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E-mail: sgem@sgem.org | URL: www.sgem.org

ASSESSMENT OF HAZARDOUS HOUSEHOLD WASTE GENERATION IN EASTERN EUROPE

Assoc. Prof., Dr. Vitalii Ishchenko¹

Prof., Dr. Sc. Volodymyr Pohrebennyk^{2,3}

Prof., Dr. Sc. Roman Kochan⁴

Prof., Dr. Sc. Olena Mitryasova⁵

Prof., Dr. Sc. Stanislaw Zawislak⁴

¹Vinnitsia National Technical University, **Ukraine**

²Lviv Polytechnic National University, **Ukraine**

³State Higher Vocational School, **Poland**

⁴University of Bielsko-Biala, **Poland**

⁵Petro Mohyla Black Sea National University, **Ukraine**

ABSTRACT

Hazardous household waste (HHW) is a small but the most dangerous fraction of household waste. Different studies estimate their content in household waste from 0.1 to 1%. In Eastern Europe, due to the low efficiency of separate household waste collection, most of the hazardous household waste is mixed with other waste and are mainly disposed in landfills. A thorough analysis of the literature on HHW has been carried out. Statistical data on HHW generation in the Eastern Europe countries (Bulgaria, Czech Republic, Poland, Slovakia, Romania, and Ukraine) were compared. A significant part of HHW is not included in special collection systems. The amount of separately collected hazardous waste reported in official statistics does not reflect the real amount of HHW generation. The largest amount of HHW is generated in Poland (over 100000 tons/year). The smallest amounts of HHW (on average) are generated in Slovakia and Ukraine (less than 10000 tons/year). Very likely, there is an underestimation of HHW generation due to low monitoring efficiency in waste management. The lowest values per person are found in Ukraine and Slovakia – respectively 0.25 and 1.7 kg/year, the highest – in Poland and Bulgaria (according to some studies, 7.4 and 9.2 kg/year per person respectively). The largest share of HHW was found in Bulgaria and Poland (respectively 3.2% and 2.7%), well above the EU average. However, most of the results in countries under investigation are close to the average European content (1%). Only Ukraine demonstrates very low HHW share (0.1%).

Keywords: toxic substances, hazardous household waste, environment, waste generation

INTRODUCTION

Hazardous household waste (HHW) is a small but the most dangerous fraction of household waste. Different studies estimate their content in household waste from 0.1 to 1.9% (mainly from 0.6 to 1.2%) [1]. Usually, this quantity does not include the waste electrical and electronic equipment (WEEE) containing also some dangerous components. Still, there are different approaches to including or not including some

types of waste to HHW in different countries. Officially, HHW is the waste generating in households or commercial buildings and having physical, chemical, biological or other properties that pose or can pose a danger to the environment or human. The most common hazardous household waste includes batteries, fluorescent lamps, medical waste, washing agents, etc. They contain various toxic substances: heavy metals, aromatic hydrocarbons, as well as many other carcinogenic and aggressive organic and inorganic compounds. In [2], an increase in the hazardous waste amount in the households (up to 7 kg/y per 1 person in the EU) was reported. However, the explanation could be the increase in WEEE streams, as well as improved waste separation and hence better HHW accounting.

According to the legislation of many countries, this waste has to be collected separately to prevent mixing with other waste and further environmental pollution. In Eastern Europe, however, due to the low efficiency of separate household waste collection, most of the hazardous household waste is mixed with other waste and are mainly disposed in landfills. Thus, data on hazardous household waste generation are important for evaluating their flows and developing effective management.

MATERIALS AND METHODS

A thorough analysis of the literature on HHW has been carried out. Statistical data on HHW generation in the Eastern Europe countries (Bulgaria, Czech Republic, Poland, Slovakia, Romania, and Ukraine) were compared. Also, the authors have studied Eastern Europe markets of the products being the sources of HHW (amount of manufactured, imported, and sold products). The complexity of estimating HHW generation is connected to three main factors: 1) there is no single and commonly accepted HHW list (sometimes some part or whole WEEE, or even end-of-life vehicles are included in this list); 2) accounting only the most common HHW (e.g., batteries); 3) no efficient separate HHW collection. Thus, statistics on the HHW generation is ambiguous and rare scientific studies are available.

