



# Incentive Based Collection of E-Waste in Ghana

Findings from the pilot incentive system for waste cables from March 2018 to August 2019



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## List of Abbreviations

EPA	Environmental Protection Agency
GASDA	Greater Accra Scrap Dealers Association
GHS	New Ghana Cedi
LME	London Metal Exchange
MESTI	Ministry of Environment, Science, Technology and Innovation
MRI	Mountain Research Institute
PE	Polyethylene
SRI	Sustainable Recycling Industries

## Acknowledgements

The activities described in this report were part of the MESTI-GIZ E-Waste Programme implemented in Ghana between August 2016 and January 2020 (also see chapter 1). The exercise would not have been possible without the strong support and backing from MESTI and EPA. At the same time, the commitment and constant co-operation with GASDA and its members have been crucial for the conduct and success. Great thanks also go to City Waste Recycling that has been a trustworthy and reliable recycling partner ensuring that collected waste cables are in fact recycled in an environmentally sound manner and that provided its know-how on recycling markets throughout the project.



# 1 | About the GIZ E-waste Programme in Ghana

Population growth, economic growth and changing consumer behaviour have led to the increasing consumption of electrical and electronic gadgets in Ghana. This has also resulted in growing quantities of electrical and electronic waste (e-waste). In addition, electrical and electronic devices with shorter (remaining) useful life-time also arrive in Ghana as second-hand goods. Around 15% of these imports are considered e-waste on arrival.

Unfortunately, the country does not yet have an effective and environmentally sound recycling sector for e-waste. The Old Fadama scrap market – better known as Agbogbloshie – lies in the centre of the Greater Accra Region and is a known example of the resulting environmental and health problems. Ground and surface water is contaminated with heavy metals and the burning of cables releases toxic gases and particles that frequently cause severe health problems. Greenhouse gases are emitted, for example from unsound recycling and disposal of fridges, thus, contributing to climate change.

The Government of Ghana has recognized the challenge and developed the “Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917)” and the accompanying legislative instrument LI 2250, creating the legal framework for more sustainable management of e-waste. Furthermore, under the SRI programme technical guidelines for sustainable management of e-waste were developed, which are in the process of being adopted by the EPA.

The E-Waste Programme aims to improve the conditions for sustainable management and disposal of electronic waste (e-waste) in Ghana. The programme for technical cooperation is commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) and implemented by “Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH” in partnership with the Ghana Ministry of Environment, Science, Technology and Innovation (MESTI).

In order to transform e-waste management from a widely unregulated and polluting sector into a modern and environmentally sound industry, the E-waste Programme supports in

various aspects and closely cooperates with all relevant public and private stakeholders in Ghana. The following areas of activity reflect the three levels of intervention of the abovementioned E-waste Programme:

1. The policy framework for sustainable management of e-waste is improved at macro level.
2. Economically viable business models are introduced and developed at meso level. This is kick-starting and promoting a sustainable e-waste recycling sector.
3. Through capacity development, informal sector players at micro level are enabled to make e-waste management more sustainable and less damaging to the environment and the population's health.

This module is part of intervention level 2 and 3 and entails the development and testing of an incentive and payment system for selected e-waste types.

## 2 | Thematic Background

Today, e-waste collection and recycling in Ghana is widely carried-out by informal players. Small-scale collectors move from house to house and offer cash money for e-waste such as waste TVs, fridges and air conditioners. While this type of collection is highly convenient to consumers, it also leads to a situation in which most e-waste is channelled towards informal and often polluting recycling practices. Studies have shown that this pattern widely follows economic motivations: Informal recyclers commonly focus on recovering valuable materials such as aluminium and copper, while non-valuable and polluting fractions are disposed uncontrolled or burned (Buchert et al. 2016; Owusu-Sekyere und Batteiger 2018). Thus, informal recyclers avoid paying for the disposal costs for these fractions and externalize the environmental impacts. Compared to formal and soundly operating recyclers, this uncontrolled disposal represents a significant economic advantage as sound recyclers use large parts of their revenues to responsibly manage such e-waste fractions and to avoid pollution. Thus, unsound and polluting recycling is currently significantly more profitable than sound recycling. Informal collectors and recyclers (who belong to the poorer strata of Ghanaian society) use this advantage to make a living out of scrap collection and recycling.

In this situation, attempts to improve e-waste management have to consider that the current collection activities are highly effective (in terms of collection rates) and give income to a large number of people. Moreover, regulatory attempts (e.g. banning of polluting recycling practices) have a high risk of failure as most informal e-waste recycling activities can easily be moved to other locations to avoid inspections.

In this situation, one key challenge is how existing collection structures can be used while collected e-waste is channelled to sound recycling. One concept to do so is to incentivise collection at the condition that collected e-waste is handed over to sound recycling. This project module made a test of such an incentive and payment system for selected e-waste types in Accra. In this test, a temporary handover centre offered monetary incentives for waste cables. These incentives were paid-out to supplying individuals upon delivery. As the default option for the treatment of cables on a scrapyards is burning, the idea was to transform the current cable waste value chain into a sustainable value chain. The incentive-level was set slightly above the local material value of the cables in order to pay for the service of collection in addition to the material value. The aims of this test were to:

- Develop and test implementation, pricing, transaction & documentation modalities;
- Test and document market reactions to such incentive based collection;
- Collect and document lessons-learned from this exercise to facilitate comparable e-waste management models in Ghana and beyond.

### 3 | Preliminary decisions

Before entering into the detailed planning of the pilot incentive systems, the following decisions have been taken:

- The pilot incentive system shall be conducted in or close to the Old Fadama scrap market, better known as Agbogbloshie in the centre of Accra, Ghana. The decision was taken, as it was intended to offer a sustainable alternative for local scrap workers that allows them to abandon polluting practices.
- The focus should be on waste cables. This is because cables are a highly relevant e-waste type when it comes to avoiding pollution (avoiding cable burning). At the

same time, the complexity in terms of material composition is still manageable and allows a learning process for more complex e-waste types (e.g. whole devices).

- On the scrapyard, the Greater Accra Scrap Dealers Association (GASDA) represents the scrap workers. It was agreed, that GASDA shall be involved in planning and implementing of the pilot.
- Decisions on incentive levels, quality requirements and payment level and conditions are taken in the project core group. To avoid conflicts of interests, no GASDA representative is part of the decision-making team.
- The pilot implementation should be done over a period of several months. Ideally, cables should be collected and incentivized over the whole time period.
- The incentive levels should be static over prolonged time periods to generate trust amongst collectors and recyclers. At the same time, the implementation shall also test the market reactions to some few price changes.

## 4 | Organisational set-up

Main responsibility for implementing this module was with Oeko-Institut. This entails an oversight and co-ordination role (including contractual issues and finances), as well as the development and adjustment of project implementation plan in close co-operation with GIZ. Oeko-Institut was also responsible for developing criteria for accepting waste cables at the handover centre, the setting of incentive levels, accountability of the system (payments and material flow) and the documentation of the pilot exercise (this report).

Oeko-Institut, based on a competitive selection process, has subcontracted GreenAd who owns a container based structure in the Old Fadama Scrap market, which is known as the Agboglobshie Recycling Center (see Figure 5.5 and Figure 5.6). Green Ad was responsible for conducting the local market survey (see section 5.2.3), purchasing test batches of cables (see section 5.2.2), upgrading of the physical infrastructure (see section 5.3) and the conduct of the implementation phase (manning the handover centre, accepting and compensating cables at defined conditions, management of incentive budget).

Mountain Research Institute (MRI) was subcontracted by Oeko-Institut and mainly responsible for the implementation of a project module on strengthening the organizational capacities of GASDA<sup>1</sup>. As both modules interact with the same stakeholders, MRI was also tasked to support the implementation of the pilot incentive systems on a communication level with GASDA and with other relevant players linked to the Old Fadama scrap market.

GIZ, Oeko-Institut, GreenAd and MRI had regular team calls to exchange relevant information and updates and to plan further activities related to this pilot. Furthermore, GIZ repeatedly conducted unannounced visits to the pilot implementation on the Old Fadama scrapyard.

Oeko-Institut signed a MoU with the local recycling company City Waste Recycling. The company has a cable granulator and can manage all parts of waste cables in an environmentally sound manner. City Waste Recycling picked-up collected cables from the handover centre and supported the project by analysing the collected cables (material composition, quality assessments) and by giving advice on cable grading, the transaction and storage process. City Waste Recycling committed to recycle the collected cables in an environmentally sound manner and to provide related disposal certificates to the project.

As indicated in chapter 3 GASDA was informed about the planned pilot incentive system in an early stage of preparation. Various suggestions by GASDA (e.g. on payment modalities) have been taken up by the project team. GreenAd also involved four individuals nominated by GASDA to actively support the implementation against basic monetary compensation. This included:

- 2 persons supporting the reception of cables (weighing, sorting, packaging);
- 1 security guard;
- 1 spokesperson to facilitate communication with collectors, recyclers and GASDA representatives.

As indicated in chapter 3 these persons were not involved in any discussions and decisions related to the pricing mechanism.

