mentioned practices are derived from the gap analysis in WP2 report and are listed below:

- give incentives to consumers through designing a take-back system where they are paid a certain percentage of the value of the product (e.g. 5%) when they hand in the used appliance, an alternative incentive can come by giving a discount to consumers to buy a new appliance when they hand in an old one;
- for awareness creation, the gap analysis indicates that communicating the availability of collection points and other aspects of waste management to households are relevant;
- involvement of manufacturers and importers is important for clear communication, since they can provide information to consumers on how to properly handle the appliance and offer guidance on how to do easy repairs (e.g. via instructions manual).

Besides the recommendations resulted from the gap analysis, the involvement of manufactures in this process was mentioned as a relevant factor to improve the collection rate of used appliances. Initiatives from manufacturers, such as LG, that facilitates a take-back system in the country were mentioned..

Practices were found in other countries where an increased collection rate is stimulated through connecting households to waste collectors via an online platform. Such a platform can also be established between repair/refurbishment shops and recyclers, to make sure that the LHHAs are properly handled in every step of the value retention process. The latter also addresses gap 4, which indicates the low level of robust interaction between sellers, recycling companies and repair shops.

3.4.2 *Policies*

The EPR policy for e-waste is currently under development and at this point it is uncertain how LHHAs management is included. A further evaluation on policy should be done once more insights regarding the regulation become known to the public.

3.4.3 *Informal sector*

The active role of the informal sector in handling LHHAs in Kenya has key importance when trying to improve the current practices concerned to LHHAs. In WP2 report, it was presented that about half of the households in Kenya perceive the collection of LHHAs by the informal sector as positive. Furthermore, generally, a positive relation exists between formal distributors and the informal sector (as indicated in the survey by the distributors). However, a few distributors show dissatisfaction and low reliability on the informal sector. Practices found in other countries on informal sector inclusion have different approaches: (1) formalize the informal sector or (2) increase the collaboration with the informal sector.

The WP2 report suggests two main actions to support formalizing the informal sector, which are to create job opportunities for the informal workers and to provide training on safely managing LHHAs. The strong relationship and broad network of customers that the informal sector has are the main added values from increasing the collaboration with this sector. Increased collaboration allows the formal sector to get access to this network as well.

Both formalizing the informal sector and increase collaboration with the informal sector are thus important. Both aims can be achieved through an online platform

that connects informal and formal sector and provides information on handling LHHAs. Practices in other countries include giving training to the informal sector by organizations such as GIZ, the focus of this initiative is to train the youth on regards to e-waste handling. This organization was also mentioned during the stakeholder meeting in January 2022. Another organization that was mentioned and is also addressed in the WP2 report is E-waste Initiative Kenya **EWIK**²³. The latter helps, mainly, informal settlements to improve the safe handling of e-waste. These organizations will be very relevant to consult when aiming to increase the level of education given to the informal sector. Additionally, some practices were found that increase the collaboration between informal and formal sector focus on strengthening and facilitate the relationship among them. A way to do this is by identifying a neutral organization that can be the liaison between informal and formal sector.²⁴

3.4.4 *Business case*

An identified gap is the higher costs of recycling compared to the value of materials that can be recovered. An overview of financing options is given in an earlier section. It could be further identified which of these options are suitable for Kenya. This will also depend on the activities that will be developed or enhanced in the short or long term. It is clearly indicated that the current development of the EPR policy provides for the longer term a promising perspective to finance LHHAs' handling. Understanding how to seize the opportunities of the EPR policy is important to address.

3.5 **Connection between value retention processes**

As the value chain at the beginning of this chapter already indicated, proper handling of LHHAs addresses all aspects of the value chain. While discussing recommendations in the sections above, overlap and connectivity between these practices are undeniably present. Therefore, it is important to consider the connection between the value retention processes and the supporting system practices. Some of the gaps that were identified in WP2 report have a strong focus on this interaction: e.g. low level of robust interaction between different stakeholders and the lack of standardization.

Recommended practices for the different value retention processes often include the use of online platforms. Online platforms can increase the interaction between these processes as well. It can help to connect small repair and refurbish shops with larger recycling companies/institutions, such as the WEEE center.

