

Vaida Dobilaitė*,
Milda Jucienė,
Virginija Sacevičienė

Study of Textile Waste Generation and Treatment in Lithuania

DOI: 10.5604/01.3001.0010.5360

Kaunas University of Technology,
Institute of Architecture and Construction,
Kaunas, Lithuania
Tunelio str. 60, LT-44405
*E-mail: vaida.dobilaite@ktu.lt
E-mail: milda.juciene@ktu.lt
E-mail: virginija.saceviciene@ktu.lt

Abstract

The constantly encouraged worldwide production and consumption of textile products is leading to an increase in wastes, which causes environmental problems. This research is aimed at identifying the present state of textile waste generation and treatment in Lithuania and compare the trends obtained with other EU countries. The investigation is based on statistical data of textile waste generation and management from 2009 to 2014 in Lithuania. Municipal textile wastes and those from the leather, fur and textile industries as well as other fields of this kind of waste generation were taken for analysis. On average, 6500 tonnes per year of total textile waste was generated during the period analysed. According to these data, Lithuania is in a middle position in comparison with other EU countries. A significant growth in the collection of municipal wastes is observed. From 2012, pre-consumer textile waste amounts to on average 32 percent of the total textile waste collected. The dominant practice of treatment was disposal in landfills, but an increasing tendency to recycle textile waste was observed. Nevertheless a great deal more effort should be made to promote the prevention of waste production and to achieve the average EU waste management indicators.

Key words: textile, waste, recycling, treatment, landfilling, recovery.

Introduction

Growth of the global population, the depletion of natural resources, the rising pollution, and the degradation of ecosystems together with climate change are the new challenging environmental issues. Constantly encouraged worldwide production and consumption increases the volumes of wastes, which are mostly disposed of in landfills [1]. The textile and clothing industry produces fast fashion garments which are so cheap that consumers decide to throw them away effortlessly. Such undesirable habits, as well as rapid production manufacturing, contribute to the emergence of a huge amount of post-consumer and post-industrial textile waste. This problem should be considered from the perspective of inappropriate waste handling and treatment.

At an international level, the improvement of waste management is recognised as one of the main environmental activities. The basic goal of the European Union waste policy is to prevent waste and promote re-use, recycling and recovery so as to reduce the negative environmental impact. The EU aims to become a recycling society that seeks to avoid waste and uses it as a resource in the long-term outlook [2]. Considering this, the EU stiffens the requirements of disposal in landfills [3]; nevertheless, little tangible progress can be seen in quantitative waste prevention [4]. Furthermore the task of waste reduction should be considered in the light of the possibilities of textile recycling and re-use.

Recycling of textile and clothing garments has a long history; however, the potential to transform this activity into a profitable industry has emerged relatively recently. The development of sorting and recycling machines, new chemical modes of treatment, high value products from recycled waste, innovations in management, and a strengthened legal framework have influenced the recycling industry positively. Authors provide an overview of the types and sources of textile waste [5-6]. Quite a number of works discuss recycling technologies and markets as well as products from recycling processes and their application areas [7-9]. The benefits of textile waste recycling and other questions on achieving environmental sustainability through recycling are under discussion [10-12]. The majority of authors confirm that textile recycling reduces the damaging impact of the textile and clothing industry on the environment, but waste management improvement is an enormous challenge [13-16].

Possibilities to organise production from recycled material are closely related to the amounts of textile waste; however, this issue is not studied very widely. The investigation of waste management shows that the situation in different countries varied a lot [17-19]. Although landfilling is the main practice, the results demonstrated that in Turkey 16% of wastes were sent to landfills, meanwhile in Macedonia almost all waste was collected by waste service companies.

The aim of the study was to identify the status-quo of textile waste generation and treatment in Lithuania, compare the data with other EU member countries, and to clarify the situation of pre-consumer textile waste management.

Methodology

This research follows official terminology describing waste as any substance or object which the holder discards or intends or is required to discard [20]. The investigation is based on publicly available statistical data of textile waste generation and management in Lithuania. The data were obtained from the statistical office of Lithuania, published by the Environmental Protection Agent (EPA) [21] and Eurostat, the statistical office of the European Union. The study covers the period from 2009 to 2014. Waste items selected for analysis are presented in **Table 1**. The selection of these items was based on the European List of Waste (LoW) [22] with regard to the European Waste Classification for statistical purposes EWC-Stat 4 [23].

