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ELECTRONIC WASTE: TRASH TO CASH

Rapid technological advances and lower product prices for more powerful machines are contributing to shorter product life spans and frequent replacement of electrical and electronic equipment. As a result it leads to generation of e-waste, which attracts more and more attention from businesses, government authorities and civilians. Waste electrical and electronic equipment is defined as electrical and electronic equipment which has reached end of life (waste); including all components, subassemblies and consumables which are part of the product at the time of discarding. There is a growing concern over WEEE due to increasing amounts generated, coupled by the toxic content and the valuable materials. WEEE is the most rapidly growing segment of the municipal waste stream. The article defines the problem of e-waste management in Ukraine. It contains the best practices of e-waste management in the EU. It analyses and compares Ukraine and EU legislation in this field, responsibility of producers of electrical and electronic equipment (as well as importers and retailers), e-waste collection schemes and financial mechanisms. The article contains suggestions of how to solve the problem of generated and accumulated electronic waste as well as the model of economically and environmentally effective e-waste management.

Keywords: *electrical and electronic equipment, waste of electrical and electronic equipment, WEEE generation, Basel convention, EU-Ukraine Association Agreement, waste classifier, advanced recycling fee, collection schemes.*

ЕЛЕКТРОННІ ВІДХОДИ: ПЕРСПЕКТИВИ ПЕРЕТВОРЕННЯ ВІДХОДІВ У ДОХОДИ Шулаєва Ю. Є.

Стрімкі темпи науково-технічного прогресу, розширення ринків збуту й сфер застосування електричного й електронного обладнання супроводжуються скороченням його життєвого циклу в результаті появи нових видів і моделей. Як наслідок, це призводить до утворення електронних відходів, які все більше привертають увагу бізнесу, органів управління й громадськості. У статті визначена проблема поводження з електронними відходами в Україні на основі вивчення передового досвіду управління електронними відходами в країнах ЄС. Виконано аналіз управління потоками цих відходів в Україні та в ЄС за законодавчим регулюванням, відповідальністю виробників електричного й електронного обладнання (імпортерів, ритейлерів), схемами збору електронних відходів, механізмами фінансування управління такими відходами. Наведено висновки, у яких запропоновано шляхи задля вирішення зростаючої проблеми нагромадження електронних відходів та модель економічно та екологічно ефективного управління ними.

Ключові слова: електричне й електронне обладнання, електронні відходи, утворення електронних відходів, Базельська конвенція, Угода про асоціацію між Україною та ЄС, класифікатор відходів, авансові платежі, схеми збору.

ЭЛЕКТРОННЫЕ ОТХОДЫ: ПЕРСПЕКТИВЫ ПРЕВРАЩЕНИЯ ОТХОДОВ В ДОХОДЫ

Шулаева Ю. Е.

Стремительные темпы научно-технического прогресса, расширения рынков сбыта и сфер применения электрического и электронного оборудования сопровождаются сокращением его жизненного цикла в результате появления новых видов и моделей. Как следствие, это приводит к образованию электронных отходов, которые все больше привлекают внимание бизнеса, органов управления и общественности. В статье определена проблема обращения с электронными отходами в Украине на основе изучения передового опыта управления электронными отходами в странах ЕС. Выполнен анализ управления потоками этих отходов в Украине и в ЕС по законодательному регулированию, ответственности производителей электрического и электронного оборудования (импортеров, ритейлеров), схемам сбора электронных отходов, механизмам финансирования управления такими отходами. Приведены выводы, в которых предложены пути решения проблемы накопления электронных отходов и модель экономически и экологически эффективного управления ими.

Ключевые слова: электрическое и электронное оборудование, электронные отходы, образование электронных отходов, Базельская конвенция, соглашение об ассоциации между Украиной и ЕС, классификатор отходов, авансовые платежи, схемы сбора.

Problem statement. This article reviews the growing problem of waste of electrical and electronic equipment (WEEE) generated in Ukraine, describes one model of a convenient and environmentally friendly WEEE management system, and outlines business opportunities for EEE producers, importers, local recyclers and EU take-back compliance schemes among producer associations.