²³ <https://ewik.org/about/>

²⁴ GIZ. (n.d.). The Economics of the Informal Sector in Solid Waste Management: Economic Aspects of the Informal Sector in Solid Waste Management.

4 Market analysis for the adoption of identified best practices for circularity of large household appliances

This section will highlight market aspects that will have an effect on the implementation of the policy developments and on the development of a pilot action that is the next phase of this project. These insights are based on the answers from interviews with 5 repair shops, 4 distributors and sellers, 2 civil society organizations and the WEEE Centre.

With respect to policies, the dominant development is the implementation of the Extended Producer Responsibility on EEE (electric and electronic equipment) under which LHHAs will fall. The EPR is currently under development in Kenya. NEMA, the Ministry of Environment and Forestry, and the county governments will play an important role in the construction of an EPR. How and when the EPR will be implemented provides important infrastructure for practices to be aligned with. Additionally, the national sustainable waste management policy stimulates the adoption of best practices by promoting avoidance of waste, improved resource recovery and increased demand and use for recycled materials/products.

There are many organizations active in handling LHHAs. An estimated 1000-2000 repair/refurbishment shops, both formal and informal, are present across the country. Although in report 2 we identified that the accessibility of spare parts is limited in Kenya, there is already some infrastructure for the trade of spare parts. Repairers buy spare parts from local spare parts shops or from informal waste collectors (or appliances as a whole). Additionally, repair shops trade spare parts among each other. However, this only happens at individual basis and there is no formal organization behind this. This indicates a good starting point for more structured collaboration to improve the repair and refurbish activities.

Besides repair and refurbish shops, there are also organizations active in the recycling sector of which WEEE center is one of the larger organizations. WEEE center does already handle LHHAs and also collaborates with repair and refurbishment shops. They have collection points in Nakuru, Mombasa and Kisumu. Therefore, it could be possible to build further on this existing infrastructure.

Internet can be an important enabler for developing value retention activities in the field of LHHAs. The current infrastructure of internet and online platforms was therefore questioned in our interviews. The increased ownership of smartphones, an expansion of areas that have access to internet and affordable internet prices assure that a significant number of repair and refurbish shops have easy access to internet. Most of these shops already make use of (social) media platforms, either to advertise their activities or for selling secondhand appliances, which indicates that there is available infrastructure for working with online platforms. Setting up collaborative digital platforms is perceived to have several benefits: (1) it will give easier access to spare parts and this can translate to lower costs, (2) increased knowledge sharing and cooperation, (3) enhanced capacity through joint capacity building sessions, (4) collective lobbying to address challenges the sector faces, (5) sharing/collectively purchase expensive machines. However, competition between

repair/refurbish shops might hinder successful development of such a collaborative platform.

The high costs of some of these spare parts compared to new products can make the business case for repair difficult. Especially, since repair is perceived as less effective compared to buying new products.

For activities such as: setting up and maintaining a collection infrastructure (collection centers, transportation), awareness creation to the general public, and, capacity building for repairers (and recyclers) additional funding is required, therefore, the implementation of the EPR scheme could give important contributions to these activities.

A Ethical considerations

The project sought ethical approval from all relevant authorities and stakeholders to conduct data research. They included permission to consult married women, youths staying with parents, at household level and relevant government departments and waste enterprises. The purpose of the study was explained including procedure for data collection and handling. Information confidentiality were explained and adhered to. No person was allowed to access raw data except the project team members. All the findings and presentations were shared with CTCN/ NDE.

