Principles and comparison criteria for e-waste compensation

Discussion paper based on the outcomes of the project E-waste Compensation as an International Financing Mechanism in Nigeria (ECoN)

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Abstract

E-waste compensation is a relatively new financial mechanism addressing the economic needs for sustainable e-waste recycling in low- and middle-income countries. Therefore, it is essential to define guardrails on how the concept should be implemented in practice. Therefore, during the course of the PREVENT funded project "E-waste compensation as an international financing mechanism" (ECoN), we developed and defined 11 general principles of effective e-waste compensation. Finally, these 11 general principles are complemented by comparison criteria for the product group flat panel screens.

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The elaboration of the general principles for e-waste compensation at hand is the result of the very intensive collaboration within the ECoN project team itself together with Alexander Batteiger and Jana Mandel from GIZ.

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We would like to apologise to all those we forgot to mention by name and thank them in the same way for their work.

The ECoN project team

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List of Abbreveations

B2B	Business to business
BMS	Battery management system
CRT	Cathode ray tube
CTL	Closing the Loop
ECoN	E-waste Compensation as an international financing mechanism in Nigeria
EoL	End-of-life
EPR	Extended Producer Responsibility
E-waste	Electronic waste
IT	Information Technology
LAB	Lead-acid battery
LCO	Lithium-cobalt oxide
LFP	Lithium-iron phosphate
LIB	Lithium-ion battery
LMO	Lithium-manganese oxide
Ni-Cd	Nickel-cadmium
NiMH	Nickel-metal hydride
NMC	Lithium-nickel-manganese-cobalt oxide
PRO	Producer Responsibility Organisation
R&D	Research and Development
SRADev	Sustainable Research and Action for Environmental Development

1 Background & purpose of the study

This report was developed within the project *E-waste Compensation as an international financing mechanism in Nigeria (ECoN)*, which was funded under the PREVENT Waste Alliance. The ECoN project aimed at advancing the concept of 'e-waste compensation', where international brands and users of electronic equipment can contribute to a sound management of equivalent e-waste volumes in low- and middle-income countries by providing finances to an organization that organizes collection and environmentally sound management of e-waste on behalf of the brands and users. The project was conducted by Öko-Institut e.V., Closing the Loop, Hinckley Recycling, SRADev Nigeria and Verde Impacto Nigeria.

Waste compensation was a rather new concept, but gained increasing interest from various sides, including governments, large corporates and waste managing companies. While compensation models had been successfully established in the plastic segment, this service was new for e-waste with Closing the Loop being one of only a few players developing and applying a similar approach to e-waste. Under this model, a customer can pay a voluntary financial contribution, which is used to organise the collection and environmentally sound management of a defined amount of e-waste in one or more low- and middle-income countries.

The model had been successfully implemented for mobile phones and was expanded to Li-ion batteries and screens under this project. While Closing the Loop was the most active player in this field, it was expected that others would sooner or later develop and implement similar approaches. Such an expansion was generally welcome as the ECoN pilot project not only delivered a proof of feasibility, but also pointed towards very positive (although still limited) effects on the local waste management and recycling landscape. Therefore, an expansion of the model could also increase the positive impacts and give stimulus and lessons-learnt to e-waste policy developments in low- and middle-income countries.

When anticipating such a growth, it was also important to stimulate a debate on general principles e-waste compensation schemes should adhere to. This report proposes such general principles for e-waste compensation schemes with a view to maximise the potential benefits of e-waste compensation, while effectively mitigating potential risks and unintended side-effects (chapter 3). In a more specific manner, it also proposes comparison criteria that shall help in accounting and comparing compensation claims with real management volumes (chapter 4).

The content of the report is widely based on the practical experiences gained during the implementation of the ECoN project, as well as from the general public, scientific and policy debate on e-waste management.

2 Objectives of e-waste compensation

E-waste compensation has various objectives, which can be attributed to two main clusters:

1 | Support compensating entity (users of a compensation service) in achieving tangible results on its journey towards greener/circular procurement of electronics
2 | Improving e-waste management in areas of predominantly unsound management practices.

Objective cluster 1 can widely be described as a starting point towards satisfying the growing buyers' demand for IT-equipment that reflects their (organisational) values, including to be able to communi-cate about their positive effects their purchase has had. This attempt is based on the compensation approach that offers a commercially viable service (as it is low-cost and easy to implement). One that offers a simple, initial attempt to use current customer needs in the developed world ("greener, more appealing devices") to create funding for a challenge predominantly found in low- and middle-income countries (the lack of environmentally sound end-of-life solutions).