All wastes from the textile and clothing industries, the packaging and management economic sector, as well as municipal wastes are non-hazardous. The investigation is largely focused on pre-consumer wastes from the textile and clothing industry. The major wastes generated by this economic sector are fibre and yarn waste (waste code 040221), fabric cut-off wastes, leftover

textile samples or damaged materials, selvages, and end-of-roll wastes (code 040222). Taking into account the specific of processes of textile product manufacturing, another category of waste should be included for analysis, namely wastes not specified (code 040199), for example leather and fur residue and fluff fall into this category). Packaging waste (code 150109), wastes from waste management facilities (waste code 191208), and end-of-service-life articles (code 200110 clothes, 200111 textiles) were involved in the evaluation as well as a list of wastes from the leather, fur and textile industries (code 040209, 040210, 040101, 040108) in order to obtain the total amount of textile waste. The waste categories mentioned last were included considering the data set breakdown in waste categories according to EWC-Stat 4, section 07.6 and a review of the European List of Waste [24] as well. The correspondence between EWC-Stat codes and LoW codes allows to compare waste amount generated in the EU 28 given by Eurostat. It should be mentioned that Eurostat environmental statistics data were last updated on 23-07-2015 from 2012, at the moment the analysis was carried out. The indicators selected for analysis of EU data were the generation of waste and waste treatment. The values of indicators mentioned are measured in tonnes of waste (European totals are rounded to 10000 tonnes for confidentiality reasons) and in kg per capita, based on the annual average of the population. The data set for the generation and treatment of waste was chosen for the textile waste category and manufacture of textiles, wearing apparel, leather and related product economic activity (code C13-C15 according to the NACE rev. 2 classification). In addition, waste generated by households was also included in the analysis. The database for waste treatment includes only the final treatment. For Eurostat analysis, the amount of total waste treatment as well as the waste amount of landfill (disposal operations D1-D7, D12), incineration (disposal operation D10), incineration/energy recovery (recovery operation R1), and recovery other than energy recovery treatment types were selected. Recycling (R2-R9) and treatment (D8, D9, D14, R12, S5) given by EPA were included in the analysis as well.

Results and discussion

The textile and clothing industry is one of the key industries in Lithuania, play-

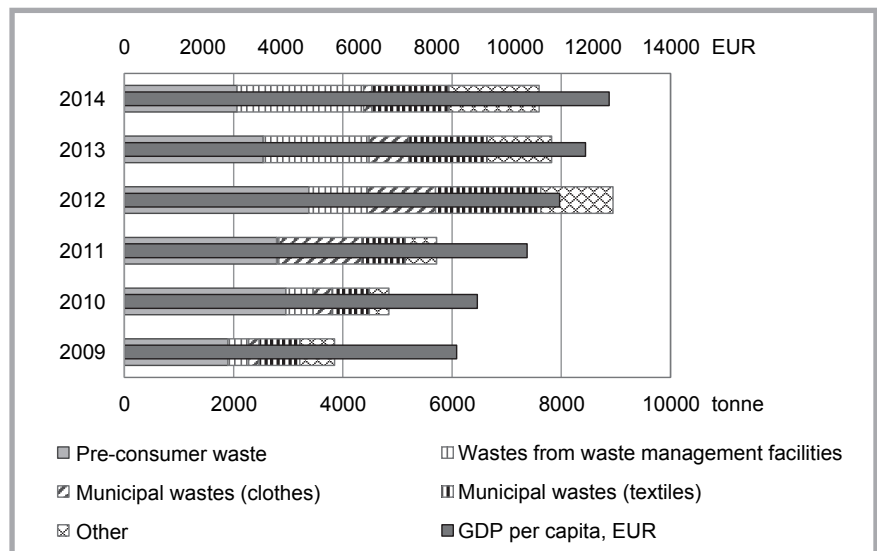


Figure 1. Textile waste amounts (t) and GDP per capita (EUR) in Lithuania in 2009-2014, (data based on EPA and Statistics Lithuania).

ing a significant role in economic growth. Based on 2013 data, the average turnover of Lithuanian textile and clothing manufacturing was 1.01 billion EUR. At the beginning of 2014, more than 26.000 employees were involved in this sector, accounting for more than a quarter of all manufacturing workers of the country. The manufacturing of textile and wearing apparel took place in 673 clothing and in 203 textile companies. Regarding production, it should be noted that over 2.4 million apparel garments per year

was manufactured, representing the generation of pre-consumer textile waste.

Research of the statistical data showed the amounts of textile wastes generated in Lithuania. It was found that waste values vary between 38511-8949 tonnes per year (Figure 1). From 2009, the collected textile waste volume increased and reached a peak in 2012. It is clear that the growth of the waste was related to the economic situation of the country. The smallest textile waste value was observed in

Table 1. Waste items according to European List of Waste (LoW) selected for the analysis. Note: ■ Codes of pre-consumer wastes; * in the analysis these codes are marked as "other wastes".

