

Original Article**WEEE Management in Maramureş County and the Framework for a Better Implementation of EU Policies****SMICAL Irina*¹, Antoanela POPOVICI², Gabriela-Emilia POPIŢA³**¹*Technical University of Cluj-Napoca, North University Centre of Baia - Mare, Victor Babeş St., no. 62A, 430083 Baia - Mare Romania*²*Technical University of Cluj-Napoca, Bd. Muncii, no. 103 – 105, 40064 Cluj-Napoca, Romania,*³*Babes Bolyai University, Fântânele St., no. 30, 400294 Cluj-Napoca, Romania,*Received 3 November 2013; received and revised form 18 November 2013; accepted 25 November 2013
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Abstract

This paper approaches the environmentally and healthly potential risk caused by e-waste and the importance of their effective management as a solution for pollution diminishing. More than hundreds of hazardous substances and tens of rare and valuable chemical elements are indentified in WEEEs. Thus, this kind of waste represents not only a dangerous environmentally factor but also an important secondary raws for various industries. The WEEEs management run in Maramures County is still developing in order to reach the collecting target imposed by european legislation. In this context, the involved factors focuss their attention not only on collecting process but also on assuring the proper conditions for e-waste secure storage and treatment. The treatment stage is very vulnerable because during its procedures the hazardous substances could release most easily. In order to improve the actual e-waste in Maramures County a lot of rules and strategies should be applied. The study proposes a local strategy, based on EU legislative provisions, for increasing the collection ratio of WEEE, especially on rural communities.

Keywords: WEEE, hazardous substances, waste management, contamination, risk.

1. Introduction

E-waste is considered as a major waste problem because of both its hazardous components and the lack of enough strategical solution for loop closing. So that an appropriate WEEEs management is required. Not all components are hazardous and some of them are very rare and valuable (Au, Ag, Pt, In, Rb). On the other hand, WEEEs are a major source of secondary materials for various industries. At global level, a production of 20 up to 50 million tones/year of WEEEs is estimated (Robinson, 2009; Lepawsky&McNabb, 2009) [5, 12].

The largest WEEE producers are United States with 2.4 million tones generated in 2010 followed by China with 2.3 milion tones generated in the same year (Lundgren, 2012) [3]. EU annual generate 6,5 up to 7.5 million tons/year of e-waste (Georgiadis&Besiou, 2009) [6].

To minimize the environmental and human health risk all responsible factors ought to involve.

In Maramureş County the WEEEs management is assured both by the authorities with attribution in waste domain and the operators which are permitted to collect and treat e-wastes. It is dealt with in order to minimize the risk for environment and human health. In present, in Maramures County, the collection ratio is much less than the target provided by EU directive [20].

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2. Legislative framework

WEEE management is carried out in respect of international and national legislative provisions which emphasize the waste management assuring the environmental and human health security.

In this context a number of legislative acts are issued. One of them is the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989), also known as Basel Convention. It provides the measures to reduce the movements and transfer of hazardous wastes between countries and especially from developed countries to less developed ones [17].

Other treaties focussed on pollutants contained in WEEE are Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (1998) and Stockholm Convention on Persistent Organic Pollutants (2001) and the Montreal Protocol on Substances that Deplete the Ozone Layer) [26, 27].

The WEEE legislative framework is represented by the 2002/96/EC Directive and 2002/95/EC Directive. The 2002/96/EC Directive has entered into force in 2003 and will be, since 15th February 2014, replaced by 2012/19/CE Directive [18, 19, 24].

The 2002/95/EC Directive regarding the Restricting the Use of Hazardous Substances in Electrical and Electronic Equipment (RoHS), has been since 1st January 2013 replaced by the new RoHS 2011/65/EU Directive which has not been transposed yet [23].

To ensure a high level of human health protection against chemicals The Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) has been issued and entered into force in 2007 [23, 25].

The national legislation related to WEEEs is represented by GD no. 1037/2010 and looks as priority the prevention of waste generation followed at end of life by their proper valorisation and elimination in secure conditions for environment and human health and also by GD no. 992/2005 on the restriction of use of certain hazardous substances in electrical and electronic equipment, as amended and supplemented [21].

A major importance is conferred to human health security both of the direct involved factors in WEEEs management (producers, consumers, distributors, collectors and treaters) and also the population (GEO nr. 195/2005, GD nr. 1037/2010, Smical&Oros, 2012) [13, 21].