WEEE is a national challenge that needs to be addressed at all levels. The Verkhovna Rada can contribute to a national solution by adopting legislation that allows temporary WEEE export and bringing Ukrainian laws on waste in line with EU legislation. EEE producers, importers and retailers need to join forces in sharing responsibility for organizing effective collection and recycling financing systems.

Analysis of the last researches and publications. There is a number of research works related to the development of an effective mechanism of management of electronic waste, which have been made by the foreign authors. This article refers to the works of Antrekowitsch H. [4] and Sinha D.K. [10]. Studies in Ukraine in this field are limited with the translated articles published in the foreign editions.

The **purpose of the article** is to offer the roadmap for WEEE management policy in Ukraine based on the analysis of the current WEEE management mechanism in Ukraine and in the EU.

The main results of the research. *What is WEEE?* The global market for electric and electronic equipment (EEE) has grown exponentially in the last 40 years as the use of equipment

such as mobile phones and computers skyrocketed, even in the poorest countries in the world. Developing countries like Ukraine are the fastest-growing markets for these goods.

More than 10 million PCs, equal to a total mass of over 400,000 tonnes, and more than 20 million mobile phones equal to about 2,400 t were imported to Ukraine over 1991-2006. In 2006, the Ukrainian PC market was the fastest-growing in Europe. In 2007, Ukraine was 3rd largest PC importer after Russia and Poland in Central and Eastern Europe [1]. Sales peaked in 2008 [2]. Demand slumped in 2009 and 2013 because of economic recession (Fig. 1).

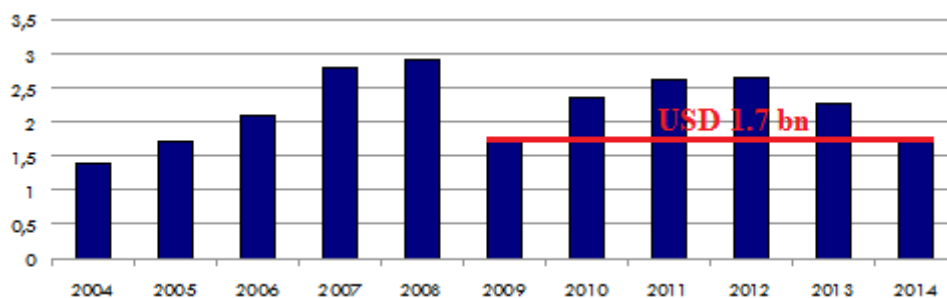


Fig. 1. Ukraine's IT equipment market, USD bn

Source: [3]

According to IDC projections [3], PCs demand is not expected to recover in the next while, as purchasing power has fallen significantly among Ukrainians. Nevertheless, the e-tablets segment in the domestic consumer electronics market was the 3rd biggest among CEE countries in 2014.

With 98.8% of its computers not made domestically, Ukraine imports large quantities of electric and electronic equipment, which means that responsibility for environmentally friendly WEEE management at the end of EEE lifespans needs to be laid on importers. This is in line with the producer-pays principle and principle of extended producer responsibility legally instituted by all developed countries to comply with the concept of sustainable development.

In Ukraine's market for electrical and electronic equipment, the main importers are: Indesit, Bosch, Phillips, Delonghi, LG, and Sony for the household appliances. The market shares of the main importers for tablets and notebooks can be seen in the pie charts below [3].

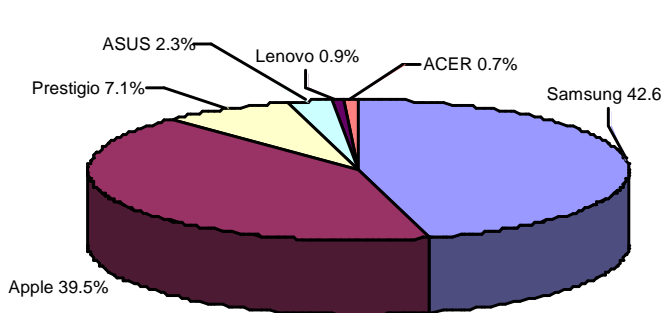


Fig. 2. Ukraine's main importers for tablets

Source: [3]