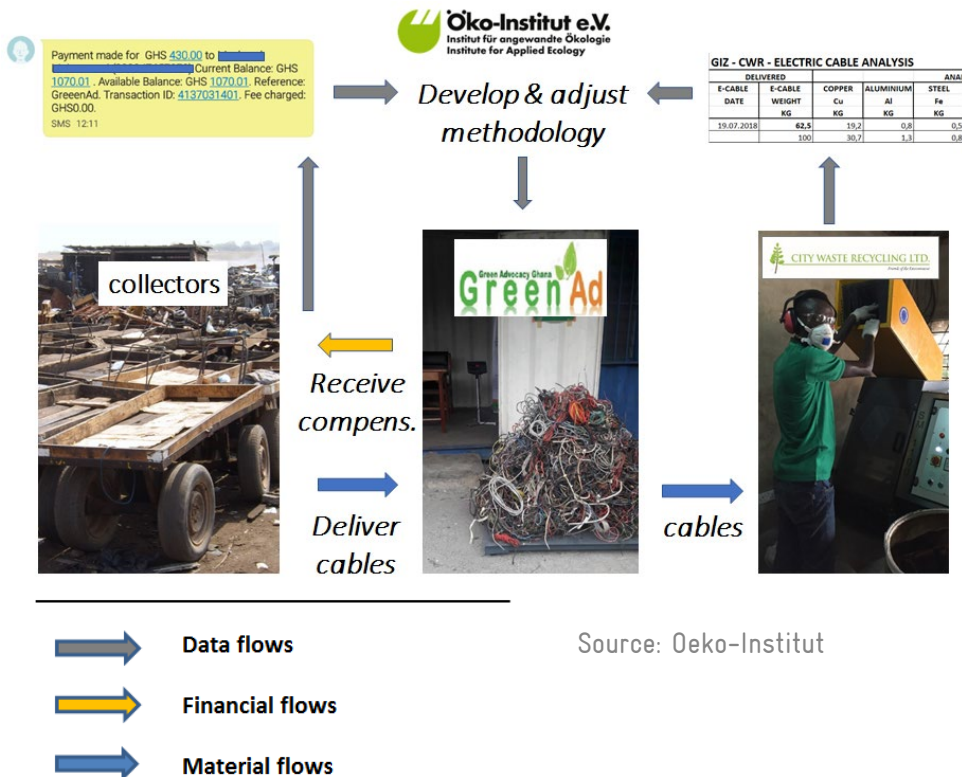
<sup>1</sup>Activities and outcomes related to this module are not documented in this report.

# 5 | System set-up phase

## 5.1 Concept overview

Figure 5.1 illustrates the concept developed and implemented in this project. The handover centre managed by GreenAd was in the centre of the exercise, where collectors and scrap workers could bring cables against a defined compensation above local material value. All transactions were recorded by digital systems and the data provided to Oeko-Institut for analysis and to adjust and fine-tune the system. Once sufficient amounts of cables had accumulated at the handover centre, City Waste Recycling picked up the cables and conducted recycling, including a material analysis. The related information was also provided to Oeko-Institut for analysis.

Figure 5.1: Concept of implementation phase



The following sections of this chapter describe preparatory steps undertaken in order to implement this concept. The actual implementation is described in chapter 6.

## 5.2 Market study & setting the incentive level

In order to define a meaningful incentive level for the implementation phase, the market for waste cables was assessed. This was done by analysing current management practices for waste cables in Ghana, studying local market prices through interviews, and by crosschecking this market findings with calculations based on material composition and international metal prices. These analytical steps also yielded valuable findings for decisions on the transaction process, compensation modalities and supply chain due diligence (see sections 5.4 to 5.6).

### 5.2.1 General observations

During numerous visits to the Old Fadama scrap market, it was observed that the practice of open burning is primarily done with cables with one or more of the following characteristics:

- Short cables;
- Thin cables;
- Cables with no massive core;
- Dirty cables;
- Twisted cables.

The main reason for this situation is the fact that alternative treatment options for these types of cables (manual or mechanical stripping, granulation) would either be associated with a significant higher labour input, or would require investments into machinery and related running costs (Buchert et al. 2016). In addition, mechanical stripping is not suitable for thin cables and cables with no massive cores.

Within the Old Fadama scrap market, the Agboghloshie Recycling Centre (operated by GreenAd in close co-operation with GASDA) has a mechanical cable stripper. With this machine, the Centre offers a stripping service to everybody who brings waste cables to the Centre. Charges are 0.45 GHS per pound of cables and the supplier gets the liberated copper (Atiemo et al. 2016). Observations from these activities indicate that manual stripping is currently only attractive for long and thick cables with massive cores.

At the same time, the cable granulator installed at City Waste Recycling (who is partnering with the project for the sound recycling of collected cables) is capable of treating waste copper- and aluminium-cables up to a maximum core thickness of 2.5 mm.

The pilot incentive system therefore decided to focus on thin and medium cables with a core diameter < 2.5 mm.

### 5.2.2 Purchase and analysis of test batches

On 19<sup>th</sup> of July 2018, GreenAd purchased various batches of waste cables from various sources in Old Fadama. The focus of these purchases was explicitly on cables that would otherwise be burned (focus on mixed thin and medium cables). The suppliers were not asked to remove plugs or any other smaller devices connected to the ends of the cables. In total, GreenAd purchased 61.8 kg of waste cables (see Figure 5.2) for 1,200 GHS (which translates into 214.20 € or 249.36 US\$ applying the exchange rates of 19<sup>th</sup> of July 2018<sup>2</sup>).

**Figure 5.2: Test batches of waste cables purchased in Old Fadama (test purchase 1)**



Source: GreenAd

The cables were given to City Waste Recycling for analysis and recycling. In this process, material composition of Table 5.1 was identified.

<sup>2</sup>Exchange rates of 19th July 2018: 1GHS = 0.1785 € = 0.2078 US\$.



Table 5.1: Material composition of purchased test batches (test purchase 1)

Total	Materials removed before treatment			Materials separated during treatment		
	dirt	steel cables	plugs & other parts	copper	aluminium	insulation material
62.5 kg	0.3 kg	0.5 kg	9.4 kg	19.2 kg	0.8 kg	32.3 kg
100 %	0.5 %	0.8 %	15.0 %	30.7 %	1.3 %	51.7 %

Source: City Waste Recycling

Table 5.2: Material composition of purchased Cu- and Al-cables (test purchase 1 cleaned from plugs &amp; others)

Total	copper	aluminium	insulation material
52.3 kg	19.2 kg	0.8 kg	32.3 kg
100 %	36.7 %	1.5 %	61.8 %

Source: City Waste Recycling

In total, the following information could be collected during the analysis of test batch 1 at City Waste Recycling:

- The weight of the cables was determined to be slightly higher when using the scale of City Waste Recycling (62.5 kg instead of 61.8 kg). With around 1.1 %, the difference is in a tolerable range.
- Some of the cables were very dirty. Dirt removed from the cables was determined to be 0.3 kg (around 0.5% of total of weight).
- Plugs and other non-cable components had to be removed prior to treatment (see Figure 5.3). This fraction made up 9.4 kg (15% of the total weight).
- There were some few cables with a steel core (0.5 kg; 0.8 % of total weight), which could not be recycled with the machine used by City Waste Recycling. These cables were sorted out prior to treatment.
- The rest of the cables was recycled with the cable granulator. This granulator automatically separates metals from insulation material.

- Some of the cables had a fibre based insulation, which is commonly used for cables of irons (see Figure 5.4). This insulation material caused some difficulties during granulation so that the machine had to be stopped every 10 minutes to remove the fibre.

**Figure 5.3: Plugs and other e-waste that was connected to the cables (test purchase 1)**



Source: City Waste Recycling

**Figure 5.4: Cables with fibre based insulation (test purchase 1)**



Source: City Waste Recycling

Based on this analysis of this first test purchases, the following considerations for the implementation phase were made:

- The primary aim is to avoid that cables are burned to liberate copper and other metals. Thus, the incentive system should be tailored in a way that all types of cables (including connected plugs and parts) are channelled to the handover centre. On the other side, it has to be avoided that the incentive structure promotes a shift to cables types and mixes with reduced value as this might lead to a situation where the majority of valuable (copper rich) cables is still burned. Such shifts may be caused by:
  - Significant contamination with dirt;
  - High weight share of plugs and other attached components with limited material value;
  - High shares of cables with steel and aluminium core<sup>3</sup>.
- It is therefore recommended to:
  - Remove all plugs and connected parts prior to weighing;
  - Remove obvious contaminations with dirt (e.g. soil) prior to weighing;
  - Identify and separate steel cables with a strong magnet prior to weighing;
  - Identify and separate other cable types (e.g. fibre-optical cables, Al-cables) by visual inspection (e.g. after clipping).
- As plugs, connecting parts and steel and aluminium cables often also contain hazardous substances, prior removal should not be encouraged. Therefore, this fraction should also be weighted and compensated separately. As this fraction has a comparably low material value, compensation level should be lower than for the copper cables.
- At the same time deliveries of plugs and mixed e-waste parts (not attached to cables) should not be accepted at this stage of the test. This is because the current test has a clear focus on waste cables.

<sup>3</sup> The implementation phase revealed in fact that a high share of Al-cables was delivered. For this reason, a separate incentive level was introduced for Al-cables on 15.04.2019 (see section 5.2.6).

Based on these findings and considerations, GreenAd organised a one day test run of the incentive system on 29<sup>th</sup> August 2018 and implemented the points above. In contrast to the first test purchases, this purchase was well communicated to GASDA members before and took place within the handover centre run by GreenAd and according to the considerations listed above. The price for cables without dirt and plugs was set at 20 GHS/kg and 1 GHS/kg for plugs<sup>4</sup>. As the price was obviously quite significantly above the local material value of cables (see section 5.2.5), there was an overwhelming interest in selling cables to the handover centre. Due to this huge interest, the test was stopped after around two hours. Up to this time, 143.8 kg of cables were collected from 11 suppliers (144.2 kg measured with the scale of City Waste Recycling). The cables were given to City Waste Recycling for analysis and recycling. In this process, material composition of Table 5.3 was identified.