3. Potential risk on environment and human health

Electrical and electronic equipment categories provided by Directive 2002/96/EC and by GD no. 1037/2010 are:

- Large household appliances
- Small household appliances
- IT and telecommunications equipment
- Consumer equipment
- Lighting equipment
- Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
- Toys, leisure and sports equipment
- Medical devices (with the exception of all implanted and infected products)
- Monitoring and control instruments
- Automatic dispensers

Waste electrical and electronic equipments mostly contain: metal (tab. 1), plastic and chemical substances. Over 1000 chemicals were identified in WEEEs streams (Lungren, 2012) [6]. For instance, one mobile telephone contains about 23% metals represented by over 40 chemical elements: Cu, Sn, Co, In, Sb, Au, Ag, and Pd. A mobile telephone without battery weights 250 mg Ag, 24 mg Au, 9 mg Pd, 9 g Cu. A mobile telephone Li-ion battery weights about 3,5 g Co (UNEP, 2009) [28]. An old PC or television set screen (CRT) contains about 2 - 3 kg lead [6, 10].

Because e-wastes mostly consist of hazardous substances Tsydenova & Bengtsson (2011), called them hazardous wastes. WEEEs also contain fibreglass, epoxy resins, thermosetting plastics, trace amounts of rare and valuable elements like germanium, tantalum, vanadium, terbium, gold, titanium, ruthenium, palladium, manganese, bismuth, niobium, rhodium, platinum, carbon, americium, antimony, arsenic, barium, boron, cobalt, gallium, indium, lithium, palladium, ruthenium, selenium, silver, tantalum, molybdenum, thorium and yttrium [1].

The major interest for recyclers are components of copper (wires, cables), steel (printer parts, PC desktop, power supply housings), plastics (computer frames, printers, telephones, monitors), aluminium (small housing devices, printer parts), printed circuit boards [6].

The WEEEs presence in environment needs an effective management to avoid the contamination risk of environmental factors and human health especially caused mainly by releasing of: hazardous substances (lead, cadmium, arsenic, mercury, nickel, fluorinated cooling fluids polychlorinated biphenyls

(PCBs) and polybrominated diphenyl ethers (PBDEs), etc), dangerous reaction products (furans, dioxins, polyhalogenated aromatic hydrocarbons (PHAHs), polycyclic aromatic hydrocarbons

(PAHs)) and also of hydrogen chlorid from plastics incineration (Frazzoli et al., 2010; Robinson, 2009; UNEP, 2009) [2, 12, 28]. These categories of substances are regulated by 2002/95/EC Directive.

Table 1. WEEEs metal content [4, 6, 12]

WEEEs devices	The most used metal type
Contacts, switches, solders, conductors, multilayer capacitors	Silver (Ag)
Bonding wire, contacts	Gold (Au)
Multilayer capacitors, conectors	Palladium (Pd)
Hard disks, termocouple wires, fuel cells	Platinum (Pt)
Hard disks, resistors, conductive pastes, plasma display panels	Ruthenium (Ru)
Cables, wires, connectors, conductors, transformes, e-motors	Copper (Cu)
(leadfree) solders	Tin (Sn)
Flame retardants, CRT glass	Antimony (Sb)
Batteries	Cobalt (Co), Mercury (Hg), cadmium (Cd), lead (Pb) and lithium (Li)
Lead free solders, capacitors, heat sinks, electrostatic screening	Bismuth (Bi)
Electrooptic, copiers, solar cells	Selenium (Se)
LCD glass, leadfree solders, semiconductors/LED	Indium (In)
relays, switches and gas discharge lamps;	Mercury (Hg)
Printed circuit boards	Lead (Pb), antimony (Sb), beryllium (Be) and cadmium (Cd)
Silicon chips and LCD monitors	Gallium (Ga) and indium (In)
Optic fibers	fluorine, lead, yttrium and zirconium

In some cases cyanides and leaching agents, mercury, could be released in the environment from various proceses of gold amalgamation [12, 28]. From these processes a lot of dangerous substances and elements like dissolved arsenic, lithium, molybdenum, chromium, antimony, silver, selenium, cadmium, beryllium, lead, cobalt, copper, nickel, zinc, mercury and volatile compounds of nitrogen and chlorine may result (Lundreg, 2012; Tsydenova & Bengtsson, 2011) [12, 14]. Workers also suffer of infant mortality, blood diseases, anomalies in the immune system, tuberculosis, malfunctioning of the kidneys and respiratory system, lung cancer, underdevelopment of the brain in children and damage to the nervous and blood systems [10].