Subsection of LoW	LoW codes	Description
Wastes from leather, fur and textile industries		
	040221	wastes from unprocessed textile fibres
	040222	wastes from processed textile fibres
Wastes from textile industry		
	040210*	organic matter from natural products
	040209*	wastes from composite materials (impregnated textile, elastomer, plastomer)
Wastes from leather and fur industry		
	040101*	fleshings and lime split wastes
	040108*	waste tanned leather containing chromium
	040199	wastes not otherwise spe
Waste packaging; absorbents, wiping cloths, filter materials and protective clothing not otherwise specified		
Packaging (including separately collected municipal packaging waste)	150109*	textile packaging
Wastes from waste management facilities, off-site waste water treatment plants, the preparation of water intended for human consumption and water for industrial use		
Wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, palletising) not otherwise specified	191208	textiles
Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions		
Separately collected fractions	200110	clothes
	200111	textiles

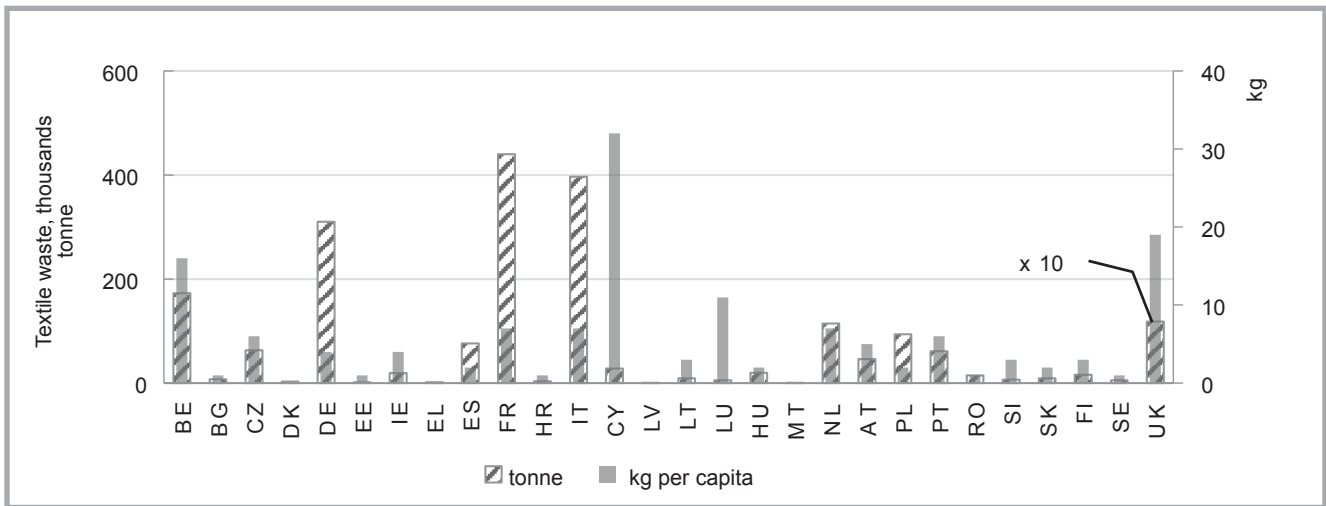


Figure 2. Generation of textile waste in EU by country, in 2012 (data based on Eurostat).

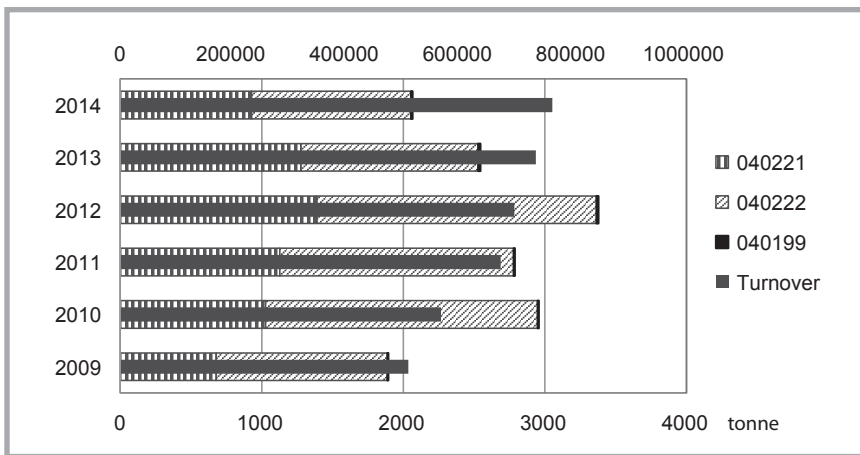


Figure 3. Pre-consumer waste amounts (t) and turnover of the manufacture of textiles, wearing apparel, leather and related product (EUR thousand) in Lithuania, in 2009-2014, (data based on EPA and Statistics Lithuania).