RESULTS AND DISCUSSIONS

Even in the developed countries, despite efficient legislative and organizational support, as well as public concern, a significant part of HHW is not included in special collection systems. For example, only about 40% of all batteries are being collected in EU countries. In the Eastern Europe countries, this number is much lower. Therefore, the amount of separately collected hazardous waste reported in official statistics does not reflect the real amount of HHW generation. Below one may find the analysis of HHW generation in the Eastern Europe countries.

Bulgaria

Of the total hazardous waste (more than 13 million tons/year) generated in Bulgaria in 2012, only a small part (22000 tons) was generated along with municipal waste: 14000 tons in the commercial buildings and 8000 tons in households [2]. With a total amount of household waste 2.7-2.8 million tons/year, the share of HHW was 0.8% or 3.1 kg/year per person. According to another source [3], HHW amount has increased to 52000 tons/year in 2016 (7.4 kg/year per person) corresponding to 3.2% share in total household waste mass. Taking into account WEEE (5-6 kg/year per person [4]), the share of HHW can go up to 5%. Currently, Bulgaria is actively implements the National Waste Management Plan 2014-2020 providing strict control over HHW. Attention will

be paid to the reuse of potential hazardous waste or their components from households through educational, economic, and other measures, such as supporting or establishing accredited reuse centres and networks, especially in densely populated areas. These actions will primarily affect the generation of hazardous waste in households. HHW prevention is included in the project under the Bulgarian–Swiss Cooperation Programme. It aims to introduce pilot models for the separate collection of HHW and the creation of major infrastructure. The implementation will significantly reduce the generation of HHW [2].

Czech Republic

One of the very few direct measurements of HHW content was carried out in the Czech Republic. According to the results obtained by Adamcova et al. [1], HHW content in fresh household waste in two Czech cities was 0.6-0.8%. Although, the share of HHW was significantly higher (2.1%) in the household waste sampled at the landfill. This may be due to the organic fraction decomposition and the reduction of total waste mass. With the same weight of HHW, it leads to their share increase. The average HHW generation is up to 2.7 kg/year per person. The same authors have also identified the potentially hazardous household waste with significantly higher share – up to 3.8%. Even greater distribution of results was obtained in [5]: from 0.1% to 2.2% in different households. At the same time, official statistics provides a much lower HHW share. According to [3] – 0.3%. Interestingly, other statistics [6] indicates a decrease in HHW content from 0.27% to 0.19% over the past few years. Batteries constitute about 30% of HHW in Czech Republic. According to the Waste Management Plan of the Czech Republic for the period 2015-2024, HHW generation should increase to 12700 tons/year in 2024.

Poland

With a total HHW generation 117000 tons/year (2014), their share in Polish household waste are about 0.8% [7]. This corresponds to 3 kg/year per person. Moreover, HHW content in waste from rural areas is higher compared to urban waste. Over the past 15 years, HHW amount has not changed considerably. For comparison, about 116000 tons of HHW were generated in Poland in 2005 constituting 0.7% of the household waste mass. Generation of various types of HHW are presented in the Table 1.

Table 1. HHW generation in Poland [8]

Type of HHW	Weight, t/y
Batteries and accumulators	12220
Detergents	5090
Photographic reagents	2040
Paints, inks, adhesives, binders, resins	35640
Acids and bases	1020
Fluorescent lamps and other mercury-containing waste	5090
Medical waste	4070
Oils and fats	10180

Pesticides	5090
WEEE	10180
Wood containing dangerous substances	5090
Devices containing freons	3050
Solvents	3050
Total	101810

As one can see, more than 30% of HHW in Poland are provided by paints, varnishes, glues. Other weighty components include batteries, oils, and WEEE. Interestingly, according to the latest official statistics [3], the content of HHW in Poland has decreased to 0.1%. Although, taking into account a big difference in HHW generation statistics for different years, these data can not be considered as reliable. For example, HHW content in one of the Polish cities was found to be 2.7% (9.2 kg/year per person) [7].