**Table 5.3: Material composition of purchased test batches (test purchase 2)**

Total	Materials removed before treatment			Materials separated during treatment		
	dirt	Fibre optical cables	plugs & other parts	copper	aluminium	insulation material
144.2 kg	0.1 kg	0.3 kg	17.1 kg	54.5 kg	18.2 kg	54.1 kg
100 %	0.1 %	0.2 %	11.8 %	37.8 %	12.6 %	37.5 %

Source: City Waste Recycling

**Table 5.4: Material composition of purchased Cu- and Al-cables (test purchase 2 cleaned from plugs & others)**

Total	copper	aluminium	insulation material
126.8 kg	54.5 kg	18.2 kg	54.1 kg
100 %	43.0 %	14.4 %	42.7 %

Source: City Waste Recycling

<sup>4</sup> On that day the price was somehow influenced by GASDA who communicated the test to its members in a way that price expectations were quite high.

In total, the following information could be collected during the analysis of test batch 2:

- The weight of the cables was determined to be slightly higher when using the scale of City Waste Recycling (144.2 kg instead of 143.8 kg). With around 0.3 %, the difference is in a tolerable range.
- The cleaning of the cables prior to weighing / accepting could reduce the amount of dirt to around 0.1% of the total weight (compared to 0.5% of the first test batch).
- Despite the specification to remove plugs and connectors prior to weighing / accepting of cables, plugs and other electrical components still made up 11.8% of the total weight (compared to 15.0 % of the first test batch).
- There were no cables with a steel core in the second test batch. Instead, there was one optical fibre cable of 0.3 kg (0.2 % of total weight).
- Compared to the first test batch, the share of aluminium was much higher (12.6% compared to 1.3 % of the first test batch).
- The copper content increased to 37.8 % (from 30.7 % of the first test batch).
- City Waste Recycling reported that the diversity of cables created challenges (no individual cable > 0.5 kg with majority between 15 g and 100 g) and required quite significant labour input to make sure fibre optical cables and steel cables are effectively sorted out prior to granulation.
- City Waste Recycling also voiced the concern that the application of a uniform incentive level for all cables pushes the collected volumes towards low grade cables.

Based on this analysis of this second test purchases, the following additional considerations for the implementation phase were made:

- Removing all plugs and connected parts prior to weighing is important. But it seems that this practice was not applied consistently in the second test. It is therefore of high importance that operating staff is trained and reminded accordingly.

- Efforts should be made to identify and reject fibre optical cables. As fibre optical cables have no material value for recyclers (and also not for the informal recyclers in Old Fadama scrap market), there is a certain danger that the pilot will attract additional waste volumes. In a worst case scenario, it would even stimulate theft of such cables.
- The share of Al-cables has to be observed. In case volumes and shares continue to be considerable, a separate system (grading system – next point) should be considered<sup>5</sup>.
- It should be considered to introduce a grading system of cables to avoid that predominantly low grade cables are collected. While grading can be done in various ways, the applied system should still be simple enough to be manageable.

### 5.2.3 Local market prices for waste cables and copper scrap

Interviews conducted by GreenAd in Old Fadama scrap market in July 2018 revealed that there are three major copper scrap types with the following indicative market prices:

**Table 5.5: Copper scrap types and prices in Old Fadama scrap market**

Description	Local value [GHS/kg]	Local value [€/kg] <sup>6</sup>
Unburned copper (thin wires)	20 GHS/kg	3.63 €/kg
Unburned copper (thick wires only)	24 GHS/kg	4.36 €/kg
Copper from burning activities	10–14 GHS/kg	1.82 – 2.54 €/kg

Source: GreenAd

Category 1 (unburned copper thin wires) matches best with the copper that can be generated from recycling of collected cables. On the other side the 3<sup>rd</sup> category best reflects the copper type prices that can be generated from burning activities. Thus, it is recommended that the pilot incentive system uses the upper boundary of prices for the 3<sup>rd</sup> category (14 GHS/kg, 2.54 €/kg) for determining a pricing mechanism.

Assuming an average copper content of 43.0 % (see Table 5.4)<sup>7</sup>, this means that the local value of mixed cables for burning should be at around 6.0 GHS/kg (1.09 €/kg).

<sup>5</sup> In fact, a relatively high share of Al-cables made it necessary to introduce a separate grade and incentive level for this type of cables. It was introduced on 15.04.2019 (see section 6.2).

<sup>6</sup> Average exchange rates from 9th of July to 8th of August: 1€ = 5.505 GHS.

<sup>7</sup> The composition data of test purchase 2 was chosen as it is widely seen as the more representative sample compared to test purchase 1.

#### 5.2.4 International market prices for waste cables and copper scrap

The material value of waste cables depends on the copper content, which varies over different cable types. Thus, there is no international market price for waste cables as such. Therefore, scrap dealers usually either buy cables at a comparably low price (to be economically on the safe side), or they buy copper generated from cable recycling. Depending on the type and quality, the generated copper scrap is classified in different categories for pricing. The copper scrap categories of Table 5.6 are commonly used in the trade of copper scrap from cables.

**Table 5.6: Common copper scrap categories**

International term	German term	Description	European market price on 08.08.2018
Milberry	Kabul	Clean, not burned, blanc, unalloyed copper wires, minimum diameter of 1 mm, no contamination with other material	4900 €/t
Berry	Kader	Unalloyed copper wires, minimum diameter of 1 mm, no contamination with other material	4550 €/t
Birch	Kanal	Unalloyed copper wires, minimum diameter of 0.15 mm, minimum Cu-content of 94 %, not burned, no coatings, no alien material	4550 €/t
Clove	Kasus	Unalloyed, blanc, granulated Cu wires, minimum diameter of 0.5 mm, no alien material	4950 €/t
Cocoa	Katze	Unalloyed, granulated Cu wires. Minimum Cu-content of 99% (cocoa) / 98.5 % (Katze).	4600 €/t

Source: Institute of Scrap Recycling Industries 2016; Verein Deutscher Metallhändler 1988; Recycling Magazin 08/2018

All prices strongly correlate with the international copper prices. Due to the small diameters of copper wires from mixed cables, the Birch/Kanal classification appears to be closest to the copper scrap that will be generated from the collected cables.

Table 5.7 indicates that the European market prices for Birch/Kanal copper scrap range between 80% and 90% of the LME copper prices (average 84.3 %). This ratio is used in the formula below (scrap price factor).

**Table 5.7: 2018 price development for birch copper scrap and LME copper**

	10 Jan	07 Feb	07 Mar	11 Apr	16 May	13 Jun	11 Jul	08 Aug
Cu-scrap (birch)	4900 €/t	4750 €/t	4700 €/t	4700 €/t	4850 €/t	4950 €/t	4600 €/t	4550 €/t
Cu-price LME	5952 €/t	5577 €/t	5568 €/t	5589 €/t	5753 €/t	6149 €/t	5251 €/t	5290 €/t
Birch/LME	82.3 %	85.2 %	84.4 %	84.1 %	84.3 %	80.5 %	87.6 %	86.0 %

Source: Recycling Magazin 01-08/2018; Markets Insider 2018

### 5.2.5 Modelling the local net value of Cu-cables

The local net value can be determined in two ways: By price modelling and by market research on site. Both approaches were used and compared in the project. This section mainly focuses on the modelling approach. The market research approach is presented in section 5.2.3.

The intrinsic copper value of waste copper cables can be estimated with the following formula:

$$V_{Cu} = W_{Cab} \times C_{Cu} \times P_{LME} \times F_{Scrap}$$

$V_{Cu}$  = Intrinsic copper value [€]

$W_{Cab}$  = Weight of cables [kg]

$C_{Cu}$  = Copper content [%]

$P_{LME}$  = LME price for copper [€/kg]

$F_{Scrap}$  = Scrap price factor [%]



Due to the negligible value of insulation material<sup>8</sup>, it is assumed that the intrinsic material value of copper cables is equivalent to the intrinsic copper value:

$$V_{Cab} = V_{Cu} = W_{Cab} \times C_{Cu} \times P_{LME} \times F_{Scrap}$$

$$V_{Cab} = \text{Intrinsic material value of copper cables [€]}$$

For e-waste recyclers, the net value of cables is lower than the intrinsic material value. This is because recyclers have efforts and costs related to treatment (liberating the copper, management of other fractions) and shipment of copper scrap to a copper refinery. Further costs are related to compliance and documentation (e.g. reporting on standards, permits), taxes and other<sup>9</sup>.

While treatment may be costly for formal recyclers operating according to high environmental standards and with machinery, related costs for informal sector recyclers are very low or even negligible. This is because cable fires are not associated with much manual labour input. In addition, other fractions are burned (cable insulation) or disposed uncontrolled. Both options do not create any direct economic costs. As this pilot incentive system aims at offering economic incentives above the cable net value of informal recyclers, treatment costs and other costs of formal recyclers have to be neglected.

To estimate the shipment costs for liberated copper, it is assumed that the copper scrap is shipped to a European refinery, which was found to be common practice in Ghana (Atiemo et al. 2016). Scrap shipments from Ghana to European refineries cost around 325 US\$/t (377 €/t) (Manhart et al. 2015).

The local net value of waste cables in Ghana can be estimated with the following formula:

$$V_{NetCab} = (W_{Cab} \times C_{Cu} \times P_{LME} \times F_{Scrap}) - (W_{Cab} \times C_{Cu} \times P_{ship})$$

$$V_{NetCab} = \text{Net value of waste cables [€]}$$

$$P_{ship} = \text{Shipment costs [€/kg]}$$

<sup>8</sup> Recycling of cable insulation material is a challenging field. Usually sound management is not associated with any profits.

<sup>9</sup> While these further costs may be substantial in many cases, they are usually not directly attributed to individual material streams and are therefore not considered in the calculations of this chapter.