2009, when the Lithuanian economy was still in a deep economic downturn brought about by the financial crisis. From 2010, economic activity began to recover, causing the growth of waste. It was observed that in 2009 and 2011 the ratio of pre-consumer (code 040199, 040221, 040222) wastes and wastes from waste management facilities, packaging, municipal as well as other textile waste was approximately equal. From 2012 the amounts of wastes from municipal, packing and mechanical treatment and other waste categories increased significantly, exceeding the amount of wastes of the textile and clothing industry. Undoubtedly such a large growth was influenced by 191208, 200110, 200111 code waste collection, which in 2012 increased 2.8, 6.6 and 2.6 times, respectively. To explain this increase, changes in the Lithuania waste management system should be evaluated, which faces a challenge

of adaptation to the European Union requirements. The Lithuanian national waste management legal framework and regional waste management infrastructure were developed, some old landfills closed, new regional landfills corresponding to the environmental requirement established, and composting and sorting areas were installed. All of this has given positive developments in waste collection.

Moreover, regarding textile waste, it should be mentioned that data of waste code 150109 were included in the waste reports from 2012 only. In the same year, old clothing collection containers were distributed widely in Lithuania.

Analysis of the data of textile waste generation in the European Union showed that 3110000 t or 6 kg per capita of waste was collected in 2012 (C13-C15 eco-

nomic activity). In different countries the total collection amounts varies widely, from 131 tonnes in Malta, up to more than 1 million tonnes in the United Kingdom, in other words almost 30 percent of all waste generated in the EU (Figure 2). Textile waste per capita ranges from 1 kg (Bulgaria, Romania, Sweden, Estonia, and Croatia) up to 19 kg in the United Kingdom and 32 kg in Cyprus.

According to size of the country's population and small calculated values of the waste amount, the waste per capita is near zero in Denmark, Greece, Latvia and Malta. Comparing the situation in Lithuanian's textile waste sector with the total in the EU, it was found that LT is in 11th place in the generation of waste (or in 14th place in terms of per-capita amount of waste – 3 kg per capita). A similar amount of waste (in tonnes) is produced in Bulgaria, Slovenia and Slovakia, as per the capita indicator in Slovenia and Finland.

Analysing the statistical data of pre-consumer textile waste in Lithuania, it was found that waste of the 040199 code is generated in small quantities, from 7.25 tonnes in 2009 up to 15.6 tonnes in 2013. This reaches only 0.43% of pre-consumer textile waste, which varies between 1894-3378 tonnes per year (Figure 3). Values of wastes from processed textile fibres exceeded the values of unprocessed textile fibres in 2009-2011 by 1.78-1.87 times and by the smallest amount in the other years of the period analysed (1.21-1.46 times). In 2013 values of these wastes were nearly equal. The growth of the turnover of the manufacture of textiles, wearing apparel, leather and related

product shows an improvement trend in the textile and clothing industry after the economic crisis. Despite the fact that textile waste quantities and manufacturing productivity obviously do not correlate, it was observed that waste from the production of the textile and clothing sector per unit of GDP (t/million Euros of GDP) started to decline from 2013.

A comparative analysis of Lithuanian's textile waste management (**Figure 4**) showed that during the investigation period, on average, almost half (49%) textile waste was landfilled, the main part (approximately 76%) being code 040222 waste. Comparing collected and treated volumes of 040199 code waste, it was revealed that almost all (97%) these wastes end up in landfill. Positive developments were observed in the field of waste treatment, where from 2009 until 2012 most of the waste was disposed in landfill, with a maximum of 4671 t (65%) being achieved in 2012. Meanwhile in 2014, landfill waste ended up 2.4 times less than in 2012. In that year, recycling overtook landfilling. During the investigation period, the relative weight of recycling significantly increased from 12% to 29%, as well as treatment methods from 1% to 13%. Thermal treatment for waste processing is used for textile at least: in 2009, 7.9 tons of waste was removed in this way and in 2014 a maximum of 217 tons; but it accounts for only 3.1% of all waste. On average (taking 2009-2014) 17% of textile waste is exported, a value varying from 9% (2011) to 24% (2014).