The potential WEEE risk for environment and human health is present all EEE life cycle and also in all treatment steps: demanufacturing and especially manual dissessembly, depollution, materials separation, mechanical processing and metal refining/smelting [7].

By inhalation, ingestion and dermal contact with contaminants, population is exposed to dioxins, lead, copper, cadmium, polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyl (PCB), chromium mercury and other metals and carcinogens [5].

The main health consequences caused by

WEEE improper management consist in: breathing difficulties, choking, coughing, skin diseases, eye irritations, tremors, pneumonitis, neuropsychiatric affections, convulsions, coma and even death, asthma, and stomach disease, DNA damage (Yu et al., 2006; Raghupathy et al., 2010; Yang et al., 2011; Nordbrand, 2009) [8, 11, 15, 16].

WEEE refrigeratory and air conditioning categories rise a special attention during their disassembly because of freon contents represented by CFCs (eg. Trichlorofluoromethane CCl_3F , Dichlorodifluoromethane CCl_2F_2 , Chlorotrifluoromethane CClF_3 , Bromochlorodifluoromethane CBrClF_2) (Regulation (EC) no. 1005/2009) [25].

CFCs are organic compound that contains only carbon, chlorine, and fluorine with a major ozone depleting potențial and also with a high globl warming potential [9].

They are commercially known as freons and are used especially în refrigeratory and air conditioning systems. Now, CFCs production and usage are banned [22]. They are regulated by Montreal Protocol (nationally transposed by Law no. 84/1993), Regulation no. 1005/2009 and naționally by GO no. 9/2011 [22, 23, 25].

Unfortunately, in majority developing countries WEEE disassembly is handly made which conducts to a high risk of human secure.

3.Aspects regarding the WEEE managment in Maramureş County

In order to ensure an efficient WEEE management in Maramureş County, the public authorities have signed protocols with operators which activate in waste management field both at

national level (SC Environ SRL, SC Recolamp SRL, SC RoRec SRL, SC Ecotic SRL) and local level (local operators) (Baia Mare City Hall and EPA Maramureş). At the moment, in Maramureş County eight operators are permitted for WEEE collection and 2 operators are permitted both for WEEE collection and treatment (EPA Maramureş). All these operators activate in urban areas (tab. 2).

Table 2. WEEE operators in Maramureş County (EPA Maramureş)

No. crt.	Operator name	Work site	WEEE permitted activity
1.	SC Remat Maramureş SA	Baia Mare	collection
2.	SC Herodot Grup SRL	Sighetu Marmaţiei	collection
3.	Primăria Borşa	Borşa	collection
4.	SC Epitera SRL	Baia Sprie	collection +treatment
5.	SC Crirob Salubris SRL	Vişeu de Sus	collection
6.	SC Nav 79 Impex SRL	Baia Mare	collection +treatment
7.	SC Silnef MG SRL	Baia Mare	collection
8.	SC Vols-Com SRL	Baia Mare	collection

The WEEE management protocols contain principles and objectives focused on people awareness and education in relation with separated WEEE collection as well as the promotion of WEEE collection actions (Baia Mare City Hall).

WEEE collection in Maramureş County is selectively made either by their periodical rising from collecting places or by their directly taking at permitted company. In public collecting spaces, WEEEs are temporary storage in a closed container which is proper for this kind of waste storage. Periodically, these wastes are taken by operator in order to treat/recovery them (EPA Maramureş).

The main legislative requirements in this area provides the achievement of some systems which enable the owners and distributors to deliver the WEEE to collection points, ensuring the electrical and electronic distributors to collect these WEEE types in the equal weight with the supplied equipment and as well ensuring the WEEE selectively collecting rate of 4 kg/inhabitant/year.