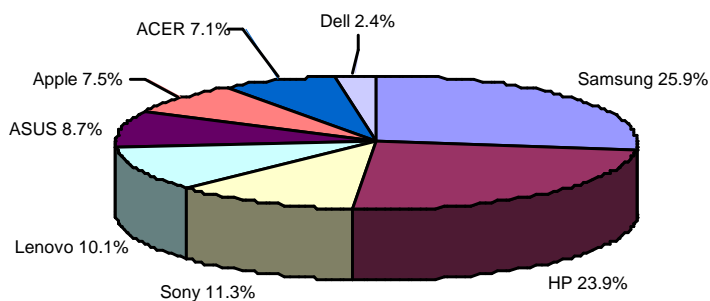


Fig. 3. Ukraine's main importers for notebooks

Source: [3]

Rapid technological advances and lower product prices for more powerful machines are contributing to shorter lifespans and frequent replacement. There is a growing concern over WEEE as increased quantities are generated, coupled with toxic content and valuable materials.

Today, WEEE is the fastest-growing segment of the municipal waste stream. There is no official data on the amount of WEEE discarded in Ukraine, but it is estimated that over 200,000 t of WEEE are generated annually and the amount keeps growing. According to one projection, by 2022 the total volume of WEEE generated in Ukraine could reach 3mn tons. In terms of per capita WEEE generated, Ukraine leaves most EU states behind (Fig. 4).

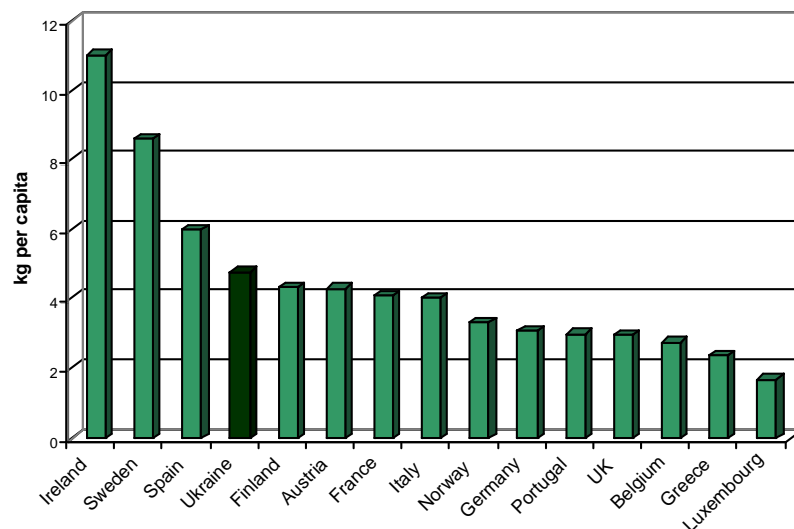


Fig. 4. WEEE generated per capita in 2012

Source: [3]

The minimum price that EU recyclers are prepared to pay for WEEE produced in Ukraine is EUR 200 per t, which means that Ukraine loses up to EUR 40mn annually.

What problems does WEEE generate? The main problem with WEEE in developing countries is uncontrolled burning and recycling using rudimentary skills and technologies to recover precious metals that pose a danger to the environment and human health.

Potentially, this is also a sizeable market that involves considerable investment from both the private and public sectors, as WEEE recycling funds depend on the quantities of EEE produced and imported in the country. Competition among WEEE recycling companies is growing dramatically in Europe. This is partly due to the growing number of companies operating in this field and partly to the rapid development of hi-tech equipment and facilities that minimize the cost of recycling and maximize the recovered secondary raw materials.

Valuable materials in WEEE. Most of the valuable substances in EEE are found in the printed circuit boards that connect and support electronic components. In a PC, these metals include iron, aluminum, copper, lead, nickel, tin, gold, silver, platinum, and palladium. Metals and other valuable materials are present in other electronics components, such as copper in wires, and iron and aluminum in household appliances. According to the US Geological Survey, 1 ton of computer waste contains as much gold as 18 tons of gold-bearing rock. The principal metal present in WEEE streams is copper, so for the purposes of comparison, the levels of valuable metals present in a

typical copper ore and typical WEEE metals contents are shown in Table 1. The comparison highlights the importance of maximizing WEEE recycling.

