

ECONOMIC SYNOPSIS ON CATHODE RAY TUBE IN WASTE ELECTRONICS RECYCLING

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ABSTRACT. In the last decades, electronic goods have become a part of our life, as a technical support for different fields, either social, communication, travel, transportation. The end-of-life electronics are also, a part of our social responsibilities and this matter has to be managed in an ecological manner and taking into account the economical implications. Annually, the amount of WEEE collected in EU increases, as a response of the joined efforts of all the factors involved: producers, collectors, local authorities, electronic waste recyclers. A sustainable management of waste electronics, with focus on CRT wastes, has become a real challenge for the recyclers, due to the hazardous components included – different types of activated glass with lead content. The aim of this study is to reveal some economic and ecological figures involved in the WEEE management in EU. Content of this study can be used by the recyclers and producers, in order to find the proper way to approach the CRT waste management, to obtain the best results of recycling.

Key words: *WEEE, CRT recycling. CRT glass, CRT waste, CRT waste recycling costs*

INTRODUCTION

In the EU, waste policy and their management are based on measures "to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use" (EC, 2008).

The new legislation brings into focus the recovery of waste and transfer of negative effects to the environment avoiding due to their management the disposal in landfills. The disposal can be acceptable only in situations when the waste hierarchy steps have been taken by: prevention, preparation for reuse, recycling, other recovery (e.g. energy recovery), disposal.

WEEE is a particular waste stream but these are also present in municipal waste (EC, 2012). At European level, WEEE can be found in a proportion of about 4%. Due to the rapid economic growth rates, the increase WEEE generation is projected (www.eionet.europa.eu).

MATERIAL AND METHOD

In the last decades, electronic goods have become a part of our life, as a technical support for different fields, either social, communication, travel, transportation. The end-of-life electronics are also, a part of our social responsibilities and this matter has to be managed in an ecological manner and taking into account the economical implications.

Annually, in EU, the amount of the collected WEEE increases, as a response of the joined efforts of all the involved factors: producers, collectors, local authorities, electronic waste recyclers.

EEE and WEEE are defined in Article 3 of Directive 2012/19/EU (EC, 2012). WEEE are grouped in 10 product categories as follows:

1. Large household appliances
2. Small household appliances
3. IT & Telecommunication
4. Consumer equipment
5. Lighting equipment (excl. 5a); (5a. Gas discharge lamps)
6. Electrical & electronic tools
7. Toys, leisure & sports equipment
8. Medical devices
9. Monitor & control instruments
10. Automatic dispensers



Fig. 1. WEEE collected, photo: Valentin Tofana

The "producers" - manufacturers and retailers - have clear obligations regarding the collection of WEEE. Based on the principle of producer responsibility, WEEE are managed at first by the electronic equipment manufacturers which produce or import such equipment in Romania. The collective organizations established and authorized under law, take the responsibility assigned to the producers and pursue recovery and recycling targets for WEEE (Table 1).

Table 1. Recovery and recycling WEEE National targets (Source: G.D.,2010)

WEEE categories according with HG 1037/2010	Recovery ratio [% average weight / unit]	Recovery and recycling ratio [% average weight / unit]
1, 10	80%	75%
3, 4	75%	65%
2,5,6,7,9	70%	50%
Gas discharge lamps	80%	80%

The concepts for monitoring of WEEE management are defined in the Art. 3 of the new Directive 2012/19/EU (EC, 2012). By 14 February 2014, the Member States shall bring into force the all the provisions necessary to comply with this Directive. The economic aspect of WEEE management regards both: municipalities and producers.

For each WEEE product category the management costs involved (Rev., 2008) are for:

- ✓ collection;
- ✓ treatment (in the Member State; in another MS; outside the EC);
- ✓ recovery;
- ✓ reuse and recycling.

A sustainable management of waste electronics, has become a real challenge for the recyclers, due to the hazardous components included – different types of activated glass, with lead content, plastics with flame retardants, freons, some nanomaterials, etc. The e-waste management which means: collection, storage, transport, treatment and recycling, shall be carry on to protect the environment and the human health. The producers are responsible with the financing costs for the collection, treatment, recovery and disposal of WEEE from users (other than private households).