The following factors can be pre-determined based on literature data and data from the preliminary analysis of cables<sup>10</sup>:

- $C_{Cu} = 43.0 \%$  (see Table 5.4)
- $F_{Scrap} = 84.3 \%$  (based on average values of Table 5.7)
- $P_{ship} = 0.377 \text{ €/kg}$  (Manhart et al. 2015)

Assuming an LME price of 5.241.35 €/kg (monthly average of August 2018), this would result in a net cable value of 1.74 €/kg (- 9.57 GHS/kg<sup>11</sup>).

The analysis in section 5.2.3 suggests that the local value of mixed cables for burning is at around 1.09 €/kg (- 6.0 GHS/kg). The difference to the net cable value can be explained by the margins taken by intermediaries.

### 5.2.6 Setting the initial incentive levels

The initial incentive level for Cu-cables was set by using the local net value of waste cables and by adding a small service fee that compensates the suppliers for bringing the cables to the handover centre. This service fee was kept variable to allow the project to adjust the incentive level in case market reactions are below or above expectations. It was intended to start with a rather low incentive level and to increase that level during the course of the implementation if needed (also see section 6.2). In general, the aim was to come to an incentive level that is sufficiently attractive for local collectors and recyclers so that they deliver cables to the handover centre instead of conducting uncontrolled burning activities.

As scrap dealers in Old Fadama are used to trade cables and copper scrap in pounds, incentives were offered in GHS per pound (GHS/lb.).

<sup>10</sup> Factors are used for the initial phase of the pilot incentive system and are reviewed on the bases of material compositions of further cables collected in the pilot.

<sup>11</sup> Average exchange rates from 9th of July to 8th of August: 1€ = 5.505 GHS.

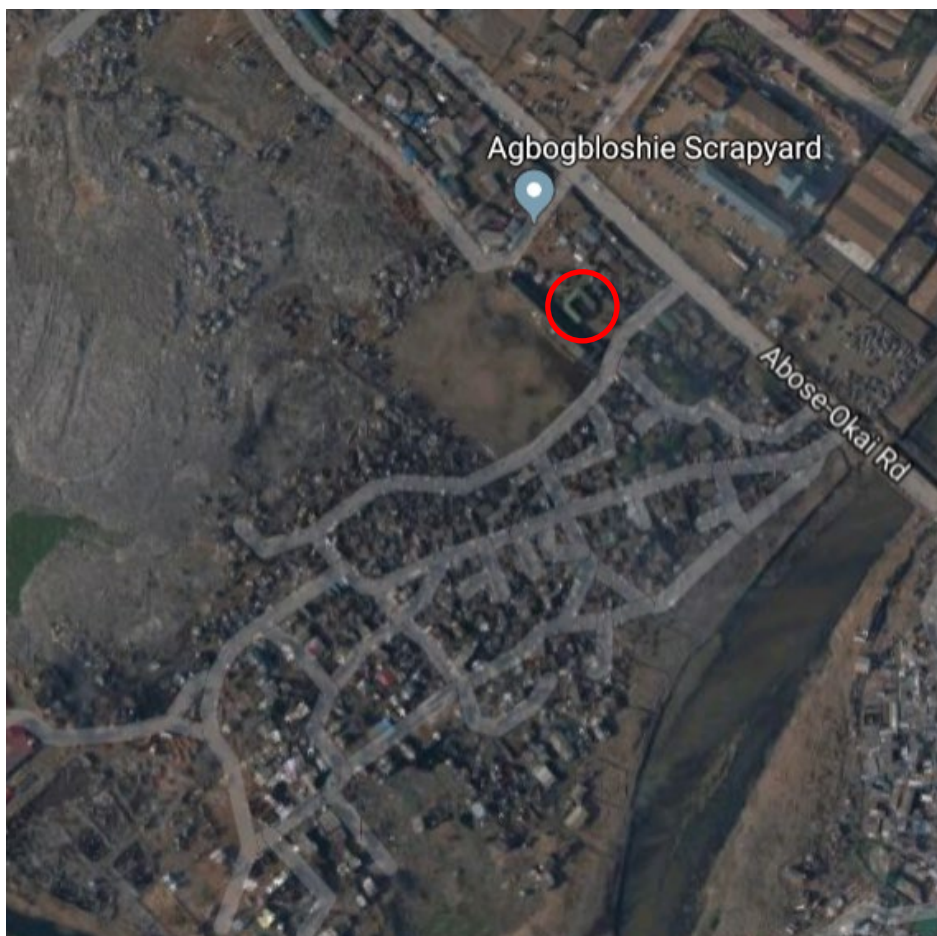
The project used a grading of cables to reflect differences in metal content. Grading and pricing methods were transparently communicated to GASDA and its members during the beginning of the implementation phase, as well before adjusting the incentive levels in December 2018 and April 2019 (see Table 6.1). During these events, the factors and calculations as displayed in Figure 6.2 were shown and explained to GASDA members. As many GASDA members are quite experienced in the scrap trading business, the explanations and figures were well received and appreciated by most participants. The calculations used in are based on the developed approach of section 5.2.5 but values partly vary due to changes in world market prices, exchange rates and copper content of cables.

The incentive level for steel cables and plugs was set on an experimental base and was mainly aimed at discouraging a disposal of attached plugs that were delivered with cables. The implementation has shown that this incentive level did not stimulate additional deliveries of plugs and was found to be suitable chosen for its purpose (no adjustments over the implementation period needed).

### **5.3 Set-up of handover centre**

The handover centre is located within the Old Fadama scrap market close to the GASDA office and next to the former National Youth Authority warehouse (see Figure 5.5). During project implementation, the warehouse was fully refurbished by the GIZ E-waste Programme and converted into a technical training centre and a clinic being run by the Ghana Health Service.

Figure 5.5: Location of the handover centre at Old Fadama scrap market (red circle)



Source: Imagery © 2019 Google, Map data © 2019 Google

The handover centre consisted of three 40-foot sea-containers that are placed to a U-shaped square. This container-structure already existed before this project and was initially set-up in a previous project financed by the US-American Blacksmith Institute<sup>12</sup> in co-operation with GreenAd. GreenAd is the owner of the container structure while the land belongs to the National Youth Authority. The structure is fenced with a lockable entry gate. All containers are converted to workshops and storage rooms with doors and windows. All windows and doors could be locked. The containers are covered by an additional roof to prevent overheating of the interior. The roof also gives shade to parts of the outside square. Cable transactions were done in the roofed area of the square.

<sup>12</sup> Today, the organization is named "Pure Earth".

The handover centre was equipped with a digital scale (see Figure 5.2). Furthermore, workers have been supplied with personal protective equipment and tools such as pliers, knives and magnets to conduct all tasks related to the transaction process described in section 5.4.

Figure 5.6: One of the roofed containers of the handover centre



Source: Oeko-Institut

## 5.4 Transaction processes

During the implementation, the handover centre was open for receiving waste cables from Monday – Friday from 8 am to 5 pm. Exemptions have been public and religious holidays and in cases of unforeseen circumstances (for details see chapter 6). Based on the market survey and the experience of the involved project members, all transaction followed the following considerations and process:

### Cables that are accepted:

- Thin cables
- Medium cables
- Mixed cables (no cables with one or more massive cores  $\emptyset > 2.5\text{mm}$ )
- Deliveries with a total weight  $\leq 500$  kg

### Cables that are NOT accepted:

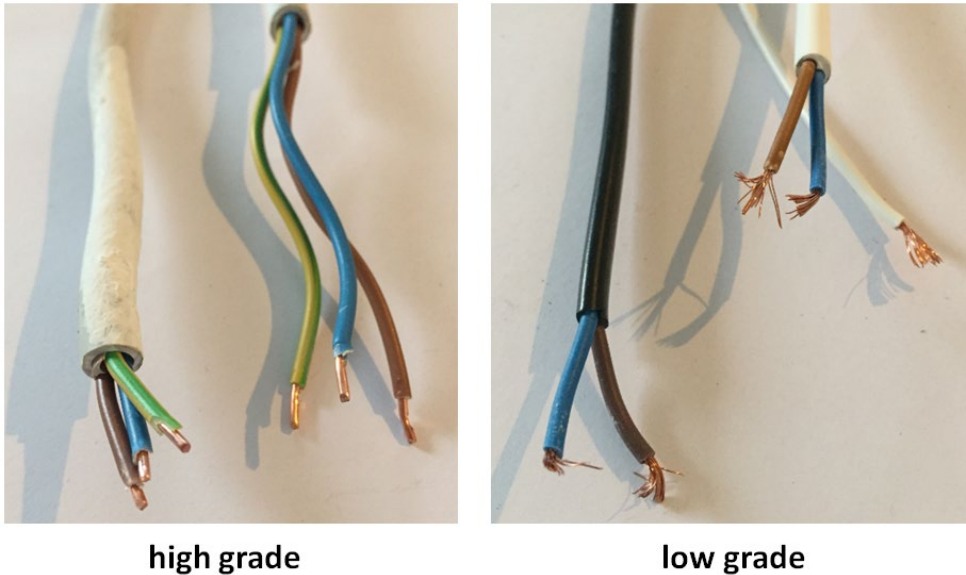
- Cables with one or more massive cores  $\emptyset > 2.5\text{mm}$
- Cables that have signs of burning
- New cables
- Cables of unclear origin that might come from illegal activities (e.g. stolen from installations)
- Cables with no metal core (e.g. fiber-optical cables)
- Deliveries with a total weight  $> 500$  kg

### Initial Grading of the cables:

For the start waste cables were classified into two grades:

- High-grade cables (very clean, sorted, all cables with massive copper cores)
- Low-grade cables (some remaining dirt acceptable, unsorted, copper cables with no massive core)

Figure 5.7: Cable grades used at the beginning of the implementation phase



Source: Oeko-Institut

There were different incentive levels for the two grades. In addition, steel cables and plugs delivered with the waste cables were compensated with a basic incentive level (see Table 6.1). For the grading process, the project tried to find a practical way to balance the practicability (clear and simple grading criteria) with the need to account for a broad diversity of cable types. In the course of implementation, grading was revised as described in section 6.2.

