

# Comparative Analysis of Plastic Packaging Recycling in Portugal and Sweden

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**Abstract:** Recently there has been concerns on how unsustainable plastic packaging waste management is and how it negatively affects the environment, combined with the fact that it does not promote a circular economy. Hence, it has given origin to a strategy for plastics in a circular economy defined by the European Commission, in 2018. This study intended to compare and analyse two different plastic packaging waste recycling systems, the Portuguese and the Swedish. Ultimately, the study seeks to find possible obstacles in the recycling systems and solutions that promote the increase of plastic packaging recycling rates. This is accomplished by focusing on some actors from the plastic recycling value chain.

Both countries' plastic packaging recycling systems proved to be very complex, hence it was not possible to determine tangible reasons for the different plastic packaging recycling rates from 2016. Furthermore, the study was highly dependent on published information like definitions and statistics that weren't always available or clear about their meaning or how they were calculated.

Nevertheless, the study showed that many solutions could be drawn. Some of them were landfill bans for recyclable waste, higher landfill and incineration taxes, as well as sorting plastic packaging waste from the unsorted waste stream and sending non-packaging plastic waste for recycling. Additional solutions could be extracted from the plastic producer's feedback. As for example, investments in recycling processes and technologies that contribute to higher quality of recycled plastics; better design that allow high recyclability of plastic packaging products; reduce multi-material plastic products; a collection scheme that increases the quality and traceability of the recycled plastic; increase correct source-sorting by consumers and implement regulation that demands a certain fraction of recycled plastic in plastic products.

**Keywords:** plastic; packaging; recycling; market; collection; sorting

# 1. Introduction

Plastic has become a major resource due to its unique characteristics that allow for packaging, building and construction, transportation, renewable energy, medical devices and others (Plastics Europe, 2017). The use of plastics has increased twenty-fold in the past half century and it is estimated to double in the upcoming 20 years (Ellen MacArthur Foundation 2016). Plastic packaging is the main application of plastic within the industry (Plastics Europe, 2017). Plastic packaging represents 39.9% of total plastics production in Europe, followed by building and construction (19.7%).

Plastic products can differ in its composition, properties and characteristics and not all have the same life time of consumption or shelf life. Some plastic products are only used for less than one year, while others can be used for more than 15 years or even several decades (Plastics Europe, 2017).

When plastic waste is not recovered, it has the potential of becoming a serious source of pollution. That could lead to plastic littering in the environment that will often end up in the ocean (Milios et al, 2018). Hence, the correct management of plastic waste is of major importance. The new circular economy package on plastic waste supports an increase of plastic packaging recycling rates, by establishing ambitious targets. Mechanical recycling is the most common method for recycling plastic waste (Ragaert et al, 2017) and 'has emerged as the most economical, as well as the most energetic and ecologically efficient option' (Maris et al, 2018).

Recycling of plastic waste leads to a complex value chain (Figure 1) which includes several actors and processes, starting with the consumer that produces the waste. This plastic waste is processed and turned into a resource again and thus can re-enter the value chain and promote a circular economy.

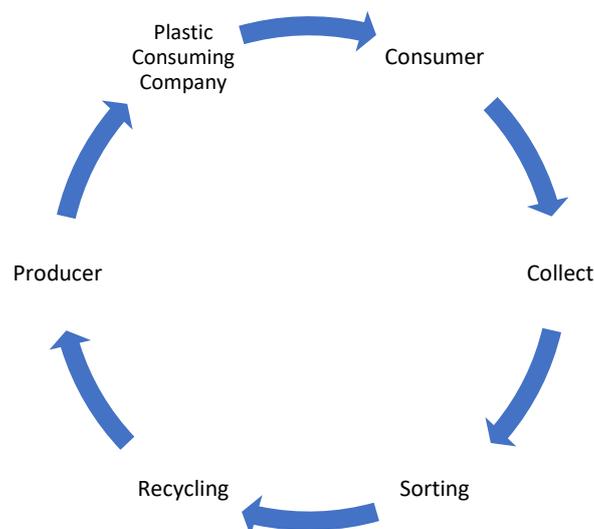


Figure 1 – Plastic waste recycling value chain, adapted from Milios et al, 2018

Furthermore, requirements regarding collection and recycling systems to provide recycled plastics of high-quality that can be used as a raw material should be made (Fråne et al, 2015). This would be of great importance to improve the market for plastic waste as a secondary raw material and circular economy. In addition, “the challenge to recycle more and to fully implement the waste hierarchy model, with prevention, reuse, recycling, recovery and disposal as the least preferable option, remains.” (Plastics Recyclers Europe)

However future challenges are ahead of us. Less than 30% of plastic waste produced in Europe is recycled; landfilling and incineration rates of plastic waste remain high (31% and 30% respectively) in Europe. The demand for recycled plastics accounts for only 6% of plastics’ demand in Europe and plastics production and incineration of plastic waste contribute to approximately 400 million tonnes of CO<sub>2</sub> emissions each year. Furthermore, alternative types of feedstock represent a very small share of the plastics’ market. Finally, in the EU alone, 150 000 to 500 000 tonnes of plastic waste enter the oceans every year (European Commission, 2018).