To be effective, all these sub-objectives rely on a credible achievement of the second objective cluster, the improvement of e-waste management in one or more target countries, which can again be broken down into the following sub-objectives:

- To avoid that unsound handling, recycling and disposal of obsolete e-products lead to pollution and adverse effects on human health and the environment;
- To open business opportunities for local waste management and recycling operators that com-ply with national and international regulations and that apply environmentally sound processes;
- To support the increase of local awareness, value-addition and investments in environmentally sound reuse and recycling;
- To provide lessons-learned and stimulus for development of effective national e-waste policies and financing mechanisms.

3 General principles of e-waste compensation

To contribute to the objectives laid-out in chapter 2, e-waste compensation must be based on a set of principles that ensure that the objectives are met, and potential unintended side-effects avoided. The following sections list and describe general objectives that appear to be meaningful from the standpoint of the ECoN project team, considering the experiences from pilot implementation, as well as the wider e-waste debate.

While these principles shall be regarded as a suggestion for minimum requirements for eligible e-waste compensation, it is of high importance that key stakeholders – including stakeholders from e-waste compensation target countries – carefully review and comment this compilation.

3.1 Compensation ratio

Each financial contribution to an e-waste compensation scheme shall translate into a defined number of devices, weight units, or w-waste related pollution equivalents to be compensated for. Generally, there are three options to define and implement such a compensation ratio:

- Comparison on the product level (One-to-one, see section 4.1)
- Weight based of the same WEEE category (see section 4.2)
- E-waste related pollution equivalents (see section 4.3).

The specified number- or weight-equivalent shall be collected and managed as according to the principles in sections 3.2 to 3.11. Subsequently, the compensation shall ideally be product specific, e.g. a notebook shall be compensated with collection and recycling of another notebook. The latter aspect should refer to more specific comparison criteria (an example for screens is presented in chapter 4).

3.2 Country selection

E-waste compensation activities shall only be conducted in countries where the following criteria apply:

- Low- and middle-income country
- Own e-waste management system (incl. financing mechanism) is either non-existent, or still in a rudimentary state

3.3 Local sourcing

E-waste compensation is aimed at managing waste from local consumption in the countries the collection takes place. It shall by no means stimulate any imports of e-waste to such countries. Operators of compensation schemes shall take convincing measures to ensure that e-waste collected and processed under such arrangements comes from local consumption (also see section 3.10 on due diligence).

3.4 Additionality

E-waste managed through compensation mechanisms shall come from a waste stream that would – without the scheme – be managed in an unsound and polluting manner (e.g. open dumping, burning, crude recycling). It must therefore be avoided that compen-

sation addresses waste volumes for which another player (e.g. the previous owner of the equipment) has already commissioned (and paid for) sound end-of-life management.

3.5 Focus on devices beyond repair

Although the waste hierarchy clearly favours reuse over recycling (see section 3.6), repair and reuse sectors are often well developed in low and middle-income countries. In contrast, environmentally sound e-waste recycling is mostly limited to small niche markets. In this context, e-waste compensation should focus on the end-of-life management of devices beyond repair. This does not rule out the utilisation of some components for repair and reuse purposes (see section 3.6).

3.6 Application of waste hierarchy

When deciding about management options for devices / parts / components, the priorities of established waste hierarchy should be applied:

- 1st priority: Prevention
- 2nd priority: Reuse
- 3rd priority: Recycling
- 4th priority: Energy recovery
- 5th priority: Disposal

While prevention and reuse of whole devices do not apply for e-waste compensation models (see section 3.5), reuse of individual parts and components should be considered where possible and prioritised higher than recycling. Recycling should be clearly prioritized over energy recovery (e.g. co-processing in cement kilns) and disposal (e.g. in controlled hazardous waste disposals) should only be considered as last remaining option in case no other possibility exists.

3.7 High quality management

All steps from collection, over dismantling to recycling shall follow high ambitions related to health & safety and the environmental performance. This includes:

- Effective mitigation of health & safety risks for workers, as well as third parties (e.g. neighbouring communities)
- Application of best practices for handling, storage, recycling, and all other involved management steps. Illegal or sub-standard processes must be avoided.

This also applies to downstream management of parts, components and materials retrieved during recycling/dismantling, and therefore also includes the practices of other organisations who take over one or more recycling outputs for further processing (also see section 3.10 on due diligence).

3.8 Local value addition

While high quality management may easily be achieved in countries with a more mature recycling infrastructure, e-waste compensation shall aim at developing and supporting local solutions, including investments in upgrade and expansion of recycling capacities. Therefore, all management steps that can be conducted locally should also be conducted locally, thereby supporting the generation of jobs and income. Exports of parts and components should only be considered where best-practices are locally unavailable.

3.9 Cooperation with local e-waste initiatives

E-waste compensation aims to provide starting points for developing national e-waste management schemes, including systems of Extended Producer Responsibility. Therefore, compensation schemes shall engage in dialogues with local and national initiatives for improving e-waste management.