Therefore, the economical interest is focussed on implementation of a financial mechanism based on costs coverage, correct costs sharing, and legislative demands.

To analyze the type of materials resulted by dismantling WEEE, a number of 95 pieces of waste TVs and PCs was treated (Popovici, 2013).

RESULTS AND DISCUSSIONS

National and EU legislation on waste apply the principle of producer responsibility by setting targets for the recycling and recovery. WEEE are a special flow in the waste management, under the coverage of each member state collection scheme.

To achieve the EU legal recycling and recovery targets, the collection system must be efficient, as well as the treatment techniques.

The effective recycling rate of e-waste (%) express the collection rate multiplied by the efficiency of WEEE treatment. To be noted that the indicator relates to the total amount of WEEE treated (ESAE, 2010).

WEEE management in Europe

In Europe, about 50,000–150,000 tons/year of waste CRTs are collected and in the next years the amounts are not expected to decrease, due to the provisions of WEEE Directive (Rocchetti, 2014).

The available data regarding the WEEE management show that the total amounts of waste monitors and IT collected in Europe increased in 2011 (figures 2 and 3).

A part of the data are provided by WEEE Forum, through its member Ecotic Asociation, Romania. The WEEE Forum is a not-for-profit association with 39 WEEE producer responsibility organizations or ‘producer compliance schemes’ in Europe.

In Europe, the quantities of the collected WEEE increased. Note that for 2011 the figures represent only the collected amounts under the ‘producer compliance schemes’.

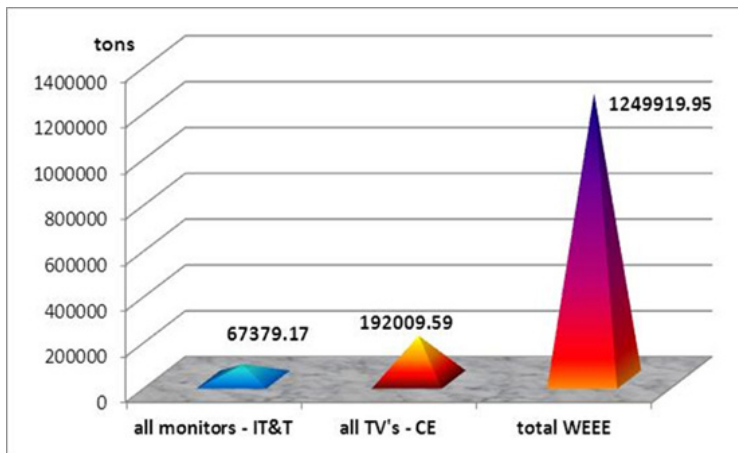


Fig. 2. Waste monitors and IT collected by WEEE Forum members – 2011
(Data source: <http://www.weee-forum.org>)

As shown in figure 3, the recycled reused waste monitors and IT equipment represents 57% from the collected amount in 2010. It must be underlined that the recycling rate of e-waste is variable from an EU country to another. A low rate had: Romania (12%), nearby Spain (14.7%), Cyprus (11.5%) or Latvia (14.5%), meantime Sweden (55.3%), Norway (45.3%) had a good one. (source: <http://epp.eurostat.ec.europa.eu>) All this treated quantities get in an important influence by economical point of view.