The largest WEEE collected amount was achieved in 2012 and the lowest one in 2011 (fig. 2). This increasing is due to intense awareness campaigns made by collectors companies (EPA Maramureş)

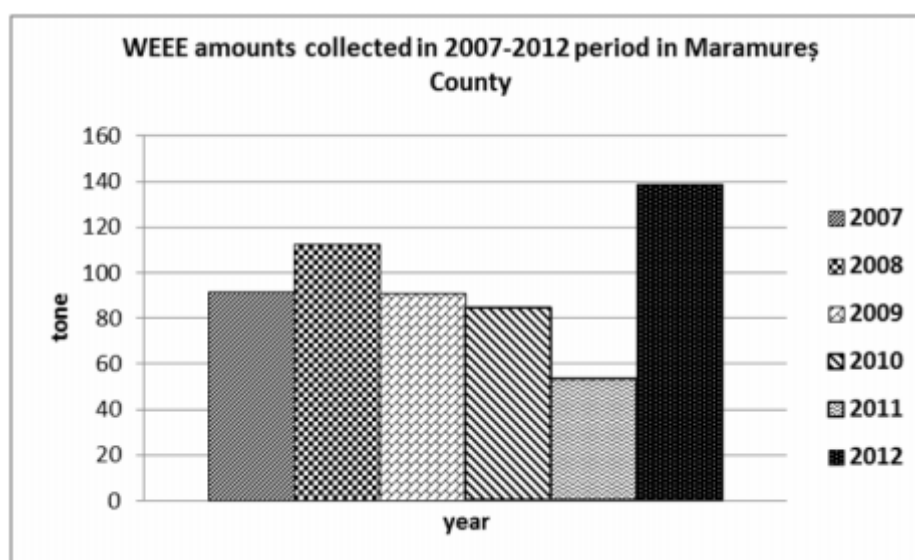


Figure 1. WEEE collected in 2007-2011 period in Maramureş County (source: EPA Maramureş)

As it is shown in fig. 2, in 2007 no WEEE treatment activities were made in the County. This may be justified by early actions of e-waste directives implementation in our country. However it is noticed a large percentage of collected WEEE categories represented by IT and

telecommunications equipment (personal computers, printers, photocopiers) and large household appliances (large refrigerator devices, freezers, washing machines). From large household appliances category majority are TV sets and washing machines (EPA Maramureş).

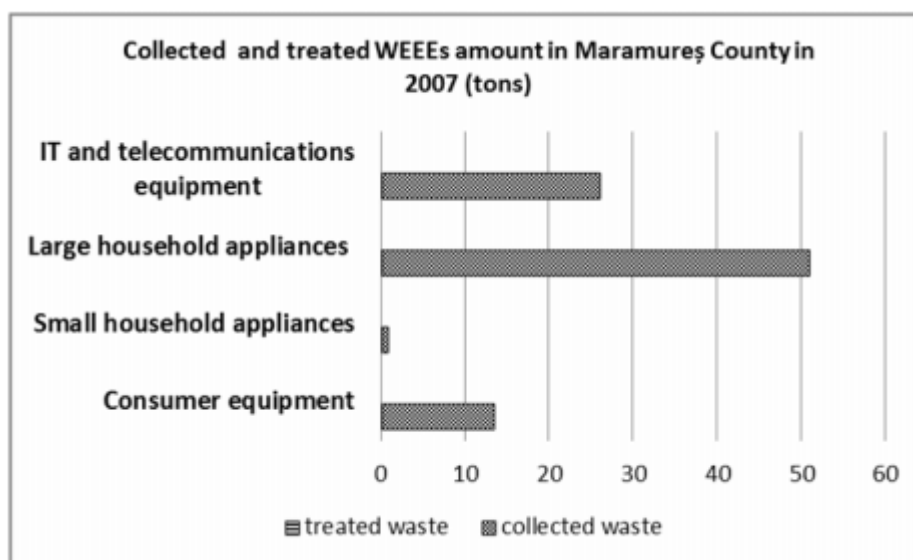


Figure 2. Collected and treated WEEEs in 2007 in Maramureş County (source: EPA Maramureş)

In 2008 the collection rate growth especially of large household appliances, consumer equipment (TV sets), consumer equipment and IT and telecommunication equipments (fig. 3).

For the first time WEEE started to be processed by a permitted operator. The most treated

category is of consumer equipment followed by IT and telecommunications devices. The highest weight of WEEE collected subcategories in 2008 belongs to large refrigeratory appliances, freezers, TV sets, washing machines and personal computers (EPA Maramureş).

