

CURRENT STATE OF THE PLASTIC WASTE RECYCLING SYSTEM IN THE EUROPEAN UNION AND IN GERMANY

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Abstract: The paper presents the results of the analysis of the current state in waste management of plastic bottles in Germany. A data overview of the differences in recycling policies between different countries in the European Union is presented. The application of twelve different polymeric materials by five different application sectors in Europe shows the predominated usage areas of selected polymeric materials. A detailed insight into the German Dual System (DSD) for plastic recycling is presented, with the reference to the famous label the "Green Dot". The evolution of the recovery rates of packaging in Germany from 1991 to 2014 is presented for glass, aluminium, tinplate, polymers, paper and cardboard and liquid packaging board. It was observed that the plastic recycling rate has risen from ~ 15 % to almost 100 %, i.e. nowadays almost the whole plastic waste is either incinerated or recycled. Current data for PET-bottles return is determined as well, and detailed current information regarding the deposit system is presented. The actual applications and specific data showing the industry sectors that use the PET from recovered bottles are presented.

Keywords: Germany; PET; plastics; recycling; waste

1 INTRODUCTION

The Earth's population is ever-increasing and with this development comes the increase in waste. In Europe, a single person is currently producing half a ton of waste per year. If industrial waste is taken into account as well, it becomes clear that the overall amount of waste is enormous. In 2010, for example, the total waste production in the EU amounted to around 2.5 bn tons. [1] However, the increasing population is not the only reason for this development. Rather, each person is producing more waste. Consumers now have more choices and products are designed to have shorter lifespans. Apart from that, more single-use and disposable products are produced. Generally, it can be stated that people, relatively, earn more money, consume more products and, thus, generate more waste. If all of it were put onto the landfills, the Earth could soon be entirely covered with waste. If all waste were incinerated, the resulting air pollution could destroy the planet's climate. The only reasonable answer to this issue is recycling.

Since plastic has become one of the most common materials, plastic waste has, in this respect, become one of the most pressing issues. Unfortunately, the properties which make plastic so useful, such as durability, light-weight and low-cost, often cause problems when it comes to the end-of-life options. Processes of degradation, incineration and recycling are not as easy for plastics as they are for other materials. This paper discusses the issue of recycling of plastics and depicts a practical example of the plastic recycling in Germany.

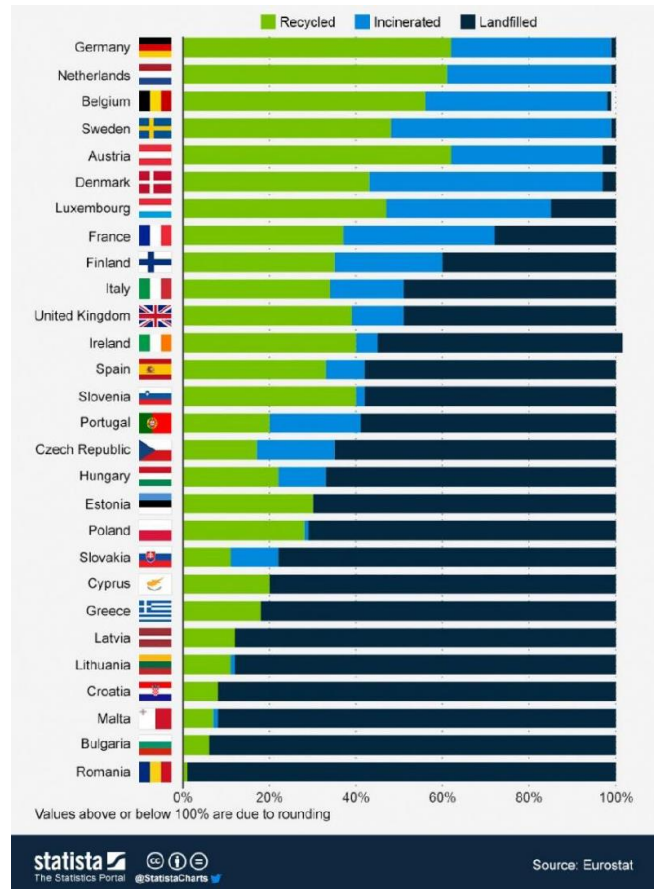


Figure 1 Recycling rates in Europe in 2011 [2]