Analysing the results of pre-consumer textile waste treatment (**Figure 5**), a different situation was found. The long term trend of giving industrial waste to landfills changed only in 2014, when the recycling of waste exceeded the amount of waste entering landfill by almost 15%. Until then 46 to 58% (that is, from 946 to 1515 tons) of waste had been disposed in landfills with municipal solid waste. The tendency to recycle industrial textile waste increased every year.

It was mentioned that in recent years the waste collection, recycling and disposal sectors have developed rapidly. It is obvious that European Union financial support, growth of the waste management infrastructure and other Lithuanian environmental policy aspects influenced the textile waste management situation positively, where an average of 911 tonnes of waste were recycled. Another clear trend

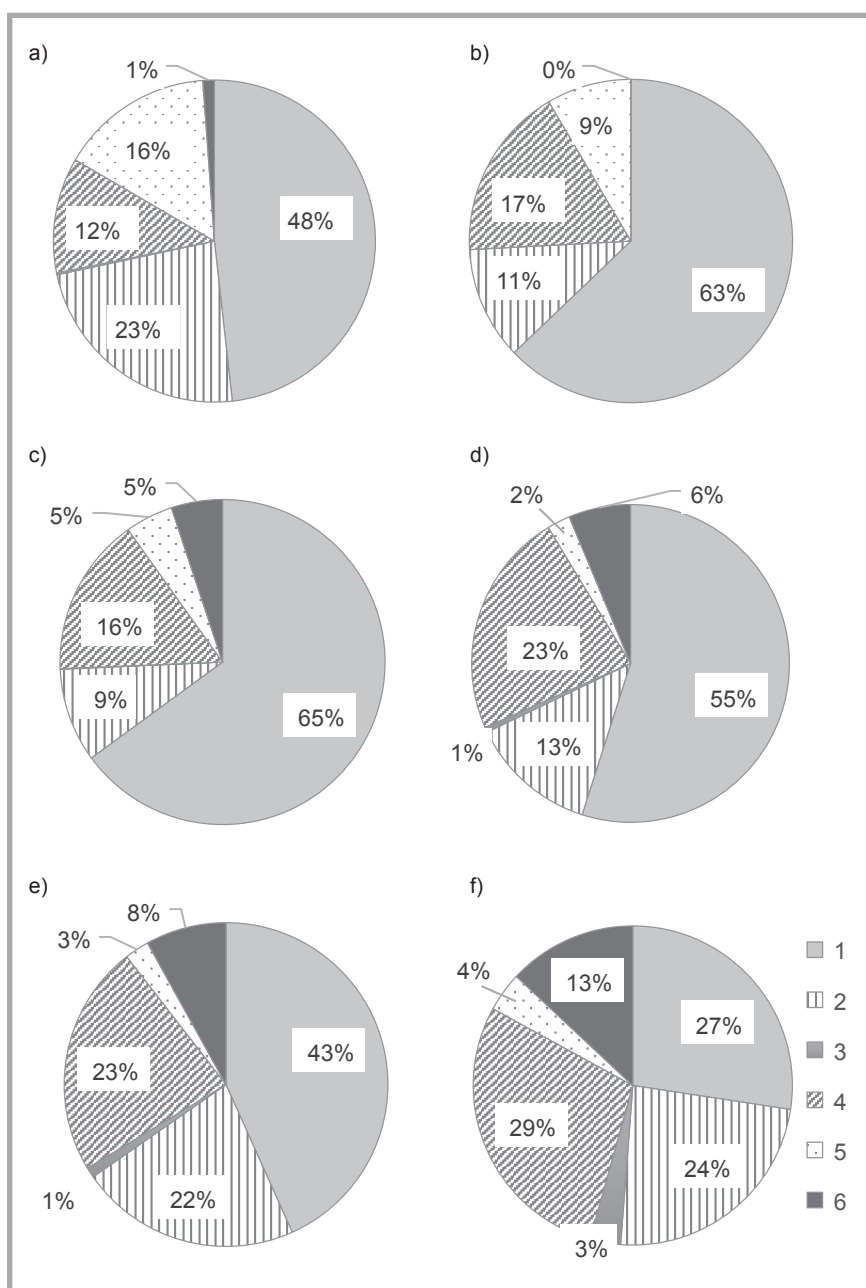


Figure 4. Textile waste treatment in Lithuania for 2009-2014, where a) year 2009, b) year 2010, c) year 2011, d) year 2012, e) year 2013, f) year 2014; 1) landfilling, 2) export, 3) energy recovery, 4) recycling, 5) recovery, 6) treatment (data based on EPA).