Incentive levels were displayed visually and also communicated to GASDA officials and other persons upon request.

#### Process of accepting and weighing of cables:

- Step 1: General check of cables. Are the delivered cables in-line with the above listed requirements?
  - If no → reject.
  - If yes → proceed with Step 2.
- Step 2: Dirt and alien material is removed manually.
- Step 3: Plugs and connected parts are clipped off and put in a separate drum.

- Step 4: Magnet-test to identify and sort out steel cables (steel cables are given into the drum with plugs).
- Step 5: Sorting of cables according to the specified grades (visual inspection and by cutting the cables with cutters and pliers). Fiber optical cables are rejected.
- Step 6: Take the weight of each cable grades and continue with each grade separately (one transaction process per grade).
- Step 7: Take a picture of the delivered cable grades on the scale. The picture must show all cables and the scale display clearly.
- Step 8: Use the weight data of step 6 to calculate the compensation.
- Step 9: Offer the compensation to the supplier.
  - In case he does not agree → supplier must remove all delivered cables and connected parts on his own effort.
  - In case he does agree → proceed with Step 10.
- Step 10: Enter all relevant data into the digital bookkeeping system (cable grade, weight of cables, total compensation paid, date, time, mobile phone number of recipient).
- Step 11: Compensate the supplier with mobile payment system
- Step 12: Store the cables in a safe manner inside the handover center.

## 5.5 Compensation modalities

The way suppliers are compensated was a widely open question when planning the pilot incentive system. The following considerations were made prior to implementation:

- All suppliers will have to be compensated directly after delivering cables – time lags are not acceptable and will undermine trust in the system.
- The presence of cash money at the handover center will represent a security risk. Thus, the amount of cash shall be limited to a necessary minimum. In addition, the transaction process shall be set-up in a way that suppliers and other observers



do not expect the presence of significant cash money.

- In this situation, compensation by mobile money is a suitable option, but might represent an obstacle for individuals that have no access to related systems. At the same time, there are different mobile money providers such as MTN, Vodafone and Airtel/Tigo. Although interoperability is given between the different platforms, transactions between different platforms are associated with fees.
- Compared to cash transactions, mobile money also has significant advantages for bookkeeping purposes as every transaction is automatically recorded, including date, time and the mobile phone number of each recipient.

For the implementation phase, the project team decided to offer the following compensation mechanism:

- Preferred compensation method is mobile money. The handover center allowed all mobile money platforms and – in case transactions across platforms are required – was willing to cover the related fees.
- In case some individuals have no access to any mobile money system, compensation in cash can be done up-to a level of 100 GHS per transaction (~18.17 €).

In the course of the implementation it became obvious that all persons supplying the handover center had a mobile phone and were familiar with mobile money, notably via MTN. Subsequently, all transactions were exclusively done with this mobile money platform.

## 5.6 Supply-chain due diligence

With its monetary incentives and its location with the Old Fadama scrap market, the pilot exercise deliberately interfered with some of the material and financial flows of the informal scrap metal sector in Accra. As informal scrap metal sectors are in many aspects closely tied to sub-standard working conditions, environmental impacts and probably also to violations of existing laws, the whole exercise was accompanied by measures to reduce the risks of directly or indirectly contributing to some of these worst practices.

With the given activity profile, the following risks have been identified prior to implementation:

- 1) Supporting sub-standard working conditions by directly engaging with informal scrap workers;
- 2) Stimulating illegal imports of e-waste;
- 3) Stimulating illegal means of scrap collection (e.g. theft of cables).

The risks were dealt with as follows:

Risk No. 1: Due to the nature of the approach, a direct relationship with informal scrap workers is inevitable. While a registration of collectors and recyclers is desirable, the limited scope and duration of the pilot did not allow for accompanying measures for registration. Moreover, the procedures of registering collectors according to the new Technical Guidelines on Environmentally Sound E-waste Management (EPA & SRI 2018) have not been established into a routine process yet. Besides that, the risk of sub-standard working conditions at supplying individuals is quite real. Nevertheless, the activity offers preferential conditions for waste cables and therefore contributes towards higher incomes of scrap collectors. In addition, the effort is part of a larger project that systematically strengthens informal scrap workers in Accra. While the focus on waste cables might partly motivate (unsound) dismantling of devices, it was estimated that the majority of waste cables in Old Fadama scrap market have to be regarded as stand-alone e-waste types as they come from general wiring and installations (e.g. in buildings) (Amoyaw-Osei et al. 2011). As the approach provides an alternative for cable burning, it also substantially reduces exposure of workers and neighboring communities to toxic pollutants.

Mitigation measures:

- No cables from underage persons
- Distribution of 200 pairs of work gloves to suppliers
- Various activities within the wider project to support informal scrap workers

Risk No 2: Ghana is worldwide associated with illegal e-waste trade. Nevertheless, it is known that most of this trade is motivated by repair and secondhand use activities. This is supported by recent findings that scrap at Old Fadama scrap market is sourced from

households and businesses in the Greater Accra region and not directly from the port in Tema (Owusu-Sekyere 2018). Moreover, scrap is mainly channeled to Old Fadama scrap market by small push carts and in limited quantities per delivery, which widely rules out direct bulk supplies from imports. Therefore, it can be assumed that cables sourced from Old Fadama scrap market mainly come of domestically generated e-waste, even if some of the devices traded and recycled in Old Fadama might have been imported as used equipment before.

Mitigation measure:

- Limit to a maximum of 500 kg of waste cables per transaction

Risks No 3: Illegal means of scrap collection are mostly related to theft of cables from installations and infrastructure. Such theft is particularly problematic as it might impact a wide range of functioning systems and infrastructure. Therefore, it has to be avoided that incentive schemes such as this one stimulates theft of cables and illegal dismantling of infrastructure. To do so, reception personnel at the handover center was explicitly called not to accept long and new looking cables. In case such cables were detected in the photo documentation, the issue was discussed in the project team. In one case, a large supply of a newly looking cable was accepted after the suppliers could prove that it was regularly sourced from a company<sup>13</sup>. Even stricter rules were applied for fiber-optical cables: As these cables have no material value and are found on many construction sites in the public space, a collection incentive can easily motivate theft of such cables. Therefore, reception personnel at the handover center was explicitly called to reject fiber optical cables<sup>14</sup>.

Mitigation measures:

- Registration of name and phone number of each supplier coupled with a picture of each supply
- No acceptance of new cables
- No acceptance of fiber-optical cables

<sup>13</sup> The company was contacted by phone and it confirmed that the cable was purposely given to the supplying scrap collector and that it carried non-visible damages.

<sup>14</sup> Despite this measure, some fibre-optical cables were collected through the system. These cables were mostly short and thin cables from communication devices such as stationary telephones and are less likely to come from illegal activities.

## 6 | Implementation phase

### 6.1 Opening periods

Implementation started on Monday 22.10.2018. Before starting the incentive system, two workshops with representatives from GASDA and interested scrap dealers were held to inform about the approach and to explain the incentive system and the way incentives are determined and paid-out (see Figure 6.1).

**Figure 6.1: Workshop at the handover centre to inform scrap dealers and collectors about the incentive system**



Source: GIZ / Alexander Batteiger

Between 22.10.2018 and 29.01.2019 the handover centre continuously offered incentives for cables as defined in section 5.4. The only closed periods have been:

- Weekends (Saturday and Sunday)
- 07.12.2018 (Farmers' Day - national holiday)
- 24.-26.12.2018 (Christmas)
- 31.12.2018-02.01.2019 (New Year)

The shutdown starting on 30.01.2019 was caused by two factors:

- Temporary shortage of money: As the first batch of money has been spent until end of January, the project account needed a top-up. To get this top-up, all past purchases had to be documented and accounted correctly. Due to the complexity of this process (that was conducted first time in this project constellation), the release of the next payment was delayed.
- The feedback from the recycling enterprise (City Waste Recycling) revealed quality control gaps during cable reception. Subsequently, processes needed to be rearranged thoroughly.

The system restarted on Monday 25.02.2019 with the same regular opening hours. The system was closed on the following days:

- 08.-12.04.2019 (restructuring of cable sorting & grading)
- 19.-23.04.2019 (Easter break)
- 01.05.2019 (Labour Day)

On 31.05.2019 the system was again shut down due to liquidity problems. As the team was now more familiar to deal with this issue, the downtime could be reduced to 7 working days with reopening on 11.06.2019 with the same regular opening hours. Apart from 12.07. (additional rest day for workers of the centre), the system was not closed on any working day until 24.07.2019 when liquidity issues caused a third downtime for 3 working days (restart on 30.07.2019). For the remaining operating time until 20.08., the system was closed on 05.08.2019 and 12.08.2019 (both public holidays in Ghana). 20.08.2019 was the last operating day of the system.

## 6.2 Incentive levels & cable grading

For the incentive level, it was clearly communicated that the project compensates the local material value of the cables + a service fee for collection and transport of the cables to the handover centre (see section 5.2.6). It was also communicated that incentive levels are periodically reviewed and adjusted depending on:

- The LME prices for copper;
- The exchange rate between US\$ and GHS;
- The required service fee to keep the system attractive for scrap collectors.

At the beginning of this process, various scrap collectors demanded that the compensation level shall be negotiated between all stakeholders prior to implementation start. Nevertheless, suggestions by many scrap collectors were far above the figures of own incentive level considerations. In this situation, the only meaningful way was to agree on a general mechanism for determining incentive levels. This was coupled by the confirmation that the incentive system shall be seen as an offer to scrap collectors and that nobody will be forced to deliver cables to the system. At the same time, it was stressed that the system operates without own economic interests and intends to compensate at levels clearly beneficial for scrap collectors (economically and in terms of health & safety). More details on the incentive levels are given in section 5.2.6.