Romania

With a total HHW generation more than 41000 tons/year [3], their average content in Romanian household waste is about 1.2% (2 kg/year per person). However, the authors [9] did not find HHW in household waste from Cluj Napoca city. At the same time, the amount of WEEE collected in Romania is 1-2 kg/year per person [Popescu], which constitutes about 10% of the total WEEE placed on the market. Therefore, the share of HHW can grow up to 2.5% along with WEEE. Besides, approximately 7 million fluorescent lamps are sold annually in Romania. Assuming that about half of this quantity is used in households and commercial buildings, and the average mass of the lamp is about 285 g, then the total mass of fluorescent lamps in Romanian household waste is up to 1000 tons per year. In the Romanian legislation, a special attention is paid to medical waste. The staff of hospitals and other medical institutions is responsible for the separate collection of infectious medical waste. Also, some types of HHW (PCB/PCT-containing equipment, expired pesticides, chlorinated organic solvents, used oils, infectious waste, batteries and accumulators) are included in Specific Strategic Goals for certain flows of hazardous waste of the National Waste Management Strategy of Romania.

Slovakia

According to the official statistics [10], the amount of separately collected HHW in Slovakia in years 2002-2017 is constantly increasing from 1196 to 9056 tons/year. This can be due to the increased efficiency of separate waste collection. At the same time, the content of HHW in household waste has increased from 0.08% to 0.42% (to 1.7 kg/year per person) or 0.3% (6000 tons, 1.1 kg/year per person) excluding WEEE. Although some studies [11] showed 1.0 and 1.1% HHW in household waste in multifamily and private houses respectively. In many Slovakian towns, HHW are collected in the special collection centres and additionally few times per year from private houses. In such a way, an effective collection of HHW and reliable data on the HHW amount are achieved. The Table 2 includes the masses of separately collected HHW in 2017.

Table 2. HHW collected in Slovakia, 2017 [10]

Type of HHW	Weight, t/y
Solvents	15.43
Acids and bases	2.64
Photochemical agents	0.46
Pesticides	8.55
Fluorescent lamps and other mercury-containing waste	34.9
CFC-containing equipment	2475.39
Oils and fats	147.99
Paints, inks, adhesives	440.54
Detergents	5.65
Expired medicines	0.1
Batteries and accumulators	2869.09
WEEE (hazardous)	3104.81
Wood containing dangerous substances	0.02
Total	9105

It was expected that the largest share among HHW have WEEE and batteries. Also, large volumes of CFC-containing equipment should be noted. These 3 types cover about 90% of HHW in Slovakia.

Ukraine

Official sources provide different data on the amount of HHW generated in Ukraine: from 3000 to 9600 tons/year [12]. The distribution of HHW by type in Ukraine is given in the Table 3.

According to the official statistics, the share of HHW in Ukraine (with about 10 million tons of household waste generated per year) is only 0.1% or 0.25 kg/year per person. However, as noted above, this is likely to be significantly lowered due to the large volume of unaccounted waste. Besides, it is known that this statistical information is provided without reliable control of the data authenticity.

Table 3. HHW generation in Ukraine [12]

Type of HHW	Weight, t/y
Fertilizers contaminated or unidentified	2381
Pesticides	1.5
Expired medicines and medical equipment	47.7
Batteries	3267.29
Emulsions	277

Oils and fats	403.9
Paints, enamels, inks, resins, varnishes	676.5
Solvents	865.9
Acids and bases	81.8
Detergents	191.6
Photochemicals	17.5
Fluorescent lamps and other mercury-containing waste	587.3
Aerosol packaging	1.3
Contaminated packaging and clothes	264.3
PCB/PCT-containing transformers and capacitors	208.4
Equipment with sources of ionizing radiation	9.4
Medical instruments	86.3
Infectious waste	209.5
Total	9578