To tackle these challenges, the strategy for plastics in a circular economy (European Commission 2018) defines targets for 2030 and measures that envision a more sustainable plastics’ industry with emphasis on design and production that increases reuse, repair and recycling, helps create jobs and economic growth and helps reduce EU’s greenhouse gas emissions and dependence on imported fossil fuels (European Commission, 2018). Moreover, the targets for 2030 are: recycling rates of urban waste of 65%; recycling rates for packaging waste of 70%; reduce landfill disposal to a maximum of 10 percent of all types of waste; forbid landfill disposal of recyclable waste (APA 2016).

## **2. Methods**

This master thesis was mainly conducted at the Energy and Environmental Systems division at Lund University, LTH. It was done in cooperation with the University of Lisbon, especially regarding the last phase of the study.

As a theoretical support of the study, several articles and reports, published by recycling and waste related organizations were assessed. In addition, current waste legislation of each country was briefly analysed. Furthermore, as part of the data collection for the study, several interviews with representatives at different companies were conducted. These were done via email or personal communication (phone or physical meeting) mainly with employees and experts from recycling and waste management companies and organizations and plastic producers. Likewise, visits to waste management companies, Sysav and ValorSul, and to a recycling company, Swerec took place.

To sum up, the approaches to this study were: enquiries to the actors involved and consultation of literature, like articles, reports, including published statistics and legislation.

### **3. Comparison between Waste Management Systems**

Sweden and Portugal have similar numbers of population, 10 million and 10.3 million people, respectively, as mentioned in previous chapters. Also, in 2016 Sweden produced the equivalent to 467 kg/person and Portugal produced 474 kg/person. Thus, the similar amounts of waste produced per capita should allow for a reasonable comparison of both countries' waste management systems.

In 2016, Portugal sent only 10% of its waste to material recycling and Sweden sent about 34.6%. When comparison is done on the total amount of both landfill and energy recovery fractions, it is possible to estimate 74% for Portugal and 49.2% for Sweden. Thus, the main cause for such differences is that Portugal sent most of its waste to the least preferable level of the EU's Waste Hierarchy, landfill which accounted for 51%. On the other hand, Sweden sent almost half of its waste to energy recovery.

Moreover, Sweden currently has more waste fractions for the same type of material waste compared to Portugal. According to the recycling guidelines presented in previous sections (4.9. and 5.9.) waste materials like plastic, paper, metal and glass have 5 waste streams in Sweden and 3 waste streams in Portugal. The higher amounts of waste fractions can possibly reduce costs and efforts for further sorting after collection. On the other hand, it may also mean to more than required one sorting facility for the different type of material waste received increasing costs.

Sweden has implemented two landfill bans on both combustible and organic waste. Therefore, the lower tax for landfilling waste (Table 1) and absence of a landfill ban in Portugal contributes greatly for such a high rate of landfilling. This means that Sweden is making more efforts to divert waste from landfill, hence contributing for focus on higher levels of the EU's Waste Hierarchy.

*Table 1 – Taxes on Landfill and Incineration in 2018, Lei n° 82-D/2014; Avfall Sverige 2017a*

Tax (€/tonne)	Portugal	Sweden
Landfill	8.8	50
Incineration	6.6	-

Nowadays, Sweden has no tax on household waste incineration. As for Portugal the incineration tax is 6.6 €/tonne and 2.2 €/tonne, if there is energy recovery. In Sweden heating is the main use of energy produced in incineration plants that receive household waste (Avfall Sverige 2017a). So, Sweden had at least 35 incineration plants receiving household waste in 2016 and Portugal had only 3.

Municipalities' role is the management of residual waste, including collection and treatment, both in Portugal and Sweden. Both countries' waste management systems are mainly organized into either municipal self-administration, municipal associations or municipal enterprises. In Sweden, FTI is responsible for managing packaging waste that is covered by the producer responsibility. However, in Portugal, the collection and treatment of waste that falls under that regulation is still widely covered by the waste management systems, although under supervision of SPV.

Both countries have transposed the waste framework (Directive 2008/98/EC) into their national regulations. Targets defined by the EU must be accomplished by both countries and thus are the same for Portugal and Sweden.

The published costs of waste management systems presented in Sections 4.8 and 5.8 could not be compared and further analysed, since for Sweden these costs refer to food and residual waste and for Portugal the costs include packaging waste management in addition to residual waste.