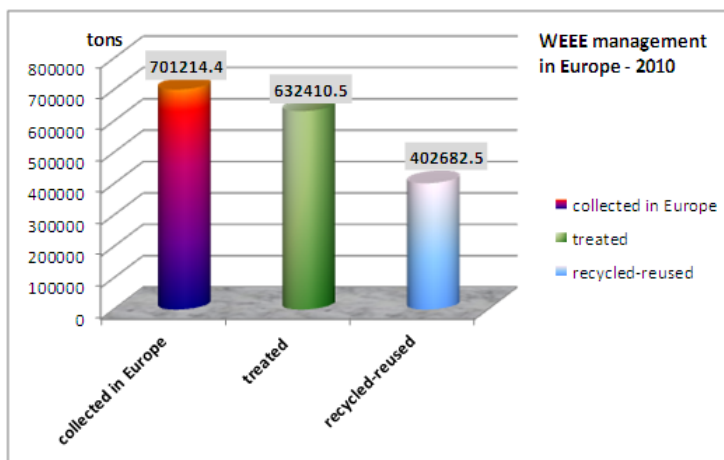


Fig. 3. Waste Monitors and IT management in Europe, 2010
 (Data source: <http://epp.eurostat.ec.europa.eu>)

WEEE management costs

To fulfill their legislative financial obligations (both of WEEE types: historical/new WEEE and household/non-household WEEE), producers can adopt one of the following paths:

- “individually”, setting up their own product recovery network or Compliance Scheme,
- “collectively” (in order to take back responsibilities).

According to Article 8.3 of WEEE Directive (EC, 2012), the historical WEEE must be managed under the collective compliance (Rev, 2008).

The total costs represents the sum of the Technical costs and Additional costs. Technical and Operational costs include: costs for transportation and costs for treatment. Additional costs depends on the producers options (complying individually, or under a collective Compliance Scheme). It are composed of: financial guarantees, costs for monitoring, awareness raising, special costs (for sorting and sampling) for specific waste streams (batteries or packaging) (Rev, 2008).

Due to the different data collection methods applied by each country, the overall cost and burden is difficult to assess.

(Source:<http://epp.eurostat.ec.europa.eu>)

WEEE collection, transport, treatment costs

The financing of the costs for the collection, treatment, recovery and environmentally sound disposal of WEEE (other than private households) is provided for by producers (EC, 2012).

Figure 4 reveals the costs allocated by producers under WEEE Forum 'producer compliance schemes' in 2011, for the IT and TV equipment.

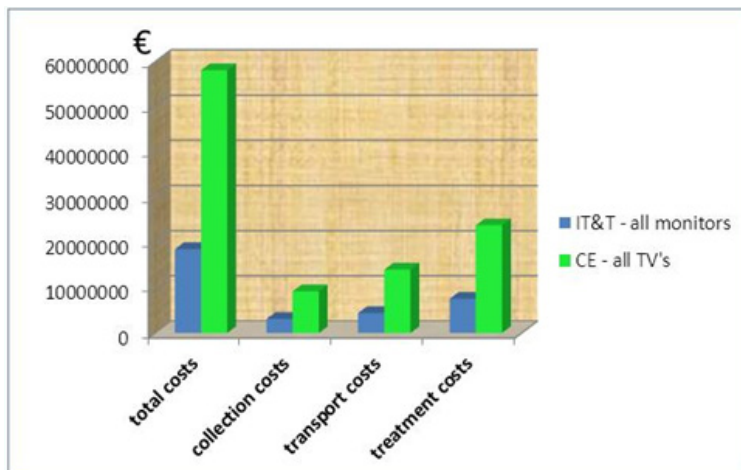


Fig. 4. WEEE costs allocated by producers under WEEE Forum 'producer compliance schemes', 2011

WEEE treated disposal costs

The disposal of the separately collected WEEE untreated is forbidden in EU (EC, 2012). Therefore, the unrecycled/valorified WEEE fractions are landfilled mostly in hazardous landfills.

In USA (2007) nearly 27 million TVs were discarded, and taking into account that in that period about 82% of WEEE collected is disposed of in landfills (Ongondo, 2011), a lot of CRT waste glass reach the landfill.

The study made on the 95 pieces of waste TVs and PCs revealed that from a total amount of 1450 kg treated waste, glass (front and funnel glass) was represented 54% (780 kg) (Popovici, 2013).

Taking into account the waste glass landfill costs in Romania: 180 €/t (Source Ecotic), landfilling cannot be an economic option.

WEEE management revenues

The economic development has a high influence on the price of waste materials as well as the price of raw materials. The revenues for secondary material pay for a substantial portion of the waste management schemes.