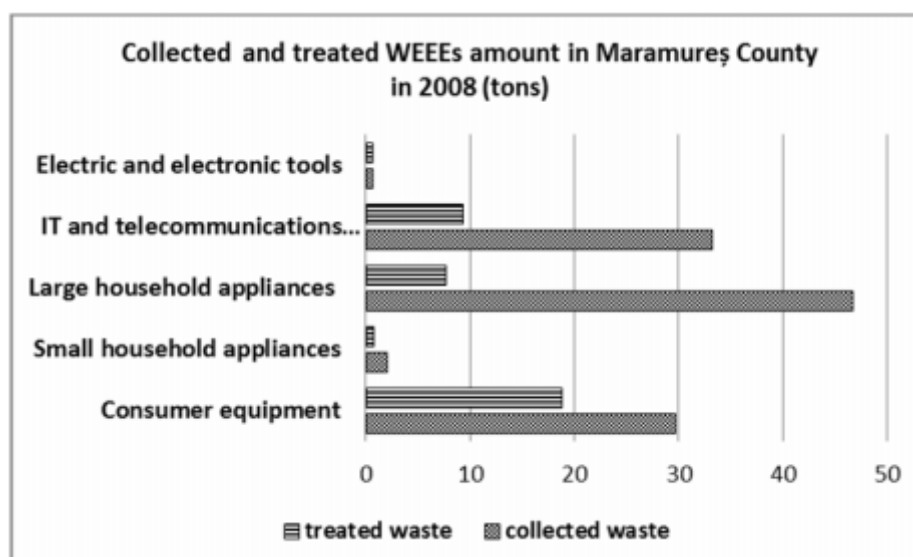


Figure 3. Collected and treated WEEEs in 2008 in Maramureş County (source: EPA Maramureş)

In 2007 - 2010 period the large household appliances are the most collected WEEE followed by IT and telecommunication equipments and consumer equipment (figs. 2 - 6). The majority subcategories are represented by: television sets, refrigeratory equipments, personal computers, printers and washing machines.

The WEEE treatment is made by two authorized operators from which only one is active (SC Epitera SRL).

Here WEEE equipments are disassambled, deppoluted and shredded.

The ground materials are separated by electrostatic (EPA Maramureş)

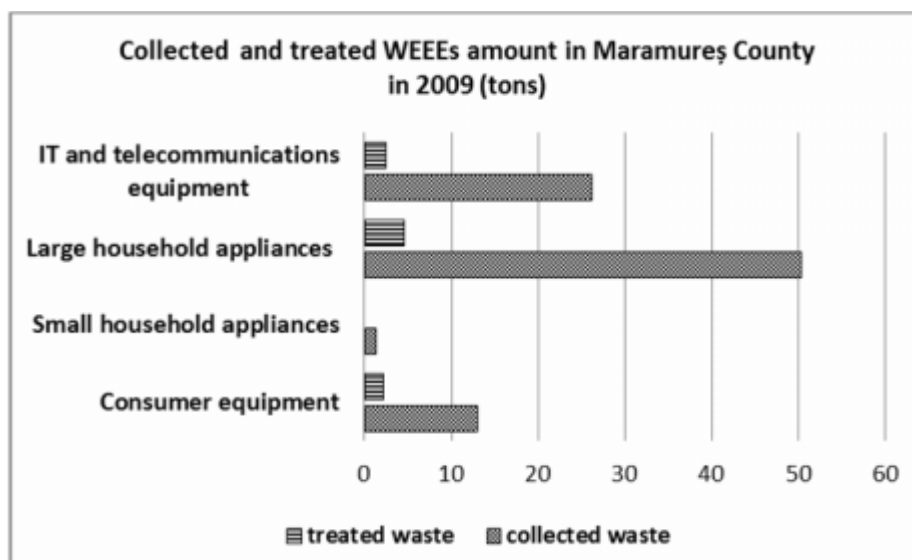


Figure 4. Collected and treated WEEEs in 2009 in Maramureş County (source: EPA Maramureş)