2 CURRENT EUROPEAN RECYCLING RATES

This infographic in Fig. 1 shows a significant difference in recycling between different countries in the European Union. [2] Germany, the Netherlands and Belgium recycle 62 %, 61 % and 56 % of their waste, respectively, while

Croatia, Malta, Romania and Bulgaria are listed at the end of the list. Croatia is the fourth country from the bottom, with only 8 % of the waste recycled, while the remaining of 92 % ends up on landfills. Bulgaria recycles only 6 % and Romania 1 % of its waste. In 2013, according to the European Environment Agency, an analysis of the recycling vs. landfill vs. incineration rate has shown that Northern and Western Europe differ strongly compared to Eastern European countries. The case of Estonia is an exception, since the recycling-rate there is relatively high, while there is no incineration at all, which leads to a high the landfill-rate.

The EU has introduced policies forcing its member states to reach certain recycling quotas until 2020. This recycling rate for example for the building sector will be 70% of its waste. In order to fulfil the criteria, a lot of states have to change their disposal systems completely. [4]

The "Zero plastics to landfills by 2020" concept is a challenging, although not an unrealistic goal, as suggested by the European Association of Plastics Recycling and Recovery Organisation. [1] Other European Commission policies which will be due until 2030 are as follows: common EU target for recycling 65 % of municipal waste, common EU target for recycling 75 % of packaging waste, a binding landfill target to reduce landfill to a maximum of

10 % of municipal waste, and a ban on landfilling of separately collected waste. [1]

If these goals set by the EU Commission will be met, it would be a major step forward in the fight against waste.

3 POLYMERIC MATERIALS APPLICATIONS

The first association which comes to one's minds when talking about plastics are probably plastic bags or food packaging since it constitutes a major fraction in the applications. Nevertheless, there are more fields of applications - for example the building and construction sector. With 20 % of the total European plastic consumption it is the second largest group after packaging. Plastic is used for equipment like insulation, pipes or window frames. Another branch is transportation, including the car and aircraft industries. By lowering the weight of vehicles, which can be achieved through the use of plastic components, emissions can be decreased. Other sectors are agriculture, electronic devices or leisure. The medical sector uses plastic for different devices, prostheses and pill capsules made of special polymers. [5] Different demands of several plastic types, sorted by the different application sectors are shown in Fig. 2.

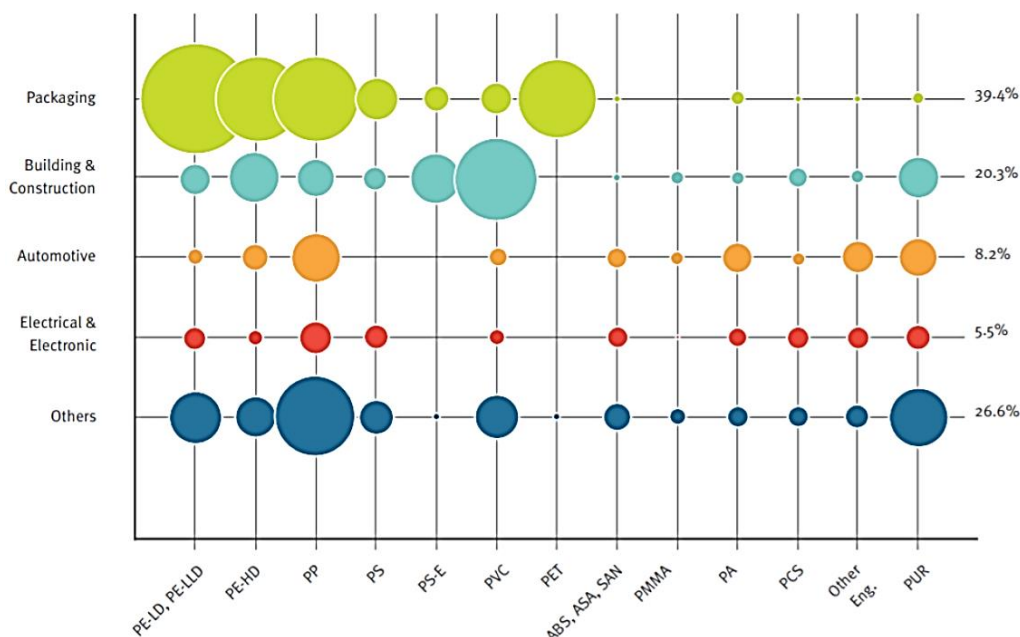


Figure 2 European plastics demand by segment and resin type in 2012 [3]