Over the course of implementation, it was decided to introduce a special category and incentive level for aluminium cables. This was motivated by the fact that the share of Al-cables was quite significant in the collected cable volumes picked-up on 21.12.2018 and 18.01.2019 (see Table 6.3). The new category and incentive level were introduced on 15.04.2019 (see Table 6.1).

**Figure 6.2: Calculation used to determine and communicate incentive levels for Cu-cables**

	lower limit	upper limit	Comment
LME price [US\$/t]	6176,51	6176,51	Average price 29.10.-27.11.2018
LME price [US\$/kg]	6,18	6,18	
LME price [US\$/lb.]	2,80	2,80	1 lb = 0.45359237 kg
LME price [GHS/lb.]	13,55	13,55	1 US\$ = 4.83601 GHS (Average 29.10.-28.11.)
Scrap price for copper [% of LME price]	80%	82%	LME price is only for refined copper. Better prices for thick cooper strings
Scrap value of copper [GHS/lb.]	10,84	11,11	
Copper content of cables [% of total weight]	30%	43%	Big differences between different cable types.
Cable value international [GHS/lb.]	3,25	4,78	
Transport costs to refinery [GHS/lb.]	0,73	0,73	the copper needs to be shipped to a refinery outside Ghana.
<b>Cable value Ghana [GHS/lb.]</b>	<b>2,52</b>	<b>4,05</b>	
Variable Service fee for collection & transport [GHS/lb.]	1,53	2,65	Add-on to the price to compensate collection efforts (flexible price item depending on budget availability)
<b>Net compensation [GHS/lb.]</b>	<b>4,05</b>	<b>6,70</b>	New price starting from Monday 03.12.2018

Source Oeko-Institut

The incentive level was determined based on the ratio between the global copper and the global aluminium price, which was 3.35 on average between 18.-29.03.2019 (copper price 3.35 times higher than aluminium price). Assuming a comparable metal content in Al-cables compared to Cu-cables, the incentive level could be calculated by dividing the incentive level for Cu-cables (6.7 GHS/lb. for high-grade cables) by 3.35, which would result in an incentive level of 2.0 GHS/lb. But as Al is lighter than Cu, a slight reduction of the incentive level to 1.8 GHS/lb. was applied.

Table 6.1 gives an overview on offered incentives over the implementation period.

**Table 6.1: Incentive levels offered during the implementation phase<sup>15</sup>**

Cable type / grade	22.10.18 – 16.11.18	19.11.18 – 30.11.18	03.12.18 – 05.04.19	15.04.19 – 20.08.19
<b>High-grade Cu-cables</b>	4.12 GHS/lb.	5.3 GHS/lb.	6.7 GHS/lb.	6.7 GHS/lb.
	1.59 €/kg	2.05 €/kg	2.59 €/kg	2.59 €/kg
<b>Low-grade Cu-cables</b>	2.57 GHS/lb.	3.52 GHS/lb.	4.05 GHS/lb.	4.05 GHS/lb.
	0.99 €/kg	1.36 €/kg	1.56 €/kg	1.56 €/kg
<b>Al-cables</b>	-	-	-	1.8 GHS/lb.
	-	-	-	0.7 €/kg
<b>Steel cables &amp; plugs</b>	0.5 GHS/lb.	0.5 GHS/lb.	0.5 GHS/lb.	0.5 GHS/lb.
	0.19 €/kg	0.19 €/kg	0.19 €/kg	0.19 €/kg

Source: Oeko-Institut

Starting from 15.04.2019 an additional grade for aluminum cables was introduced. From that day on, the pilot worked with 4 explicit grades, namely

- Grade 1: High-grade copper cables (very clean, sorted, all cables with massive copper cores)
- Grade 2: Low-grade copper cables (some remaining dirt acceptable, unsorted, copper cables with no massive core)
- Grade 3: Aluminum cables (cables with aluminum core)
- Grade 4: Steel cables, plugs and alien material connected to delivered waste cables

### 6.3 Verification procedures

Each transaction was photo-documented and all data (weight of the cable, grade, paid compensation, payment mode, name of recipient) entered into a digital system using AkvoFlow Software. Additionally, the photo was uploaded and the photo always had to show the full cable delivery on the scale, including the well visible scale-display (see Figure 6.3). With this photo-documentation, later cross-checks of data were at least partly possible.

<sup>15</sup> Euro values are calculated with an exchange rate of 1€ = 5.70684 GHS. This exchange rate reflects the average real exchange rate for all financial transactions from Euro to GHS done in this project.



Figure 6.3: Example of mandatory photo-documentation of each cable delivery



Source: GreenAd

Further cross-checks of the entered information were done by comparing the recorded weight data with the measured weights taken after pick-up of accumulated cables for recycling. Table 6.2 shows that weights match quite well for the cables collected. Differences for individual pick-ups (e.g. on 18.01. and 15.04.2019) can be explained by the fact that the cumulative weight data is based on data for full days (cable volumes collected from the morning of a day until the evening of another day), while some pickups were made during the course of the day.

Figure 6.4: Pick-up of collected cables for recycling



Source: GreenAd

Table 6.2: Weight based cross-checks

Date of pick-up	Cumulative weight recorded at HOC	Weight taken at pick-up
21.12.2018 (cables only)	776 kg	760 kg
18.01.2019 (cables only)	2240 kg	2542 kg
15.04.2019 (cables only)	3592 kg	3140 kg
03.05.2019 (cables only)	3716 kg	3800 kg
07.06.2019 (cables only)	2996 kg	2980 kg
11.07.2019 (cables only)	5540 kg	5050 kg <sup>16</sup>
16.08.2019 (cables only)	7560 kg	5710 kg <sup>17</sup>
10.09.2019 (cables + all plugs collected during the implementation phase)	787 kg (cables) 245 kg (plugs & others)	3560 kg
<b>Sum</b>	<b>27452 kg</b>	<b>27543 kg</b>

Source: Oeko-Institut

<sup>16</sup> Due to limited transport capacities, 520 kg of cables remained at the handover centre (measured with the scale at the centre).

<sup>17</sup> Due to limited transport capacities, around 100 sacks of cables remained at the handover centre. These sacks were picked-up on 10.09.2019.

Cross-checks were also made for the financial flows: The paid compensations were entered into the digital system together with other transaction information (see above). At the same time, transactions were automatically recorded by the MTN mobile money system. With this double recording, financial flows could be cross-checked and verified.

#### 6.4 Market reactions

Figure 6.6 displays the weekly collection volumes over time. Despite some few transactions in week 1 and 2, the data shows that market reaction to the incentive levels were quite low up to week 6 (also see Table 6.1). With the incentive levels starting in week 7, the system became attractive to collectors. Interestingly, the weekly collection rates after week 6 show pronounced changes over time, which can mostly be explained by the following factors:

##### Factors for a steadily increase of collection volumes over time:

- Strong involvement of the Greater Accra Scrap Dealers Association that agreed on the pricing mechanism and conditions of transaction.
- Increasing familiarity and trust of collectors with the system (also see discussion below).
- Many cable burners have agreements with workshop owners and scrap dealers to do the service of cable burning for them for a defined fee (take their cables, burn them and return the liberated metals). As these arrangements are sometimes long-term, alternatives (even those providing better economic conditions) are not picked-up immediately.
- Some months after the start of the pilot phase, also scrap collectors of other areas of the Greater Accra Tema Region got aware of the system and started to deliver waste cables.

##### Factors causing erratic changes in weekly collection volumes:

- Liquidity issues of the system (see section 6.1).
- The rainy season: Heavy rains during the rainy season that impacted activity of collectors and the scrap market as neither collection vehicles nor scrap workshops

are sheltered from rainfall. At the same time, traffic situation usually deteriorates during heavy rains leading to a general diminishing of economic activities.

- Ramadan: Most collectors and scrap workers are Muslim and fast during Ramadan. During that period activity level of scrap collectors is somewhat lower as during other times of the year.
- Random events leading to high volumes of cable waste (e.g. cable fire in a company, electrical shop auctions at Accra High Street).

In general, both, data of Figure 6.6 as well as experiences from interactions with collectors suggest that acceptance of the system, thus the collected volumes increased over time. In particular the collection volumes from week 34 to 44 indicate that the incentive system was started to be routinely used as sales option for cables. This gradually increasing acceptance is interesting as incentive levels for copper cables have not been changed from week 7 to 44 (see Figure 6.6). Generally, it is assumed that the increasing acceptance has to do with a newcomer-effect: While most collectors and scrap dealers have been embedded in economic networks in Old Fadama and beyond for many months and years before the system started, a cooperation with the newly installed handover centre required them to leave part of their established business connections, which was presumably regarded as business risk. In this situation, the prolonged existence of the handover centre, its quite attractive incentive levels above material value and its transparency regarding role and pricing mechanism (see section 5.2.6) are thought to be the main factors that gradually led to an acceptance of the system and increasing weekly collection volumes over time. Furthermore, collectors have reported that the immediate mobile money payment was appreciated.

Figure 6.5: Cable deliveries during the second half of the implementation period



Source: GIZ

According to numerous interactions with collectors and scrap workers, as well as by visual observations, it was found that most of the groups of cable burners<sup>18</sup> stopped cable burning within the course of the implementation period and restructured their services to supply waste cables to the handover centre<sup>19</sup>. Only one group, the Kilimanjaro Burners, continued to burn cables but lost market shares as many scrap dealers started to channel cables to the handover centre instead<sup>20</sup>.