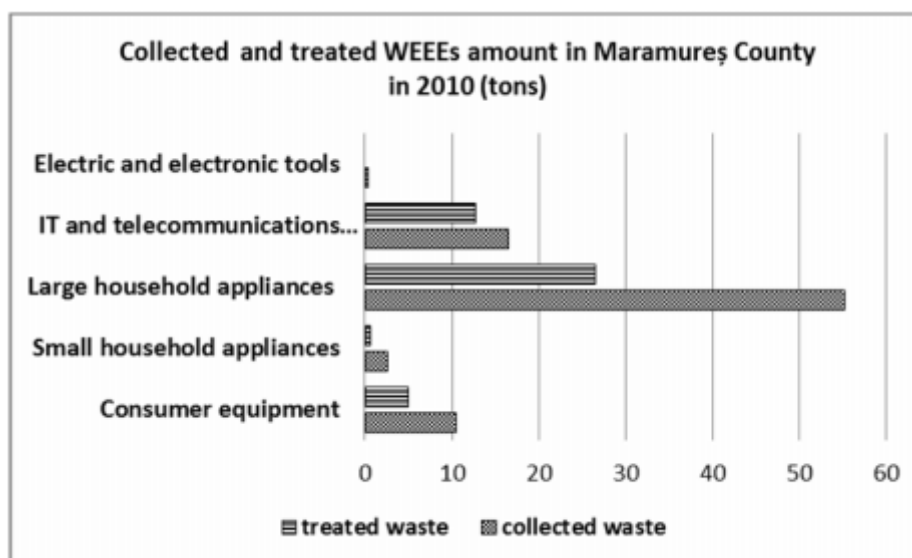


Figure 5. Collected and treated WEEEs in 2010 in Maramureş County (source: EPA Maramureş)

In 2011 the most collected e-waste were the IT and telecommunications followed by large household appliances and consumer equipment.

This means a major people orientation to a society based on the best informational and communication technologies.

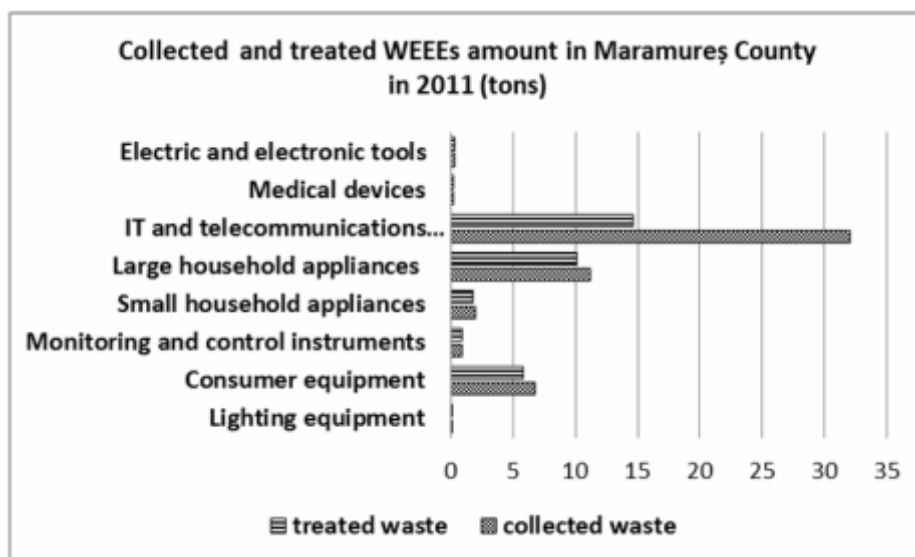


Figure 6. Collected and treated WEEEs in 2011 in Maramureş County (source: EPA Maramureş)

No e-waste treatment was made in 2007. In 2008-2010 period the proportion of collected and treated e-waste was almost the same only small differences are seen for 2011 year when the e-waste categories are treated in close proportions (EPA Maramureş). Even there have been made efforts in implementing all the e-waste directive requirements, its target to collect 4 kg/inhabitant/year has not been

achieved yet. Taking into account the county population (CS Maramureş, 2012) during 2007-2012 period the WEEE collecting rate (EPA Maramures) was very small every year (tab. 7).

The most important amount was collected in 2012 (138.63 tons) but the collection ratio remained less than 0.5 kg/inhabitant/year and obviously much less than 4 kg/inhabitant/year.