3.10 Due diligence

E-waste compensation schemes shall conduct due diligence to avoid that their activities may have unintended side effects negatively affecting human health, livelihoods, human rights or the environment. Due diligence should particularly focus on up-stream and down-stream activities that are not fully controlled by the scheme (e.g. collection through agents, further processing of parts and materials by other players). Due diligence efforts shall include 1) an ongoing or periodically repeated risk assessment 2) taking effective measures to mitigate identified risks 3) documentation of the process.

3.11 Transparency, documentation & verification

All flows of e-waste, including the whereabouts of all generated output fractions must be documented and filed in a format suitable for third party review/auditing, and to provide transparency. For output fractions with hazardous properties contracts and/or disposal certificates must be filed that allow tracing of flows until final processing/disposal.

4 Suggested comparison criteria for screens

The above-mentioned principles – particularly principle 1 on compensation ratio - shall be illustrated by applying concrete comparison criteria for flat panel screens in the following. The stepwise methodology also draws on the principles developed in chapter 3.

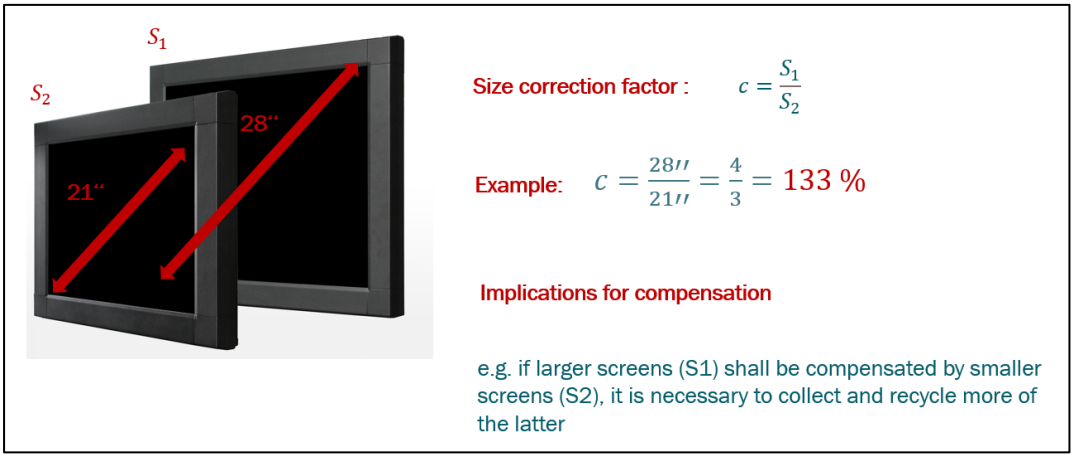
The motivation is to provide a practical approach to answer the following underlying research question: How can different products (e.g. flat panel screen) within one product category (e.g. within the same e-waste collection group or even beyond) be compared in a scientific robust and also practical way.

Therefore, several options are elaborated in the following summarized by a recommendations sector.

4.1 Comparison on the product level

A first presented method is based on a comparison on the product level, however, considering different product sizes. As illustrated in Figure 1 flat panel screens can be measures in terms of size (e.g., screen diagonal). Depending on the size of the screens, relative differences could be equalised for comparison in terms of a correction factor c that is the ratio of the larger screen S1 and the smaller screen S2.

Figure 1: Size connection on the product level



Source: Own illustration

Accordingly, a large screen with a screen diagonal of 28'' would result in a correction factor of c=1.33 (or 133 %) as compared to the smaller screen with a diagonal of 21''. A suitable practical application of this approach translates into the formation of size classes (e.g. S, M, L). This approach was applied throughout the ECoN pilot project (see Schleicher et al. 2022) and elaborated in section 4.3.

Related to compensation fees, the size factor could also be a feasible correction factor, i.e. for screen 2 (smaller) could not completely compensate for screen 1 (larger). Hence, more small screens would need to be collected and recycled in a sustainable manner. As indicated in Schleicher et al. 2022, three different size categories were applied throughout the ECoN project. Never accumulate and store larger volumes of batteries at one place. Instead use small buckets or sacks and do place them with some distance from each other.

Figure 2: Size categories used within the ECoN project

SIZE CLASS	CM	INCH
S	<43.18 cm	<17”
M	43.18 – 73.66 cm	17- 29”
L	>73,66 cm	>29”

Source: Own illustration

Accordingly, for class M (17’’ – 29 ‘’, average: 23”) an average correction factor of c (M) = 35% based on class S could be derived. In parallel, for class L, an correction factor of c (L) = 70 % based on class S can be derived.

