

## WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT MANAGEMENT IN UKRAINE

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### ABSTRACT

Waste electrical and electronic equipment (WEEE or e-waste) is a relatively new type of waste generated due to the market growth for electronic and electrical devices. Thus, recycling and treatment of WEEE are crucial for every country. Although this waste contains both toxic and valuable components, it is mostly delivered to landfills. That leads to negative environmental consequences. E-waste is constantly exported from developed to developing countries, often illegally. Due to the high environmental impact caused by the misuse of such waste, this research is relevant.

A detailed literature review on WEEE management was conducted. E-waste generation in Ukraine was estimated using electronics market analysis. Besides, all the companies managing WEEE in Ukraine were analysed (i.e., collection, transportation, storage, processing, recycling, disposal).

Waste electrical and electronic equipment management in Ukraine is still primitive. There is no appropriate legislation and infrastructure. There are very few companies managing this growing type of waste. The existing data collection is not efficient. This leads to a great underestimating of e-waste flows. Therefore, Ukraine needs the adoption of relevant legislation, as well as assistance and control over WEEE management.

**Keywords:** *waste electrical and electronic equipment, e-waste, environment, waste management, e-waste treatment*

### INTRODUCTION

Waste electrical and electronic equipment (WEEE or e-waste) is a relatively new type of waste generated due to the market growth for electronic and electrical devices. Last years, WEEE managing and recycling is crucial for every country. Although this waste contains both toxic and valuable components, it is mostly delivered to landfills. That leads to negative environmental consequences. According to [1], [2], [3], [4], [5]. WEEE commonly contain toxic substances, such as lead, mercury, arsenic, and other heavy metals which may leach into soil and groundwater. In USA landfills, 70% of heavy metals come from e-waste [6].

Besides, the plastic from e-waste contains various accessory substances (pigments, retardants, stabilizers, plasticizers) [7], being the source of many toxic compounds.

The estimated world WEEE generation is about 42 million tons per year [8]. Although Europe and the United States were previously responsible for most of this waste, China, Latin America, and other emerging economies are now generating even more e-waste [9].

E-waste is constantly exported from developed to developing countries, often illegally. For example, in the USA, an estimated 50–80 percent of the waste collected for recycling is being exported in this way [6]. Compliance with the e-waste export ban remains a major challenge for the Basel Convention implementation. Particularly large e-waste volumes are illegally delivered to China via Hong Kong [10]. Lee et al. [6] provide a study of WEEE transportation and illegal global commerce of e-waste. The authors also give an overview of new ways to monitor, regulate, and enforce the rules on the international shipping of hazardous e-waste materials. In Ukraine, there is also a problem of illegal import of used electronics and other equipment.

Efficient WEEE management in Ukraine has already been under consideration for some time. The EU, Japan, Korea Republic, and other countries have examples of efficient financial tools for e-waste processing [11], [12], [13]. These include, for example, advanced producer responsibility ensuring the payment for WEEE collection and managing. Despite these facts, Ukraine still has no strategy on WEEE management. In 2016, a draft Law on waste electrical and electronic equipment was prepared, but it has not yet been adopted. According to the sustainable development concept, the legislation in the field of WEEE should be improved, as well as creation of modern infrastructure is planned. This should ensure 20% reduction of e-waste volumes.

WEEE does not decompose over a long time, but accumulates in the environment contaminating with toxic substances. Due to the high environmental impact caused by the misuse of such waste, this research is relevant.

The purpose of this work is to study waste electrical and electronic equipment management in Ukraine and the analysis of entities involved.

## **MATERIALS AND METHODS**

A detailed literature review on WEEE management was conducted. E-waste generation in Ukraine was estimated using electronics market analysis. A significant industrial, scientific and technical, and entrepreneurial potential is involved in the field of waste management in Ukraine with more than 1500 companies operating. Ukrainian legislation does not envisage the licensing of WEEE management as a separate waste type. Thus, a list of entities [14] licensed by the Ministry of Ecology and Natural Resources of Ukraine for hazardous waste management was analysed. This is because many WEEE are also categorised as hazardous waste (e.g., fluorescent lamps, spent batteries, etc.). According to Ukrainian legislation [15], the license is issued for an unlimited period. All the companies managing WEEE (i.e., collection, transportation, storage, processing,

recycling, disposal) in Ukraine were analysed. Also, e-waste generation rates in Ukraine are estimated using electronics market analysis and statistics on waste generation in the industrial and commercial sectors

## RESULTS AND DISCUSSIONS

### WEEE generation in Ukraine

After the economic decline in 2014, the electronic equipment market in Ukraine has been showing steady growth in recent years (Fig. 1). This leads to an increase of WEEE volumes.