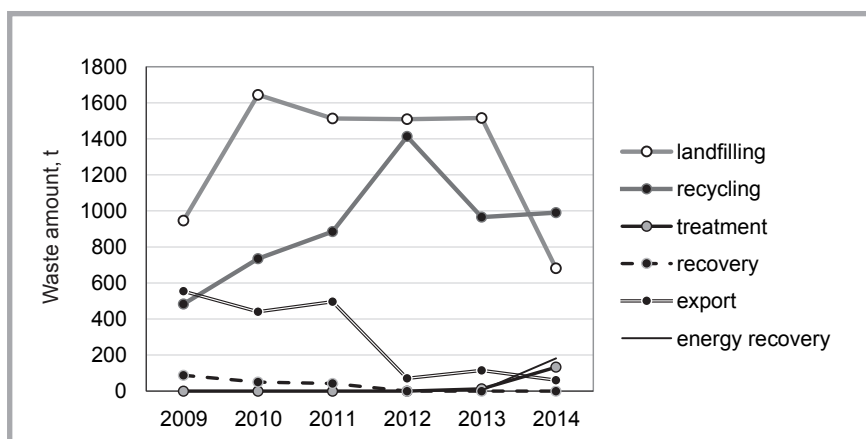


Figure 5. Pre-consumer textile waste treatment in Lithuania, 2009-2014 (data based on EPA).

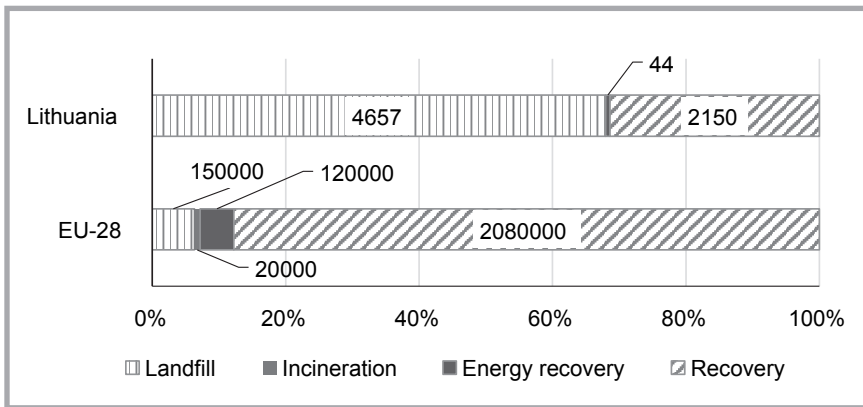


Figure 6. Comparison of textile waste treatment in Lithuania and EU-28 in 2012 (data based on Eurostat).

was established in that pre-consumer textile waste exports declined from nearly 27 up to 3 percent of the total industrial waste. Nearly all (98%) of waste exported is 040222 code. If in 2009-2011 the treatment method called “other usage” was applied for a small amount of collected textile waste, this method was replaced by other treatment in years 2013-2014. Again code 040222 waste is managed by method (120 t in 2014). It should be noted that there was a significant jump from 0.15% to almost 9% in field energy recovery from textile waste in 2014. By this method, 0.56 tons of 040199 code, 34 tons of 040221 code and 147 tons of 040222 code waste was treated. A comparative analysis of textile waste treatment in the EU-28 and Lithuania was performed. It was found that the average amount of waste treated across the EU-28 amounted to 2.37 million tonnes in 2012, a majority (88%) of which was recovered (Figure 6). Of the amount of total textile waste of the EU-28 disposed in landfill, 6% and 5% of waste was energy recovery.

In that year, the situation in the Lithuanian textile waste area compared to the EU-28 was completely different, where a majority (68%) of waste was delivered to collectors and disposed in municipal waste landfills, while others (31%) were recovered. In Lithuania only 44 tons of waste was energy recovered. As can be seen in (Figure 6), in 2012 less pre-consumer textile waste was landfilled compared with the total amount of textile waste. However, it should be noted that waste from the textile and clothing industry is clean, thus reducing the cost of using it for other products. Comparing the situation in Lithuania with other EU countries, it was obtained that in Estonia (98%), Croatia (72%), Cyprus (99%), and Portugal (72%), there were more waste landfills than in Lithuania (Figure 7).

Regarding landfill waste treatment, Lithuania is situated in 21st place among the European countries, considering that data of textile waste treatment is not included for analysis in Luxembourg, Malta and

Sweden (data of these countries presented 0). The dominant textile waste treatment method is recovery other than energy recovery. Belgium, Germany, Ireland, France, Italy, Finland and the United Kingdom processed from 82 to 100% of waste in this way. Lithuania significantly lags behind these results.