Comparison of HHW generation

The largest amount of HHW is generated in Poland (over 100000 tons/year). This is evident because of the relatively big population of this country. The smallest amounts of HHW (on average) are generated in Slovakia and Ukraine (less than 10000 tons/year). For Slovakia, low volume is obvious, since the population of the country and household waste generated are the smallest among the countries under investigation. However, for Ukraine with the largest population and household waste amount in the region, the amount is too low. Very likely, there is an underestimation of HHW generation due to low monitoring efficiency in waste management. Interestingly, the lowest values per person are also found in Ukraine and Slovakia – respectively 0.25 and 1.7 kg/year (see Table 4).

Table 4. HHW generation in the Eastern Europe

Parameter	Bulgaria	Czech Rep	Poland	Romania	Slovakia	Ukraine
Total HHW, tons	22000–52000	3600–78000	117000	41591	9056	9578
% of HHW in household waste	0.8–3.2	0.1-2.2	0.1–2.7	1,2	0.3–1.1	0.1
kg/year per person	3.1–7.4	2.7	3–9.2	2	1.1–1.7	0.25

At the same time, the highest HHW amount among Eastern European countries is found in Poland and Bulgaria – according to some studies, 7.4 and 9.2 kg/year per person respectively. For comparison, the average HHW generation in Austria – 1-1.5 kg/year per person, in China – 2.2 kg/year per person. Thus, HHW amounts in some Eastern European countries are quite high.

By the share in household waste, the lowest content of HHW was found in Ukraine (0.1%), which is much lower in comparison to other Eastern European countries. At the same time, the largest share of HHW was found in Bulgaria and Poland (respectively 3.2% and 2.7%), well above the EU average. However, most of the results in these two countries, as well as in Romania, are close to the average European content (1%). In the Czech Republic and Slovakia, many researchers provide even lower HHW share – 0.8% and 0.4% respectively.

Batteries is the major component of HHW by the weight. In EU countries [13], [14], about 0.25% of the household waste mass and about 50% of HHW are batteries and accumulators. In some Eastern European countries (Slovakia, Ukraine) their share is 30-35%. For example, in Poland more than 12000 tons of spent home batteries (less than 15% of the HHW mass) [15] are generated annually. Other important components of HHW in Eastern Europe are as follows: a) paints, inks, and adhesives (share in Poland – up to 35%); b) CFC-containing equipment and hazardous WEEE (share in Slovakia 27% i 34% respectively).

The share of one of the most hazardous components of HHW, mercury-containing waste, including fluorescent lamps, is relatively low – from 0.4% in Slovakia to 5% and 6% in Poland and Ukraine respectively. At the same time, the highest per person generation was found in Poland – more than 130 g/year.

It should be noted that a significant results spread even within one country indicates significant variations in approaches to HHW content evaluation and poor HHW generation accounting system.

CONCLUSION

The content of hazardous components in household waste from Eastern European countries is ranged from 0.1 to 3.2%, though majority of the results is ranged from 0.1 to 1.2% corresponding to the average European value. Per person HHW generation is found to be 1.1–3 kg/year. However, some countries are behind the range (Ukraine, 0.25 kg/year; some studies in Bulgaria and Poland, up to 9.2 kg/year). The lowest rates of HHW generation are in Ukraine, which is probably connected to the inefficient waste separation. Also, a relatively low HHW content was found in Slovakia. The highest rate of HHW generation are defined for Bulgaria and Poland. Among the various types of HHW, the largest share in the Eastern Europe belongs to batteries, paints, inks, adhesives, CFC-containing equipment, and hazardous WEEE. The data collected may be underestimated or incorrect due to the low efficiency of separate waste collection. Besides, the real content of HHW is likely to be higher since official statistics provide data only for separately collected waste. However, many HHW in mixed waste remain excluded. The main obstacles to the correct assessment of HHW flows in many Eastern Europe countries include low funding for HHW generation monitoring and no HHW separate collection resulting in incorrect data.

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