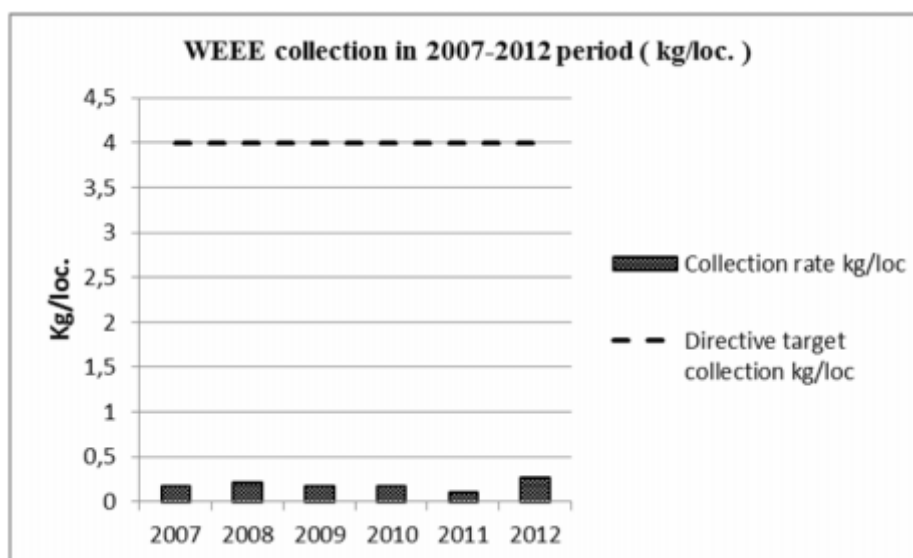


Figure 7. WEEE collection rate in reference with the WEEE Directive target

According GD no. 1037/2010 administrative authorities have the obligation “to ensure the existence and functioning of at least one selectively collecting point of WEEE originated from households at 50000 inhabitants but not less than one point in every locality”. Hence results the necessity to establish new selectively collecting points.

4. Proposal for improving the efficiency of WEEE collecting activity

To grow the efficiency of WEEE collecting rate originated from households in Maramureş County the following methods are proposed:

- Multiplication of actual WEEE collection points based on collaboration of local authorities operators in accordance with GD no. 1037/2010;
- According with the statistic data refering to Maramureş County, rural population represents 40,74% of the total county population (CS Maramureş). Taking into account this information and the lack of WEEE collection points in rural areas (tab. 2) the setting up WEEE collection points in rural areas is strongly necessary;
- Establishing a day per week in which the WEEE collection „from door to door” to be made especially in rural areas, small towns and in neighborhoods with houses;
- WEEE delivering, at the e-waste holders request, directly to the permitted operator for collecting and treating this kind of wastes;
- WEEE delivering by the final holders to electrical and electronic equipment distributors in “one to one” system at new e-product buying, even if the equipment is not of equivalent type as the supplied equipment;
- Rising the WEEE collecting awareness in urban area but especially in rural ones;
- Rising the waste management education in schools and institutes;
- Introduction of legislative provisions for several more obligations for distributors like directly WEEE collecting from people at their requirement even that the new e-product is not equivalent;

5. Conclusions

Because of the contamination risk with hazardous substances the e-waste management must be achieved taking into account all the secure rules provided by actual legislation. In EEE

manufacturing process the usage of hazardous substances is still allowed mostly due to the technology limitations but the trajectory of these substances is legally monitored along all their life cycle.

At present, the WEEE storage on municipal waste deposits is forbidden and a higher attention is given to WEEEs selectively collection and their re-use, and recycling.

The results registred for 2007-2012 period show a very small rate of WEEE collection which is very far from reaching the legislative collecting aim. Thus, the e-waste directive target of 4 kg/inhabitant/year is still the major aim for all involved factors in WEEE management.

For improving the WEEE collection both in urban and rural area a rethought strategy should be implemented. This new strategy should involve a stronger cooperation and participation of local public authorities, local environmental agency, operators and not in the end population. A greater attention should be focused on rural WEEE collection and the financial or material stimulation for inhabitants to deliver their WEEEs.

Besides the mentioned above measures, a stronger awareness campaign and more education in schools and mass-media involvement is necessary to develop a better WEEE management in Maramureş County.

List of abbreviations

CS-County Statistics
 EEE - Electrical and Electronic Equipment
 EPA – Environmental Protection Agency
 GD – Government Decision
 GEO –Government Emergency Ordinance
 GO – Government Ordinance
 UNEP – United Nations on Environmental Programme
 WEEE - Waste Electrical and Electronic Equipment

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