Conclusions

The investigation has shown that on average 6500 tonnes/year of the total textile waste was generated in the period of 2009-2014 in Lithuania. According to this indicator, Lithuania holds in a middle position compared with other EU countries and a slight decreasing trend in the amount of waste generation is observed. Analysis of the statistical data showed a significant growth in collection of municipal wastes. It can be stated that the development of a municipal solid waste management system in adaptation to EU requirements influenced such a situation. During the period analysed, textile and clothing enterprises produced on average 2600 tonnes/year of pre-consumer textile waste. From 2012, this kind of waste amounts to on average 32 percent of the total textile waste collected. For a long time, discarding textile waste in landfills was the dominant treatment method in Lithuania. Analysis of the results has shown there is an increased tendency to recycle textile waste. In 2014 this treatment method overtook the landfill method in the case of pre-consumer waste. However, compared with other EU countries, still a lot of textile waste is transported for landfilling. Considering environmental problems caused by this disposal method and in the light of the

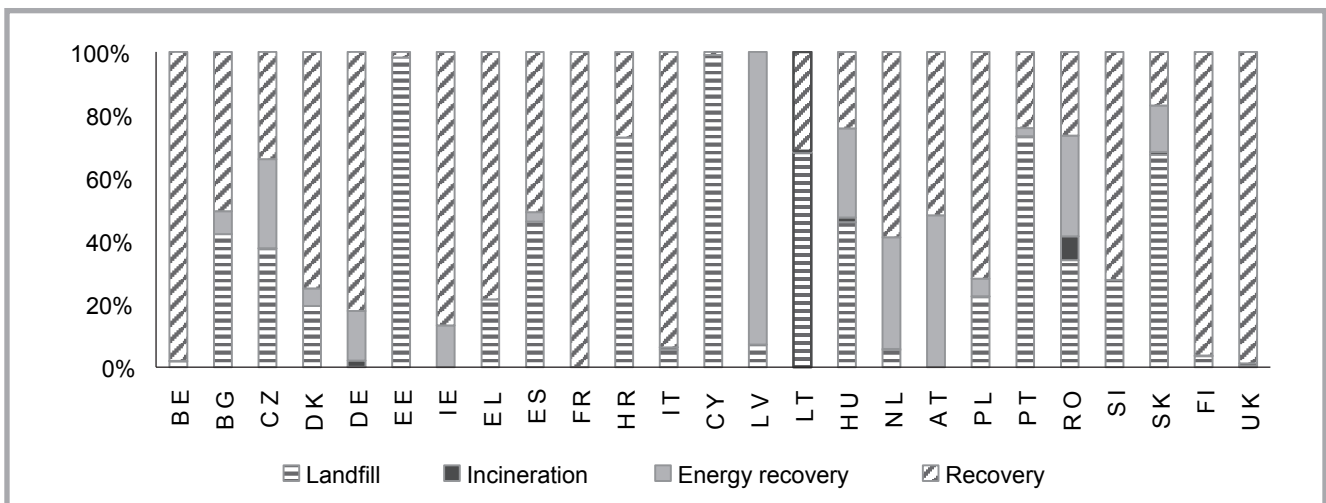


Figure 7. Textile waste treatment in EU by country 2012 (data based on Eurostat).

aim to reduce the landfilled part of municipal waste declared in the Lithuanian State Strategic Waste Management Plan, a great deal more effort to promote the prevention of waste production should be made. The need to reduce the quantities of waste going to landfills must take into account the economic effect of the usage of textile waste as recycled material in the creation of value-added products.