Table 1. Extractable metals in WEEE compared to typical copper ore (%)

Metal	Typical copper ore	Keyboard	PC	PCBs
Silver	0.00034	0.050	0.0090	0.300
Gold	0.00010	0.005	0.0010	0.008
Copper	0.80000	13.000	7.0000	25.000
Zink	0.12000	3.000	1.3000	1.500
Palladium	0.04000	0.0002	0.0004	-
Aluminium	-	18.0000	11.0000	3.000

Source: [4]

This sector of business in Ukraine is still nascent. It is a consequence of the imperfect legislative regulation and the absence of the financial mechanism of WEEE management.

WEEE management in Ukraine today. Legal Framework. Basel Convention. Ukraine ratified [5] the Basel Convention on The Control of Transboundary Movements of Hazardous Wastes and Their Disposal in 1999. This Convention:

- limits the transboundary movement of hazardous wastes;
- recommends that hazardous wastes and other wastes should, as far as is compatible with environmentally sound and efficient management, be disposed of in the state where they were generated;
- lays responsibility for the transport and disposal of hazardous wastes on the waste generator (producer, importer or trader).

At the same time, the Basel Convention also regulates the cross-border movement of WEEE where the state that generated the WEEE does not have the technical capacity and the necessary facilities or suitable disposal sites to dispose of the wastes in an environmentally sound and efficient manner.

Since Ukraine doesn't have enough facilities for WEEE recycling, the Basel Convention states that it should export the WEEE generated in the country to ensure its' environmentally friendly management.

Ukrainian law complicates and makes the export of such waste nearly impossible because some of it contains precious metals. Certainly, exported WEEE means a loss of valuable resources for the country, but in the meantime thousands of tonnes of WEEE are simply being dumped and accumulated in landfills around the country, causing significant environmental damage from the toxic chemicals and hazardous materials that this waste contains.

Waste Classifiers. Ukraine lacks a coherent methodology to identify the hazard class of the waste. Apart from it, classifiers consider only wastes generated from market players. The waste streams from households are not regulated.

There are several documents, so called waste classifiers, which refer waste to a certain waste group:

- Temporary Classifier, enacted by the USSR Ministry of Health. Industries still use it to identify the hazard class of waste generated during production.
- Sanitary requirements for the treatment of industrial waste.

• The State Waste Classifier groups waste according to the economic or service sector generating the waste, while producing goods or rendering services. It is based on two classifiers: the Classifier of Categories of Economic Activity and the State Classifier of Products and Services. It does not identify hazard classes. WEEE is positioned in Group Б6 with a code of 7740.3.1.04 as damaged, obsolete or irreparable electronic equipment generated in companies from different economic sectors.

EU-Ukraine Association Agreement. Currently EU companies interested in recycling and ready to handle WEEE generated in Ukraine cannot gain access to the Ukrainian WEEE market because of discrepancies between EU and Ukrainian legislation.

The Association Agreement opens up new opportunities in environmental and waste management cooperation but requires that Ukraine harmonizes its legislation with EU laws.

The EU-Ukraine Association Agreement's [7] political section was signed on the March 21, 2014, and economic section on June 27, 2014. It calls for the gradual approximation of Ukrainian legislation to EU law and policy on environment. Accordingly:

- EU Directive 2008/98/EC on waste must be adopted in national legislation within 3 years of this Agreement entering into force.
- Competent authority/ies must be designated within those 3 years.
- Full cost recovery mechanism following the polluter pays principle and extended producer responsibility principle must be established within 5 years.

As EU-Ukraine Association Agreement was supposed to have been signed in November 2013, several steps had already been taken to harmonize Ukrainian legislation on waste with EU laws and regulations:

• The law of Ukraine on waste had been significantly amended in 2010. Responsibility for collecting WEEE and recycling it was laid on the Cabinet of Ministers and other Ministers and municipal governments.

• A plan for measures to adapt Ukrainian legislation to EU legislation was developed and confirmed for 2013. The plan included a list of EU Directives on environmental protection to serve as guidelines and standards for Ukraine's lawmakers. The Directive on Waste 2008/98/EC, which also regulates WEEE stream, is one of them.

• In order to implement this plan, the Recommendations on WEEE Collection, which stipulate collecting it on sites for bulky domestic wastes and organizing a mobile collection system together with collection points, were approved. These recommendations were developed for local councils and local governments responsible for collecting and processing domestic waste.

Since then, the situation in Ukraine has not changed and no subsequent steps were taken to implement the plan or regulations.