<sup>18</sup> In Old Fadama, cable burning is mostly done by specialized “burners” who are organised in groups of around 10-20 people. They mostly conducted burning services on behalf of scrap dealers. At the time of the implementation phase, there were around 4-5 groups of cable burners active in Old Fadama: While most of them were somehow affiliated to GASDA, one group (named “Kilimanjaro Boys”) considered (and still considers) itself as independent.

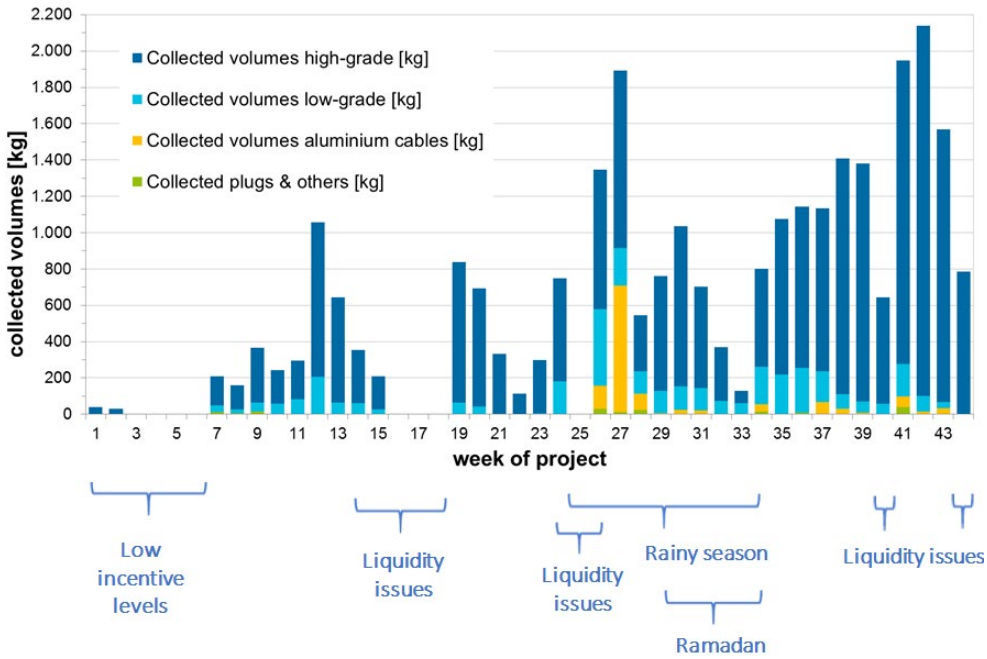
<sup>19</sup> In this context it needs to be noted that there are various other burning activities that have not been influenced by the system. This includes fires to reduce waste volumes and burning of other scrap types to liberate metals. Thus, further efforts are needed to fully resolve the problem of waste and scrap fires in hot spots such as Old Fadama scrap market.

<sup>20</sup> It was reported that some individuals of this group also deserted burning and became suppliers to the centre.

The reasons why this group continued to burn cables despite an economically more attractive option are manifold but are believed to mainly be related to the following factors:

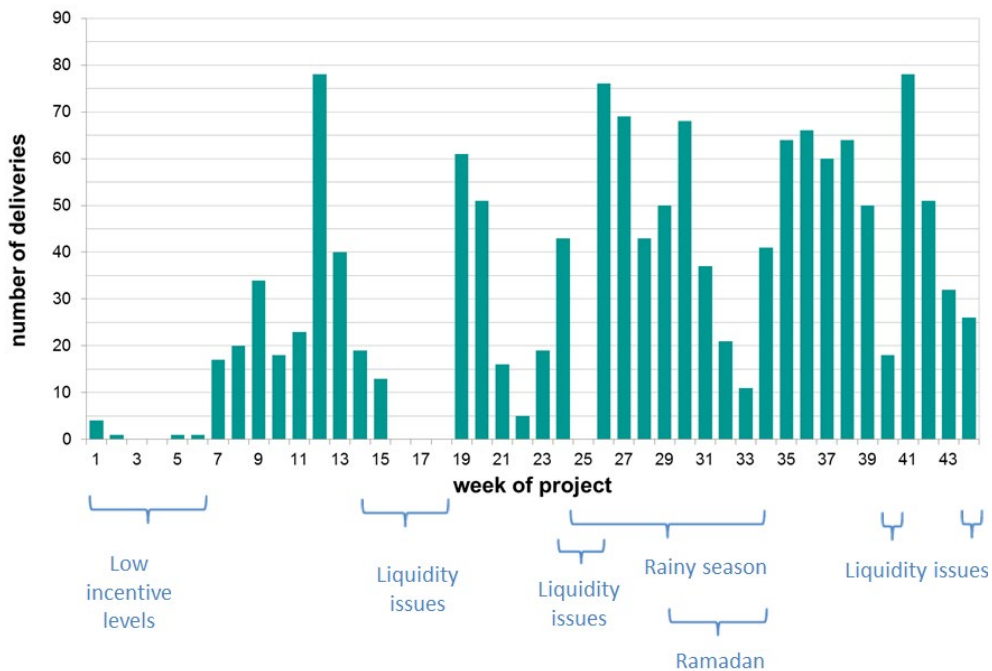
- The leaders of the Kilimanjaro Burners cultivate a strong sense of independence and are reluctant to enter co-operations with a project that has a strong affiliation to GASDA. While representatives of the Kilimanjaro Burners regularly visited the handover centre to seek co-operation under special conditions (e.g. to be provided with upfront payment to collect waste cables to be then delivered to the centre), these conditions were unacceptable to the project as they would have jeopardized transparency and accountability.
- Over the last years of intensive media coverage on the Old Fadama scrap yard, pictures of cable burning activities became iconic and many journalists visiting the area seek to get such pictures for their coverage and agree to pay cash money in that context. As visits of journalists to the scrap market are quite frequent, charges for pictures and films developed into a second income stream for many burners. In that context, a stop of burning may lead to reduced net-incomes even if (unburned) cables can be sold for higher prices.
- A company selling personal protective equipment in Ghana repeatedly visited the Kilimanjaro Burners and built close ties with them. While the burners received various advantages that may have ranged from small payments, over food to medical treatment, the company used pictures and stories from cable burning and its dangers to promote their sale of personal protective equipment. Similarly, to the payments from journalists, this led to benefits to continue with burning activities.

Figure 6.6: Weekly collection volumes over time (calendar weeks 43/2018 to 34/2019)



Source: Oeko-Institut

Figure 6.7: Weekly number of transactions over time (calendar weeks 43/2018 to 34/2019)



Source: Oeko-Institut

## 6.5 Recycling & material analysis

All cables and plugs collected during the project were picked-up by City Waste Recycling. Of the more 27 metric tonnes of cables, 82.2 % were high grade cables, 12.7 % low grade and 4.4 % aluminium cables. Plugs & others accounted for around 0.6 %. The Recycling by City Waste Recycling included the following steps:

- Further manual sorting of cables into the following fractions:
  - Copper cables
  - Aluminium cables
  - Plugs, steel cables and others
- Granulation of copper and aluminium cables to separate insulation from metal. This step was done with a mechanical granulator and automated separation. Staff working at the granulator were equipped with PPEs (dust masks, ear protection, eye protection, working gloves) (see Figure 68). An attached dust filter effectively reduced unnecessary dust emission from the process.
- Generated Al- and Cu-granulate was exported to foreign metal markets<sup>21</sup>.
- Granulated insulation material was exported together with the Cu-granulate to Germany where it was given to high temperature incineration.
- Plugs, steel cables and other waste were sent to Tema landfill.

<sup>21</sup> Export was necessary because there is a very limited local industrial demand for the given grades of aluminium and copper scrap.



Figure 6.8: Granulation of Cu- and Al-cables at City Waste Recycling



Source: Oeko-Institut

The recycling process yielded the following data on material compositions:

**Table 6.3: Material composition of all cables collected during the project (including plugs & others, and including test batches)**

pick-ups		analysis														
date	weight	copper			aluminium		steel		fibre cables		plugs & others		plastic insul.		total output	
	[kg]	[kg]	[%]	[kg]	[%]	[kg]	[%]	[kg]	[%]	[kg]	[%]	[kg]	[%]	[kg]	[% of input]	
19.07.18	62,5	19,2	30,7	0,8	1,3	0,5	0,8	-	-	9,4	15,0	32,3	51,7	62,2	99,5	
11.09.18	144,2	54,5	37,8	18,2	12,6	-	-	0,3	0,2	17,1	11,9	54,1	37,5	144,2	100	
21.12.18	760	139,7	18,4	171,2	22,5	1,9	0,2	-	-	89,2	11,7	358,3	47,1	760,3	100	
18.01.19	2.542	573,2	22,5	587,4	23,1	136,4	5,4	45,3	1,8	267,4	10,5	921,5	36,2	2.531,2	99,6	
15.04.19	3.140	802,1	25,5	796,3	25,4	161,3	5,1	-	-	123,5	3,9	1.254,0	39,9	3.137,2	99,9	
03.05.19	3.800	1.098,3	28,9	782,8	20,6	202,6	5,3	33,2	0,9	165,9	4,4	1.506,3	39,6	3.789,1	99,7	
07.06.19	2.980	741,0	24,9	607,5	20,4	254,4	8,5	49,4	1,7	228,8	7,7	1.090,1	36,6	2.971,2	99,7	
11.07.19	5.050	1.516,8	30,0	700,8	13,9	281,6	5,6	203,9	4,0	405,5	8,0	1.915,1	37,9	5.023,7	99,5	
16.08.19	5.710	1.854,3	32,5	801,3	14,0	321,6	5,6	208,9	3,7	478,9	8,4	2.021,7	35,4	5.686,7	99,6	
10.09.19	3.560	410,6	11,5	1.276,8	35,9	598,6	16,8	62,2	1,7	550,7	15,5	635,4	17,8	3.534,3	99,3	
<b>Totals</b>	<b>27.749</b>	<b>7.209,7</b>	<b>26,0</b>	<b>5.743,1</b>	<b>20,7</b>	<b>1.958,9</b>	<b>7,1</b>	<b>603,2</b>	<b>2,2</b>	<b>2.336,4</b>	<b>8,4</b>	<b>9.788,8</b>	<b>35,3</b>	<b>27.640,1</b>	<b>99,6</b>	