References

- European Commission. Being wise with waste: the EU's approach to waste management Luxembourg: Publications Office of the European Union 2010 16 p. ISBN 978-92-79-14297-0 DOI: 10.2779/93543.
- COM (2005) 666 final. Taking sustainable use of resources forward: A Thematic Strategy on the prevention and recycling of waste Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, Brussels, 2005).
- P6_TA(2007)0030 Waste recycling European Parliament resolution on a Thematic Strategy on the recycling of waste (2006/2175(INI)).
- COM (2011) 13 final. Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Thematic Strategy on the Prevention and Recycling of Waste, Brussels, 2011.
- Dinesh B, Ankush S, Urvashi M. Recycled fibers: An overview. *International Journal of Fiber and Textile Research* 2014; 4(4): 77-82.
- Wang Y. Fiber and textile waste utilization. *Waste and Biomass Valorization* 2010; 1: 135-143.
- Park S H, Kim S H. Poly (ethylene terephthalate) recycling for high value added textiles. *Fashion and Textiles* 2014; 1(1): 1-17.
- Thilak V, Saravanan D. *Textiles and apparel development using recycled and reclaimed fibers*. Roadmap to sustainable textiles and Clothing Eco-friendly raw materials, technologies, and processing methods, S. S. Muthu (Ed.), Singapore: Springer Singapore, 2014, pp. 139-160.
- Hawley J M. Digging for diamonds: A conceptual framework for understanding reclaimed textile products. *Clothing and Textiles Research Journal* 2006; 24(3): 262-275.
- Chavan RB. Environmental sustainability through textile recycling. *Textile Science & Engineering* 2014; S2:007. DOI: 10.4172/2165-8064.S2-007.
- Muthu SSK, Li Y, Yan J and Ze L. Carbon footprint reduction in the textile process chain: Recycling of textile materials. *Fiber Polym.* 2012; 13(8): 1065-1070.
- Sule AD and Bardhan M K. Recycling of textile waste for environment protection – an overview of some practical cases in the textile industry. *Indian J. Fibre Text.* 2001; 26(1-2): 223-232.
- Roy Choudhury A. K. *Environmental impacts of the textile industry and its assessment through life cycle assessment*. Roadmap to sustainable textiles and clothing: Environmental and social aspects of textiles and clothing supply chain, S. S. Muthu (Ed.), Singapore: Springer Singapore, 2014, pp. 1-39.
- Deo H T. Ecofriendly textile production. *Indian J. Fibre Text.* 2011; 26(1-2): 61-73.
- Palm D. Improved waste management of textiles. *IVL Report B1976*, 2011; 1-26.
- Madsen J, Hartlin B, Perumalpillai S, Selby S and Aumônier S. Mapping of evidence on sustainable development impacts that occur in the life cycles of clothing. Environmental Resources Management (ERM) Ltd. Defra, London, 2007.
- Larney M & van Aardt A M. Case study: Apparel industry waste management: A focus on recycling in South Africa. *Waste Management & Research* 2010; 28(1): 36-43.
- Altun Ş. Prediction of textile waste profile and recycling opportunities in Turkey. *Fibres & Textiles in Eastern Europe* 2012; 20, 5(94): 16-20.
- Jordeva S, Tomovska E, Trajković D and Zafirova K. Current state of pre-consumer apparel waste management in Macedonia. *Fibres & Textiles in Eastern Europe* 2015; 1(109): 13-16.
- Lithuanian waste management law, last amended XII-1720 2015-05-14 (1998). <https://www.e-tar.lt/portal/lt/legalAct/TAR.8D38517814F1> (accessed 13.05.2016).
- Environmental Protection Agency (EPA) <http://gamta.lt/cms/index?lang=en> (accessed 13.05.2016).
- Commission Decision 2000/532/EC. COMMISSION DECISION of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste. Official Journal of the European Communities, 6.9.2000 L 226/3 – L 226/24.
- Commission Regulation (EU) No 849/2010 of 27 September 2010 amending Regulation (EC) No 2150/2002 of the European Parliament and of the Council on waste statistics. Official Journal of the European Union, 28.9.2010 L 253/2 – L 253/39.
- Ökopol GmbH in cooperation with ARGUS GmbH. Review of the European List of Waste Final Report. November 2008, p. 222.

Received 16.05.2016 Reviewed 24.07.2017

Institute of Textile Engineering and Polymer Materials



The Institute of Textile Engineering and Polymer Materials is part of the Faculty of Materials and Environmental Sciences at the University of Bielsko-Biala. The major task of the institute is to conduct research and development in the field of fibers, textiles and polymer composites with regard to manufacturing, modification, characterisation and processing.

The Institute of Textile Engineering and Polymer Materials has a variety of instrumentation necessary for research, development and testing in the textile and fibre field, with the expertise in the following scientific methods:

- FTIR (including mapping),
- Wide Angle X-Ray Scattering,
- Small Angle X-Ray Scattering,
- SEM (Scanning Electron Microscopy),
- Thermal Analysis (DSC, TGA)

Strong impact on research and development on geotextiles and geosynthetics make the Institute of Textile Engineering and Polymer Materials unique among the other textile institutions in Poland.

Contact:

Institute of Textile Engineering and Polymer Materials
University of Bielsko-Biala
Willowa 2, 43-309 Bielsko-Biala, POLAND
+48 33 8279114,
e-mail: itimp@ath.bielsko.pl
www.itimp.ath.bielsko.pl