Producer Responsibility. At the moment, none of the stakeholders in the EEE lifespan - producers, importers, wholesalers or retailers - is legally responsible for the WEEE generated.

WEEE collection schemes. Household WEEE collection schemes are stipulated by the Recommendations on WEEE Collection, but the Recommendations have not been implemented. This means that this WEEE stream is not controlled in Ukraine. Second-hand EEE is an informal market, with devices being resold for the purpose of reuse or dismantling for spare parts. This prolongs EEE lifespan and helps to temporally slow down WEEE generation, but it does not

prevent it altogether. At the end of the day, what's left goes to landfills, together with other domestic waste.

WEEE collection from business is regulated in such a way that the state legally obliges companies to make agreements with recyclers that handle waste containing precious metals. However, most such firms take WEEE only to extract precious metals: the rest of the waste goes to landfills.

Financial mechanism. There is no official/state financial mechanism developed for the collection, take-back and recycling of WEEE. An example of the financial mechanism that works among EU member states is offered in Section 5.4.

Best practice in WEEE management in the EU

Legal Framework. There are two main Directives that regulate WEEE management in the EU:

- WEEE Directive [8]. It is intended to establish collection schemes for consumers to return their WEEE free-of-charge. These schemes aim to increase the recycling and/or re-use of WEEE. The requirements for collecting and recycling volumes were revised in order to tackle the rapidly expanding WEEE stream. The revised Directive came into effect in February 2014.

- RoHS Directive [9]. Its purpose is to limit certain hazardous substances, such as mercury, chromium, cadmium, lead, PBB and PBDE, in EEE. In December 2008, the European Commission proposed revising the Directive. The RoHS recast Directive 2011/65/EU came into effect in January 2013.

WEEE and RoHS observance by the EU member states has led to leading global positions in reducing the volumes of WEEE generated and accumulated, while in increasing volumes of WEEE collected and recycled.

Waste Classifiers. The European Waste Catalogue and Hazardous Waste List [10] are used for the classification of all hazardous and non-hazardous wastes and are designed to form a consistent waste classification system across the EU. They form the basis for all national and international waste reporting obligations, such as those associated with waste licenses and permits, the National Waste Database and the transport of waste. Wastes are grouped according to the properties of wastes in the same group and the treatment method is chosen accordingly.

WEEE are positioned in Group 16 02 "Wastes from electrical and electronic equipment" in Sec. 16, which also includes end-of-life vehicles, batteries and accumulators. WEEE includes 8 subgroups, most of them marked with an asterisk, indicating that they are hazardous.

Producer Responsibility. WEEE Directive establishes producer responsibility for EEE products. Producers must contribute to financing and bear responsibility for a fully-functioning collection system for their spent products. In the Directive, "producer" refers to those manufacturing and, under their own name, importing and/or selling electric and electronic products (stakeholders).

Collection schemes. To comply with the WEEE Directive and Basel Convention, EU member states established WEEE take-back compliance schemes, which bring together the biggest producers of electrical and electronic equipment, such as Samsung, Panasonic, Electrolux and so on, behind special enterprises, such as ICT Milieu and NVMP in the Netherlands, Recupel in Belgium, El Kretsen in Sweden, El Retur in Norway, SWICO in Switzerland, and Asekol in Czech Republic.

The most common collection schemes are: collection yards run by city councils; mobile collection points, mostly for bulky WEEE; municipal collection points; EEE points of sale and service; collection points at schools, private companies and governmental offices.

Financial mechanism. Since August 13, 2005, producers must fund the recycling of WEEE basing on their current market share, by filling WEEE recycling fund with:

- Advanced Recycling Fees (ARF) charged to consumers of new EEE at the moment of its purchase, together with
- Administration Flat Fee.

The WEEE Directive requires EU member states to ensure that for a transitional period of 8 years (10 years for large household appliances) producers are allowed to show consumers the visible advanced recycling fee at the time of sale of new products. The visible advanced recycling fee consists of the costs of collection, treatment and disposal of historic WEEE in an environmentally sound way.

Fig. 5 shows the circular flow of materials, which aims to optimize a closed loop material cycle, together with the financial flow designed to fill the Recycling Fund.