Source: City Waste Recycling

The following findings and interpretation of the material composition are seen as particularly relevant:

- A fully accountable process for the management of the weight of the material flows was established. In total the differences between the collected volumes, the weight of the pick-ups and the total output were marginal and can be explained by the accuracy of the different measurements.
- The deviations between input and output weights of Table 6.3 can be explained by some attached dirt and generation of dust (e.g. from attached dirt residues or cables that contain powder like material between insulation and core). The dust was captured and collected during recycling operations but not accounted for in the figures of Table 6.3 .
- With 26% the average copper content was lower than initially expected after analysing the test batches. This might point towards strategies of suppliers to primarily supply cables with a low average Cu-content. Nevertheless, the limited representative manner of the two test batches does not allow final conclusions in this regard. In addition, a later introduction of Al-grades somehow mitigated overpayment in the second half of the implementation phase.
- With 20.7% the Al-content was higher than initially expected after analysing the test batches. Considering the comparably small volumes being identified and declared as Al-cables at transaction (see Figure 6.6), it needs to be assumed that

many Al-cables were in fact identified and declared as Cu-cables and compensated with a higher incentive. This can be explained by the following factors:

- The cores of many Al-cables are in fact coated with Cu or copper colour and give a copper-like appearance. Thus, visual observations often lead to a false sorting<sup>22</sup>.
- Suppliers might deliberately try to classify Al-cables as Cu-cables to benefit from higher incentive levels.
- The high share of steel (7.1%) can be explained by 'two-components' cables that have an inner core from copper, a second coating from plastic, a third layer of steel casing and a final outer coating from plastic. Here it needs to be noted that pure steel cables actually appear in the column "plugs & others".
- Despite a clear ban on collection fibre optical cables, a volume of 603.2 kg (2.2% of total) was collected during the pilot. Although this is not a desired outcome, a large share of these fibre cables are thin varieties (e.g. from landline telephone sets) and not thick cables used for telecommunication infrastructure. For these thin varieties, the risk of illegal sourcing (e.g. steeling from construction sites) is considered to be very low.

## 7 | Findings & recommendations

For an extension of the incentive based collection system or any other attempts to set-up comparable systems in Ghana or other countries, the following findings and recommendations can be derived from the pilot implementation:

- Incentivizing the collection of waste cables is a strategy that works in Accra and that has the potential to dry-out highly polluting cable burning, while not ignoring existing players and structures in scrap collection and handling. In total 27.5 t of waste cables (including attached plugs and others) were collected and channelled to sound recycling during the implementation period. These volumes

<sup>22</sup> The risk of false sorting can somehow be reduced by using knives because they expose a larger cutting surface than pliers.

were collected in 1389 individual transactions that were all recorded transparently, including supplier names and phone number, delivered cables types and volumes, as well as paid-out incentive and photo documentation.

By motivating collectors and scrap dealers to hand over unburned cables, the approach helps to redesign the interface between informal and formal recycling economy: While under usual conditions, scrap collectors and traders sold copper from burning activities to registered traders, most of them changed to sell unburned cables to the handover centre during the pilot implementation.

- By offering compensations above the local material value, suppliers have a measurable economic benefit from a higher economic return for their waste cables. Considering the fact that scrap collectors are a particular vulnerable group of society, such benefits may improve livelihoods and also add to the wider recognition of their work. In general, it is recommended to see the work of scrap collectors not only as a means to aggregate and recover (valuable) raw materials, but to also give them an active role in the important service of keeping the environment free from waste and pollutants. Thus, related collection incentives shall be regarded as compensation for conducting a service to the society and the environment.
- In this context, scrap workers and also neighbouring population benefit from reduced pollution from cable fires. Although some level of cable burning continued during the whole course of implementation, a significant reduction was evident, in particular in the second half of the trial.

The reasons for continued cable burning are manifold, but can most likely be found in the fact that some cable burners benefit from additional income streams such as cash payment from journalists who visit the scrap market. As journalist visits to the Old Fadama scrap yard (Agbogbloshie) are frequent (on average more than 1 group per week) and as most journalists and their fixers pay for the allowance to shot picture and films for their coverage, this additional income should not be underestimated<sup>23</sup>.

<sup>23</sup> A potential solution could be to work out a code of conduct for journalists visiting the scrap yard and to build awareness that some types of interactions might have unintended effects.

- The set-up of the pilot has proven that a fully accountable system providing all necessary information and documentation on mass-flows, financial flows and individual transactions is possible with reasonable efforts.
- Naturally, incentive based collection as conducted in this pilot requires constant financing as collectors were compensated above the local market value of waste cables. In Ghana, the Hazardous and Electronic Waste Control and Management Act (Act 917 of 2016) does foresee the establishment of a National E-waste Fund that shall be filled by e-waste levies on imported equipment. The collected funds are to be used for sound management of e-waste and to reduce negative impacts. To do so, Act 917 does – amongst others – foresee “incentives for collection, transportation and disposal”. Therefore, Ghana already has the legal pre-condition to provide constant financing for sound e-waste collection. This pilot exercise can serve as a starting point to plan and roll-out related collection efforts and to use the resources of the e-waste fund in an effective manner reducing environmental impacts while integrating vulnerable groups.
- For countries and settings where such legal pre-conditions do not exist, it is recommended to explore the concept of Extended Producer Responsibility (EPR) to support incentive based collection. In this context, it is worth to note that incentive based collection offers very good means for monitoring and quantification: As all delivered volumes as well as paid-out incentives can be fully recorded, measuring and monitoring of cost/effect relationship is relatively easy. And with a known baseline (e.g. that cables would all be burned without such intervention), this data can also be used to calculate avoided emissions to the environment.
- The costs associated with setting-up and running of an incentive-based collection system can be divided in two main lines: Costs for setting-up and operating the system and costs for collection incentives. Over the whole implementation period, the latter costs were at 2.35 €/kg of cables (including plugs & others). Here it needs to be considered that waste cables were given to sound recycling and material analysis for free and that – in larger and more mature systems – some financial compensation from recyclers should be expected. As the local material value was determined at 1.32 €/kg when using the measured material composition

of Table 6.3, it is assumed that net incentive costs would range between 1.25 €/kg and 1.75 €/kg assuming comparable LME prices and exchange rates as during the project period<sup>24</sup>.

- At the same time it is assumed that incentive levels could possibly be slightly reduced after such a system has been accepted as reliable and attractive downstream market for collected cables (and possibly also other waste types). This assumption is based on the consideration that many market players are already embedded in existing economic networks when incentive based collection starts. In such a situation, the cooperation with a newly installed handover center requires them to leave part of their established business connections, which is presumably regarded as business risk. This risk might initially only be acceptable when the alternative (the incentive system) offers substantial economic improvements<sup>25</sup>.
- Furthermore, if an incentive system is implemented permanently (e.g. in combination with continuous funding from an EPR- or eco-levy system) enforcement of a burning ban could become an option. Such a ban might further reduce burning activities and possibly also allow a slight reduction of incentive levels.
- Incentive based collection is not only possible for waste cables, but assumed to be an effective measure for all waste types that:
  - Are associated with high environmental impacts if not managed properly;
  - Can easily be distinguished from other waste types;
  - Where standards, auditing and sanctions are prone to failure (informal sector settings where the number of individuals is large and where processes can easily be relocated).

It is also noteworthy that incentive based collection is already an established and successful concept in other waste streams such as plastic waste. While some

<sup>25</sup> During the pilot project, there was no adaption of the incentive levels between December 2018 and August 2019. Nevertheless, inflation of local currency somehow led to an effective reduction of levels by around 8% in this time period. This reduction had no measurable influence on the acceptance of the system

<sup>24</sup> Net incentive costs = incentive value – local material value + treatment costs. Treatment cost are estimated at 0.22 to 0.72 €/kg

of these concepts build on mandatory deposit-refund systems (e.g. for plastic beverage bottles in Germany), others are financed from other sources (e.g. plastic collection organized via PlasticBank<sup>26</sup>). With regards to e-waste, incentive based collection exists for waste mobile phones and is organized by Closing the Loop<sup>27</sup>, which is widely based on voluntary financial contributions from producers and/or users of mobile phone worldwide.

- Generally, it needs to be stressed that the concept of incentive based collection is not meant to replace other approaches to reform informal collection and recycling activities such as registration/formalization, training and provision with appropriate handling and treatment technologies and enforcement. On the other side, previous interventions and experiences around cable burning have shown that reform strategies solely based on training and technology provision had very limited measurable impact as open burning still holds economic advantages compared to sound (mechanical) treatment (no investments and running cost and very little labour input overcompensate slightly higher prices for clean copper from mechanical treatment<sup>28</sup>). Comparable limitations also exist for many other e-waste types, in particular where sound recycling comprises the (costly) management of hazardous fractions.
- The concept of incentive based collection should be further tested and elaborated in different geographic and socio-economic set-ups, as well as regarding waste types in scope.

<sup>26</sup> See: <https://plasticbank.com>

<sup>27</sup> See: <https://www.closingtheloop.eu/>

<sup>28</sup> At the same time, copper from burning (brownish in colour) offers the opportunity to manipulate the weight of retrieved copper (e.g. by adding rusty steel cables or by preliminary extinguishing the cable fires so that residual plastics still sticks to the material).

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