4 ANALYSIS OF PLASTIC RECYCLING IN GERMANY

As mentioned before, the rate of Germany landfill waste is the lowest in the EU. Also, Germany is producing the largest part of the European plastic waste. In 2015, the European plastic demand was 49 megatons and 24.6 % of that came from Germany. [3] Since the early 1990s, a considerable effort has been made to recycle plastics in Germany. As a result, Germany is the largest market for recycled plastics in Europe today, followed by Spain. [7]

4.1 German Dual System (DSD)

In 1991 a rapid entry into plastic recycling occurred in Germany with the implementation of the German Ordinance on Packaging Waste ("Verpackungsverordnung"). As a result of that law, the privately operated German Dual System (DSD), also known as "Green Dot" (in German: "Der grüne Punkt"), was established. [8] In order to liberate industrial firms and retailers from their individual take-back

and recovery obligations under the German Packaging Ordinance, on the basis of this ordinance DSD established a second (dual) disposal system besides the public-sector waste disposal service. As the first system of this kind worldwide, it has been providing a nationwide collection of used sales packages since 1991. [9]

In Germany, private households receive a yellow barrel or a yellow bag ("Gelber Sack"), what is part of the Dual System. In that they can put every packaging, which is labelled with the "Green Dot". The companies have to pay for the disposal of the packaging beforehand, if they want to participate in the German Dual System. DSD only collects packaging material from manufacturers who pay a license fee to DSD. These license fee payers can then add the Green Dot logo to their package labelling to indicate that this package should be placed into the separate yellow bags bins that will then be collected and emptied by DSD-operated waste collection vehicles and sorted in DSD facilities. German license fees are calculated using the weight of packs, each material type used and the volumes of product produced per annum. [9]

Since the population is relieved from the charge of the plastic waste in the yellow bags, but has to pay fees for the

municipal waste, the motivation for separating the waste is huge. The system for the waste fees differs in different federal states, but in general, people only pay for the municipal waste. The separated waste in the paper bins, organic and plastic waste is not charged. If a household is not separating the trash correctly, the garbage collection will not take it away. Furthermore the household may be forced to pay a penalty.

The dual system is one of the largest purchasers for waste management services too. Not only in Germany but in many countries in Europe, the DSD delegate the collection and processing of used sales packaging to waste disposal companies. [7]

4.2 Recycling and incinerating rates for plastic waste

Fig. 3 shows the evolution of the recovery rates of packaging in Germany from 1991 until 2014. The blue line constitutes the plastics and is very close to the 100 %-mark since 2013. This means that nowadays nearly the whole plastic waste is either incinerated (energetic recovery) or recycled (material recycling).

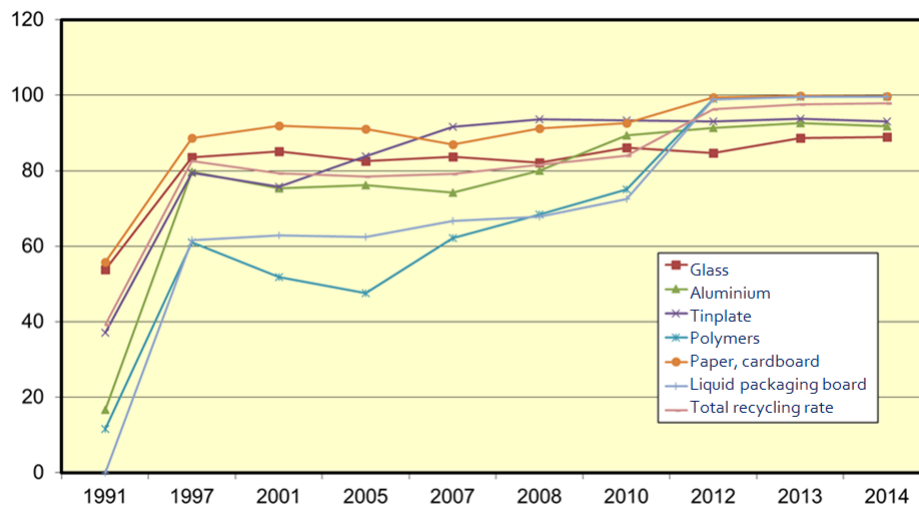


Figure 3 Evolution of recovery rates in Germany from 1991 to 2014 [6]