As an example, waste glass price in 2008 was 55 euro/tonne (ESAE 2010) and declined in 2012 up to 48 euro/tonne (Source:<http://epp.eurostat.ec.europa.eu>).

In our study, an estimation of the revenues (Table 3) of the obtained materials by dismantling of the WEEE equipment (Table 2), shows that the revenues aren't negligible even if couldn't be valorificated all the materials. Unfortunately, the waste CRT glass which is the biggest waste component doesn't represent a market trade opportunity. Therefore is demandable to find attractive recycling solutions.

Table 2. *Materials resulted from the treatment of the 95 pieces of waste TVs and PCs telecommunications equipment waste electronic collected (Popovici, 2013).*

Material	kg
Total equipments treated	1,450
Glass panel	498
Glass funnel	282
Metallic shadow mask	80.5
Metallic belt	36
Electronic gun	9
Contacts	0.5
Cables	47
Aluminum	33
Condensers	3
Transformers	32.5
Plastic	133
Cu coils unassembled	69.5
Panels	66.5
Impurities	75.5

Revenues from selling it and fractions (Romanian market*)

Table 3. *Waste fraction prices**

Material	Price lei/kg	Price lei (materials dismantled for study)
Cables	8	376
Aluminum	5	165
Transformers	2	65
Plastic	10	1330
Cu coils unassembled	6	417
Total		2288

** Prices obtained from Ecotic Association*

CONCLUSIONS

Integrated waste management systems must be considered of WEEE economic and eco-toxicological value.

In present in Romania CRT glass is landfilled and the landfilling costs are high. Based on cost efficiency analyze, the producers should find recycling ways in order to rise the rate of revenues and to mitigate the environmental impact.

The study offers a start from a data base usefull for the Romanian recyclers and producers in order to find the proper way to approach the CRT waste management, to obtain the best results of the CRT recycling.

Note that the content of this study can be used by the recyclers and producers.

Nomenclature

WEEE – Waste Electrical and Electronic Equipment

CRT – Cathode Ray Tube

EU – European Union

EEE - Electrical and Electronic Equipment

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REFERENCES

- EC, 2008, Directive 2008/98/CE of The European Parliament and of the Council of 19 November 2008, on waste and repealing certain Directives, Official Journal of the European Union L312/2008, 22.11.2008, Brussels.
- EC, 2012, Directive 2012/19/EU of The European Parliament and of the Council of 4 July 2012, on waste electrical and electronic equipment (WEEE) (recast), Official Journal of the European Union, L 197/2012, 24.7.2012, Brussels.
- ESAE, 2010, Environmental statistics and accounts in Europe 2010, ISBN 978-92-79-15701-1 doi:10.2785/48676, on line at http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-32-10-283/EN/KS-32-10-283-EN.PDF, accesed at 4.11.2013.
- G.D., 2010, Governmental Decision no. 1037, from 2010, regarding electrical waste and electronic equipments, published in the Official Monitory no. 728.
- Ongondo F.O., Williams I.D., Cherrett T.J., 2011, How are WEEE doing? A global review of the management of electrical and electronic wastes, *Waste Management*, **31**, pp. 714–730.
- Popovici A., Rusu T., Tofană V., Dan V., Popița G.E., Hațegan R., Măruțoiu C., 2013, Study on recycling feasibility of activated glass from WEEE equipment treatment, *Environmental Engineering and Management Journal.*, **12(2)**, pp. 1535-1545.

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Rev., 2008, Review of Directive 2002/96 on Waste Electrical and Electronic Equipment (WEEE), 2008; http://ec.europa.eu/environment/waste/weee/pdf/final_rep_unu.pdf

Rocchetti L., Beolchini F., 2014, Environmental burdens in the management of end-of-life cathode ray tubes, *Waste Management*, **34**, pp. 468–474.

**** <http://epp.eurostat.ec.europa.eu>

**** www.weee-forum.org

**** www.eionet.europa.eu