4.2 Compensation per waste mass of an e-waste category

A second possibility to compare flat screens for e-waste compensation is related to the waste mass, typically measure in kg or tonnes. This means that a compensation fee is directly linked to an e-waste mass that shall be compensated. In the following a practical approach for this is proposed:

1 | Selection of a whole product category (e.g. EU WEEE category II, screens >100 cm2)
2 | Definition of exclusions (e.g. CRT screens)
3 | Definition of kg of product category as comparison criteria

The weight of a lot per product category (without exclusions) could determine a comparison factor in analogy to the size factor introduced in section 4.1. However, compensation per waste mass should be limited to the same e-waste categories (e.g. within large household appliances, or within lamps). Compensation of one e-waste category by another is not recommended.

4.3 Comparison based on “pollution equivalents” (PE)

Based on the due diligence approach (see section 3.10), compensation and product comparison could be based on pollution equivalents. Therefore, the following stepwise would be recommended:

1 | Selection of one or several relevant pollutants of the product category (e.g. mercury in CCFL of flat panel screens)
2 | Set up of requirements to compensate for ‘pollutants equivalent’ for the (new/old) device
3 | Definition of the allowed methods of sourcing (see section 3.3 and 3.4).

In the case of flat panel screens a very relevant pollutant is mercury used in cold cathode fluorescent lamps (CCFL, see Figure 3). Other than comparing products based on

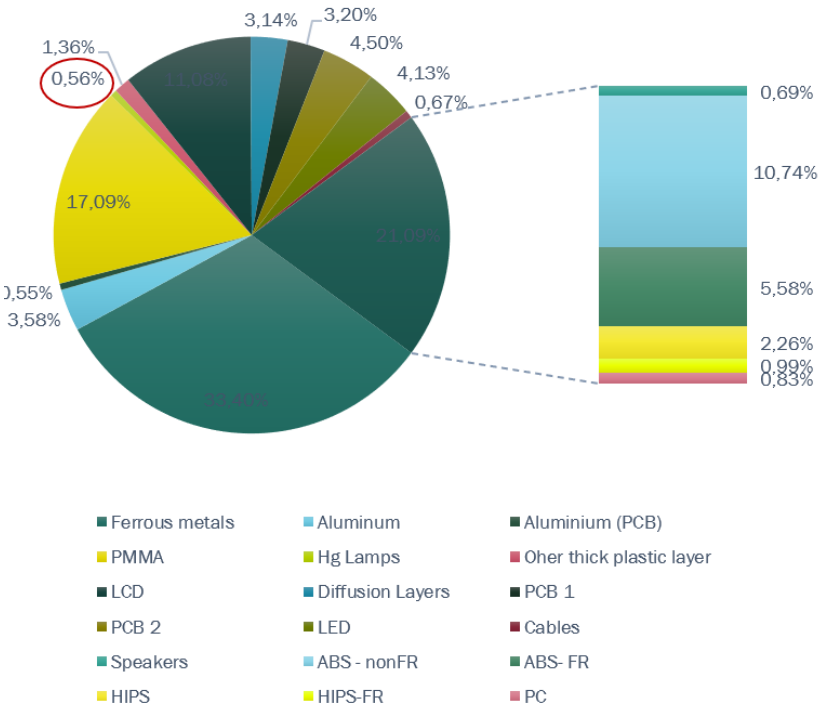
size or weight, it is the content of hazardous substances that serve as a comparison factor c.

Figure 3: Comparison based on mercury content of screens

Source: Own illustration.

The concrete application of this approach for flat panel screens shall be sketched in the following. Figure 4 therefore illustrates an indicative bill of material of a flat panel screen based on the total sample of n=2'658 flat screens collected in the ECoN project (weight=10'837 kg, Phase 1 until March 2022).

Figure 4: Average Bill of Materials (BoM) for a flat panel screen



Source: Own illustration based on >20t of collected flat panel screens in the ECoN project.

The BoM shows that on average 0.56 % of the total mass of a flat panel screen is related to mercury lamps (CCFL). The corresponding comparison correction factor for

compensation c (based on mercury as selected hazardous substance) is illustrated in the formula below.

$$c\ (Hg) = x[kg] \cdot 0.56\%$$

This means that for each kg of an equivalent amount of at least 0.0056 kg (0.56 %) of mercury lamps must be collected and safely recycled. Requirement to compensate for the collection and safe downstream solution based on the equivalent amount of mercury could be realised by focusing on (a) the same product category (CCFL from waste collection group 2) or (b) other mercury containing categories such as mercury containing lamps from category 3 (lamps).

Alternative pollution equivalents could be derived from the amount of brominated plastic components used in flat panel screens. The analysis of the same sample of flat panel screens (10.8 t) resulted in a total amount of 0.712 t of brominated plastics. This would translate into a correction factor based on brominated plastic components as follows:

$$c\ (Br) = x[kg] \cdot 6.57\%$$

Hence, for one kg of collected screens at least 0.0657 kg of brominated plastics must be collected and recycled in a responsible manner.