In 2001 only 51.8 % of the amount of plastic packaging waste was recovered or recycled. In 2013 it was already 99.6 %. [10]

Currently there are 68 waste incinerating plants in operation in Germany, which have a capacity of 20 million tons. The plants have to follow strict restrictions of emission control [11] to avoid water and air pollution. [12]

The waste management in Germany has been privatized since the 80s, so there are no specifics about the number of recycling plants in Germany. Furthermore, many companies are recycling their waste themselves. Because of their usual economic inefficiency, the plastic recycling plants are typically subsidized by the German state.

One large plastic recycling company in Germany is Multipet in Bernburg, which produces recyclates of PP, PET and HDPE in form of flakes or granulates. Moreover

they sell drainage channels and cable ducts, which are 100 % recycled products made by the injection moulding. [13]

4.3 Plastic bottle deposit system

The huge demand of PET, mostly caused by the PET-bottles produces greenhouse gas emissions of 1.5 tonnes of CO₂-e per ton of recycled PET as well as a reduction in landfill and in energy consumption. An average net reduction of 1.45 tonnes of CO₂-e per ton of recycled plastic has been estimated. Most of the net energy and emission benefits arise from the substitution of the virgin polymer production. [14]

In order to avoid PET-bottles contaminations for easier recycling, the system of deposit is introduced. A lot of

countries have a deposit system for plastic bottles, but the deposit in Germany is the largest: 25 cents for each plastic bottle. A side effect of that are people collecting these bottles from trashcans, streets or parks. The system in Germany is very strict - except for a few juice bottles, most plastic bottles are included in the deposit system. Since the system was introduced in 2006, nowadays, i.e. 10 years later, it is possible to take a review of the deposit system.

4.4 Recollection of PET-bottles

In 2005, the DPG (Deutsche Pfandsystem GmbH), the German Deposit-system company, was founded. Since then every shop with more than 200 m² shop area is obliged to take back every drink packages of the same kind of material which they are selling. Nowadays the recycling-rate of PET-bottles with the deposit in Germany is 97.2 %. For the PET-bottles without a deposit the recycling-rate is 93.6 %. The deposit of 25 cent has to be on every plastic bottle which has a volume between 0.1 and 3 litres and has a one-way-use. They are labelled with the logo of the DPG, which is shown in Fig. 4.



Figure 4 DPG – logo [15]

This high PET-return is due to the consumers, which are bringing back 96 % of the plastic bottles. Also, bottles thrown-away in the waste are filtered out, and brought back to the recycling route.

4.5 Recycled PET-bottles usage

New PET-bottles were made from more than 26 % recycled PET-material in Germany in 2013. In this example of the recycled PET-bottles usage, the lifecycle of PET-bottles is closed. Other sectors too are increasingly using the recovered material of plastic bottles. Recycled PET is used in the textile industry, in the foil industry or for other applications, such as ribbons or detergent packaging, with the exact values shown in Tab. 1.

Table 1 Sectors using the PET from recovered bottles [16]

Recovered PET used for:	PET-bottles	Textile industry	Foil industry	Other
	32.1 %	29.4 %	27.3 %	11.2 %

According to the increased usage of the recycled PET, the deposit system on PET-bottles in Germany has proved to be a huge gain in conserving resources.

5 CONCLUSION

Recycling is a promising strategy for the end-of-life management of plastic products. It is slow, but it does make increasing economic sense, as well as an undoubted positive environmental impact. Recent trends demonstrate a substantial increase in the rate of recovery and recycling of plastic wastes. These trends are likely to continue, but some significant challenges still exist from both technological factors and from economic or social behaviour.

The recycling of plastics is a very important issue in the modern society, with aims to the reduction of waste on the landfills and saving the environment. Material recycling is the most efficient way of recycling, with less energy or feedstock lost as compared to incineration.

Finally, the common people thinking should evolve, from a throwing-away to an exchange-community.

Note: This investigation was presented at the International Conference MATRIB 2017 (29. 6. - 2. 7. 2017, Vela Luka, Croatia).

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