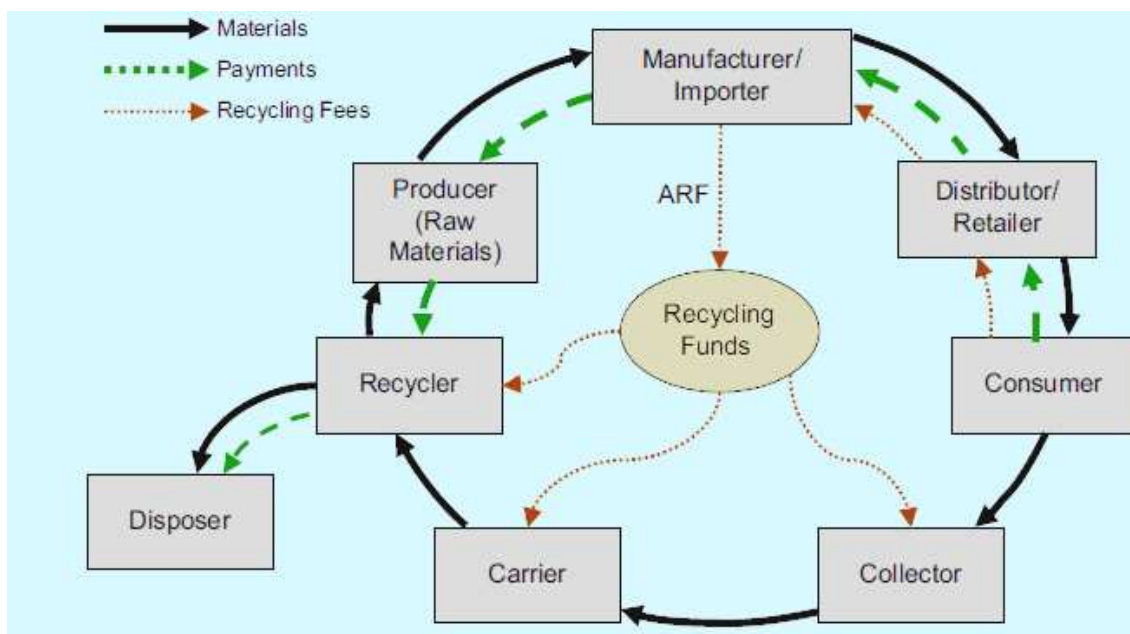


Fig. 5. Flow of materials and finances in EU WEEE management system

Source: [10]

An industry-based national WEEE registration body is responsible for keeping and updating the database of registered EEE producers or importers and their market shares, and approving environmental management costs. These costs fund collective compliance schemes operating in EU states, to enable them to pay for environmentally sound management of all household WEEE taken back by retailers or deposited by members of the public at local civic amenity sites.

Conclusions. *A roadmap for WEEE management policy in Ukraine*

A. Improve the national legal framework regulating WEEE by:

- harmonizing Ukrainian legislation on WEEE management with EU legislation (such as the Waste Classifier and the Ukrainian Law on Waste);

- adopting certain EU standards, rules and regulations in this field. This means not only the adoption of laws and so on, but also the implementation of, for example, Basel Convention requirements to comply with internationally observed rules of transboundary movement of hazardous waste, Extended Producer Responsibility and polluters pay principles;

- allowing the temporary export of WEEE for environmentally sound treatment, until Ukraine builds up its own facilities to handle domestic recycling, in accordance with the Basel Convention instructions;

- drafting new laws based on EU practice, such as WEEE and RoHS Directives.

B. Establish an industry-based national WEEE registration body responsible for the database of registered EEE producers and importers in Ukraine, and their market shares, environmental management costs, and statistics for WEEE generated, collected and recycled.

C. Introduce WEEE take-back compliance schemes, associations of WEEE producers/importers, to implement the concept of Extended Producer Responsibility by providing effective collection and treatment schemes.

D. Launch a WEEE Recycling Fund to cover the expense of environmentally sound WEEE treatment.

E. Raise awareness among decision-makers, the public and other stakeholders around issues related to EEE and WEEE. This means that, besides improving the system of checks and penalties along the entire product lifecycle, an effective information campaign is needed to raise awareness among both consumers and retailers, and among public authorities. Only a comprehensive approach will reduce the profitability of the black market and produce a new economy and new jobs that respect the environment.

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