Analysis shows plastic (30%), copper (20%) and iron (8%) as main e-waste components in Ukraine. The content of other precious metals is less: tin – 4%, nickel, aluminium, lead – 2% each, zinc – 1%, silver – 0.2%, gold – 0.1%. Since WEEE is very diverse and also contains valuable components, special and expensive technologies are required to process it. This requires new high-tech companies that does not exist in Ukraine at the moment.

Today, much of WEEE is delivered to Ukraine from the EU, including some illegal part (14–18%). In 2017, according to the official statistic, Ukraine generated about 28225 tons of WEEE (Table 1).

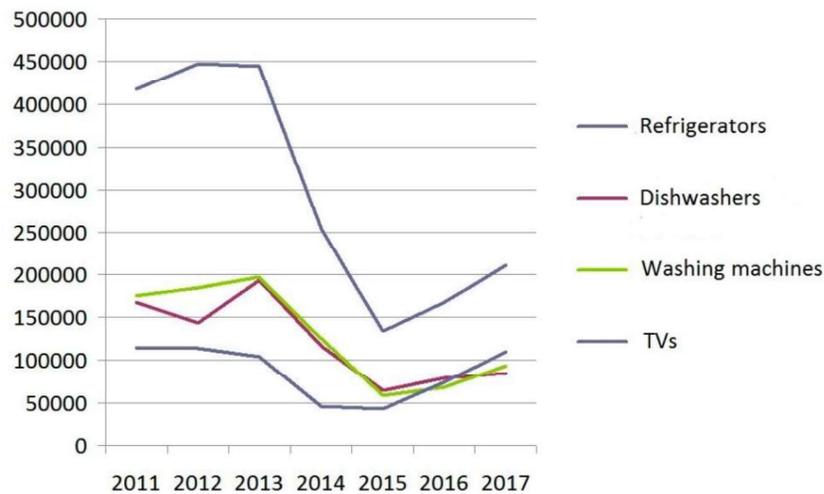


Figure 1. Sales of some home appliances in Ukraine, pcs.

Table 1. WEEE generation in Ukraine, 2017

WEEE	Source	Weight, tons	Recycled, tons
toner remnants	waste of printed products manufacturing	0.1	
wires and cables	waste of rubber and plastic products manufacturing waste of electric equipment manufacturing	695.2	42.8
electrodes	waste of metals manufacturing waste of electric equipment manufacturing	2.9	
conductors	waste of machines and equipment manufacturing	0.2	
electrical insulating materials	waste of machines and equipment manufacturing waste of electric equipment manufacturing	208.7	13.0
radiators	waste of machines and equipment manufacturing	1.5	
special technological equipment	waste of machines and equipment manufacturing household waste	16506.6	418.8
electric detonators	waste of machines and equipment manufacturing	0.1	
electrical household appliances	commercial waste household waste waste of machines and equipment manufacturing	3637.5	1.2
electronic components	waste of machines and equipment manufacturing	34.8	
office equipment	waste of office equipment manufacturing	20.3	
industrial batteries and their components	waste of electric equipment manufacturing waste of car manufacturing and use	5934.8	34400.6
household batteries	household waste waste of electric equipment manufacturing	7.2	
other electric appliances	waste of electric equipment manufacturing	0.6	
fluorescent lamps	household waste waste of television and radio equipment manufacturing	588.5	429.1
cathode-ray tubes	waste of television and radio equipment manufacturing	2.3	17.7
scrap of household radio equipment	waste of television and radio equipment manufacturing household waste	1.1	
television and radio transmitting devices	waste of television and radio equipment manufacturing	0.6	

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medical equipment	waste of medical equipment manufacturing household waste medical waste	292.3	73.9
measuring devices	waste of measuring equipment manufacturing household waste	0.1	
transformers and capacitors	household waste	208.4	3.0
electromagnetic equipment	household waste	9.4	
scientific equipment	household waste	72.3	
Total		28225.5	35400.1

Summarizing the data, one can find such composition of e-waste in Ukraine:

- technological equipment – 60%,
- batteries – 21%,
- home and office appliances – 13%,
- components of electric equipment – 4%,
- fluorescent lamps – 2%.

Data from the Table 1 seem to be underestimated due to the lack of WEEE monitoring from households. This is confirmed by an estimated 0.7 kg/year of WEEE per capita, which is significantly lower in comparison to other countries (for example, in Sweden – 17.5 kg/year [13]). Obviously, a large volume of used equipment remains unaccounted. Besides, many old appliances are imported to Ukraine illegally. The absence of separate WEEE collection system and places for its delivering, does not allow complete evaluating the flows of e-waste from the households.