- a. The informant's approval: The most important principal concerns the informant's approval, which implied that the informant had to volunteer to become involved in the research process, and had the right to be informed about the aim of the study. In addition, the informant had the right to interrupt their involvement in the research process. This contributed to ensuring that the informants have control over their own participation in the research process. Therefore, a written consent was issued to the participant prior the interview, to read and sign where necessary. The researcher fully explained the details of the information in the consent form in the preferred language by the participant.
- b. Confidentiality: The principle of confidentiality aims to secure that the information given by the informants is kept confidential. The researcher was therefore, preserve an informant's anonymity if the informant so requests. In addition, the information obtained was not shared with unauthorized persons and when it is no longer necessary to keep it, the information was disposed- off in accordance with TNO information disposal principles. Computer equipment used was used to keep security software up to date to protect against malware, viruses and hackers.
- c. Consequences: The third ethical principle involves the consequences the research can have for the informants. Those who took part in the research process were not exposed to physical or social embarrassment. It was therefore important that the researcher does not ask the informant's questions that are too probing or lead to problems for them after the research. The interviews were therefore, arranged in a manner that preserves the informant's integrity and dignity, where the researcher takes the informant's evaluations, motives and self-respect into consideration (Touitou et al., 2004).
- d. Accountability – the team demonstrated accountability and transparency in regularly disclosing with stakeholder's progress in implementing the research, where necessary.
- e. COVID19 compliance – the study took into account and observed all COVID-19 restrictions so that the respondents and the public are not put in danger. Therefore, where face to face contact was employed, face masks were worn correctly; hands were washed and sanitized regularly and social distancing measures was employed. Where a respondent or company was not comfortable with attending face to face meetings, virtual meetings were arranged. No unnecessary risks were taken.

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- f. Inclusion – the study ensured inclusion of all necessary respondents and put additional measures where necessary to ensure this inclusion happens. Inclusion of women and men was ensured and times and/or meeting places or modalities adapted to ensure that both sexes participate in the research study. Inclusion also meant availing both face to face meetings and virtual meetings for respondents and offering respondents a choice based on their preference.
- g. Child protection – where necessary and if contact had to be made with minors, for example, in cases where minors are engaged in waste management practices, due care to protect the minors' identity, or other issues in line with Child Protection issues were followed. No photographs were taken without express and written consent of the minor's parent or guardian. Interviews, if necessary, were done in the presence of the minor's parent or guardian. No gifts were given to encourage giving of information and participation in this study was entirely on free will.

B Consulted stakeholders

Stakeholder group	Key stakeholders	Interest	Influence
National Government	<ul style="list-style-type: none"> Ministry of Environment and Forestry (MoEF) 	High	High
	<ul style="list-style-type: none"> Ministry of Information, Communication and Technology 	High	High
	<ul style="list-style-type: none"> Ministry of Industrialization, Trade and Cooperatives 	High	High
	<ul style="list-style-type: none"> Ministry of Energy 	High	High
Government departments and agencies in the environment sector	<ul style="list-style-type: none"> National Environmental Management Agency (NEMA) 	High	High
	<ul style="list-style-type: none"> National Environment Trust Fund (NETFUND) 	High	Mid
Households	<ul style="list-style-type: none"> 385 households will be interviewed 	Mid	High
County Governments	<ul style="list-style-type: none"> Nairobi Metropolitan Services (NMS) 	High	High
	<ul style="list-style-type: none"> Mombasa County 	High	High
	<ul style="list-style-type: none"> Kisumu County 	High	High
	<ul style="list-style-type: none"> Nakuru County 	High	High
	<ul style="list-style-type: none"> Uasin Gishu County 	High	High
Companies- Producers and Distributors/sale	<ul style="list-style-type: none"> Ramtoms, Bose, Hisense, BRHUM, Hotpoint, ARMCO, SHARP, BEKO, MIKA. Orient, SAMSUNG, PHILIPS 	Mid	Low
Companies (Companies dealing in e-waste treatment)	<ul style="list-style-type: none"> WEE Centre, Sintmund, Niko Green, T3, Close the Gap, 	High	High
Civil Society Organizations	<ul style="list-style-type: none"> E-waste Initiative Kenya (E-wik), Niko Green, 	High	Mid

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Stakeholder group	Key stakeholders	Interest	Influence
(NGOs, CSOs, CBOs)	<ul style="list-style-type: none"> • Komb Green, • WWF 		
Academia	<ul style="list-style-type: none"> • University of Nairobi (UoN) 	Mid	Mid
	<ul style="list-style-type: none"> • Kenyatta University (KU) 	Mid	Mid
	<ul style="list-style-type: none"> • Africa Nazarene University (ANU) 	Mid	Mid
	<ul style="list-style-type: none"> • Technical University of Kenya (TUK) 	Mid	Mid
	<ul style="list-style-type: none"> • Jomo Kenyatta University of Science and Technology (JKUAT) 	Mid	Mid