In 2017, WEEE weight recycled in Ukraine amounted to 35400 tons (Table 1). This exceeds the amount of waste generated. It is possible if industrial batteries accumulated in previous years were recycled. Excluding the batteries, the amount of e-waste recycled was about 1000 tons providing only 4.5% of the waste generated.

**Organisation of WEEE management system**

In Ukraine, among 219 companies licensed to manage hazardous waste, 128 companies can manage some types of WEEE containing hazardous components (batteries, fluorescent lamps, etc.). But other WEEE are not covered. 22 companies have the relevant license and capacity to process WEEE, but only 4 of them are actively operating (one – in Odesa, three – in Kyiv region). These companies collect, store, treat, dispose and recycle hazardous e-waste (mercury and its compounds, waste lead batteries, waste and scrap of electrical and electronic components containing batteries).

There are 22 regions in Ukraine where licensed companies operate (Table 2). Two regions (Volyn and Chernihiv regions) do not have any entity managing e-waste.

Table 2. Companies managing e-waste as part of hazardous waste

Region	Number of companies	Region	Number of companies
Kyiv	27	Vinnytsia	4
Donetsk	13	Ivano-Frankivsk	4
Cherkasy	9	Zhytomyr	4
Zaporizhzhya	8	Mykolayiv	3
Dnipro	8	Sumy	2
Lviv	7	Chernivtsi	2
Luhansk	7	Ternopil	2
Khmelnyskyi	6	Kherson	1
Poltava	5	Zakarpattya	1
Kharkiv	5	Rivne	1
Kirovohrad	5	Volyn	0
Odesa	4	Chernihiv	0

Therefore, the largest quantity of companies licensed to manage hazardous waste (i.e. able to manage some types of WEEE) are located in Kyiv and Donetsk regions (21% and 10%, respectively). There are also regions with very few companies or even without (Volyn, Chernihiv, Rivne, Zakarpattya, Kherson regions). This fact, as well as the lack of WEEE management system lead to the disposal of e-waste with hazardous components at landfills. That significantly damages the environment, and also valuable resources are lost.

Taking into account a big area and population, there are not enough companies managing e-waste Ukraine. Besides, only a small part of these companies provide real recycling. Moreover, a significant part of WEEE remains uncovered, while posing a big risk to the environmental safety of Ukraine.

## CONCLUSION

Analysis shows plastic (30%), copper (20%) and iron (8%) as main e-waste components in Ukraine. The content of other precious metals is less: tin – 4%, nickel, aluminium, lead 2% each, zinc – 1%, silver – 0.2%, gold – 0.1%. Because WEEE is very diverse and also contains valuable components, special and expensive technologies are required to process it. This requires new high-tech companies that does not exist in Ukraine at the moment. In Ukraine, among 219 companies licensed to manage hazardous waste, 128 companies can manage some types of WEEE containing hazardous components (batteries, fluorescent lamps, etc.). But other WEEE are not covered. 22 companies have the relevant license and capacity to process WEEE, but only 4 are actively operating. Today, much of the WEEE is delivered to Ukraine from the EU, including some illegal part (14-18%). In 2017, according to the official statistic, Ukraine generated about 28225 tons of WEEE. These includes (in tons): toner remnants – 0.1, wires and cables – 695.2, electrodes – 2.9, conductors – 0.2, electrical insulating materials – 208.7, radiators – 1.5, special technological equipment – 16506.6, electric detonators – 0.1, electrical household appliances – 3637.5, electronic components – 34.8, office equipment – 20.3, industrial batteries and their components – 5934.8, household

batteries – 7.2, other electric appliances – 0.6, fluorescent lamps and other mercury-containing waste – 588.5, cathode-ray tubes – 2.3, scrap of household radio equipment – 1.1, television and radio transmitting devices – 0.6, medical equipment – 292.3, measuring devices – 0.1, transformers and capacitors – 208.4, electromagnetic equipment – 9.4, scientific equipment – 72.3. Obviously, many e-waste is not included in this list (many WEEE from household waste) due to the lack of data.

Waste electrical and electronic equipment management in Ukraine is still primitive. There is no appropriate legislation and infrastructure. According to official data, about 28000 tons of e-waste are generated yearly in Ukraine. However, this amount does not count household waste, since appropriate statistics are not being provided. Estimation of e-waste flows as a separate category is not carried out. There are very few companies managing this growing type of waste. They are not able to manage efficiently the waste amount that is already accumulated and will grow. The existing data collection is not efficient. This leads to great underestimating of e-waste flows. Two Ukrainian regions do not have any entity managing e-waste. Therefore, Ukraine needs to adopt appropriate legislation, create special places for WEEE collection, conduce and control e-waste management operations, establish efficient monitoring system of WEEE flows. Besides, the necessary task includes public informing about the hazard caused by the misuse of e-waste, as well as preventing disposal such waste in the environment.

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