In addition, a PAYT system could help improve recycling rates by charging a tax on the amount of produced residual waste, since it implies that the more a household properly sorts its waste, the less recyclable waste will end up in the residual fraction. Efforts for implementing a PAYT system are more evident in Sweden, since 30 municipalities have implemented a weight-based charge. In Portugal, there is only one municipality that has implemented this kind of system. Nonetheless, both countries still show little interest in implementing this kind of system, considering that only 10% of Swedish municipalities have a weight-based waste charge. In addition to this, in Portugal, the variable tariff for waste management paid by households is mostly based on the amount of consumed water. Thus, the tax does not depend on the amount of produced unsorted waste, which does not contribute to better source sorting. The substitution of this kind of tariff for a charge based on amount of residual waste produced could possibly improve the national recycling rate.

## **4. Comparison between Plastic Packaging Recycling Systems**

### **4.1. Collection and Recycling**

In 2016 Sweden had higher collected amounts of plastic packaging waste when compared to the amounts produced, meaning its recycling rate was higher. One possibility is to say that the deposit return system in Sweden could be one of the factors contributing to higher collected amounts, about 21 300 t that corresponded to 17% of the total collected plastic packaging waste.

In both countries, Portugal and Sweden, all municipalities have a bring system. In Portugal, this system includes eco-centres and eco-points and in Sweden it includes recycling centres and recycling stations.

Kerbside collection leads to higher amounts of recyclables collected per capita per day, when compared to an exclusively bring systems and mixed system (both kerbside and bring system). Since in 2016 Sweden had slightly higher amounts of collected plastic packaging waste collected through kerbside collection, it could be another factor contributing to consequently higher amounts of collected plastic packaging waste, even though this could be of minor difference, given the close collected amounts.

In 2016, Sweden had a plastic packaging recycling rate of 50% and Portugal had a recycling rate of 42%. This difference in the recycling rates simply means that Sweden is collecting more plastic packaging waste that is to be sent for recycling than Portugal, because of the way this recycling rate is calculated. Unfortunately, the current recycling rate calculation method does not allow for comparison between sorted and produced amounts.

#### **4.2. Main Actors**

The main actor within the management of packaging waste, including plastic packaging is the producer responsibility organization (PRO). This organization is owned by the producers, that rely on PROs for the waste management of their packaging waste. The PRO has the most significant influence on the other actors. In Portugal, SPV is the PRO and in Sweden, there is FTI and TMR.

In Sweden, the sorting of plastic packaging is done by private companies and in Portugal this is done by the SGRUs that are usually private-public or public companies. It should also be mentioned that in Sweden there is a deposit return system for PET bottles, and so Returpack appears also as a relevant actor. As for sorting processes the equipment or processes that are common to sorting facilities in each country are: sieve, bag opener, optical sorting, ferrous or magnetic separator, manual sorting and baling.

#### **4.3. Costs and Financial Instruments**

The costs for managing plastic packaging waste, including collecting and sending it for recycling are paid by the producer responsibility companies. These costs should be covered by the fees ('eco-value' for Portugal) presented on Table 24 and the sales of the recycled plastics ("retake" value for Portugal). The fees are paid by the plastic packaging producers and are charged by SPV, in Portugal and FTI, in Sweden. The fees applied in both countries are quite similar. The costs showed that, in 2016, Sweden had a profit before appropriations and tax of 44 MSEK or 4.4M € and Portugal had a net profit of -1.061 M €. This means that Sweden was able to cover the costs for sorting, collection and other expenses and Portugal was not. Furthermore, this may also

mean that current Portuguese fees and the recycled plastic sales are not enough to cover the costs.

#### **4.4. Plastics' Market**

Primary plastics are much more expensive than secondary (recycled) plastics. However, both the price and quality of the secondary raw material appear to go through many variations, which may occasionally lead to closer value prices of the secondary and primary raw material. Nonetheless, the 'quality for a product is considered much more important than the marginal gain from the lower price' (Miliotis et al, 2018). Moreover, in the cases where the plastic producers make quality testing to the incoming secondary raw material, it ends up being an extra cost, that leads to more similar costs for acquiring primary and secondary plastics. However, the plastic market is still mainly dominated by the primary raw material. Some of the reasons for such is the fact that there is a lack of traceability and transparency along the value chain of recyclables and general deficiencies when it comes to the recyclability of products (Miliotis et al, 2018). Also, there is a lack of demand for products made from recycled plastic. Overall plastic producers prefer to buy virgin plastic especially due to higher and clearly defined quality specifications.

In Sweden, it was possible to obtain valuable feedback on the recycled plastic market from three companies that use recycled plastic in their products. These companies mainly used recycled PE (various types), including PET, HDPE and LDPE. In Portugal, one company responded claiming it uses recycled PET and LDPE.

Several solutions to increase the recyclability of plastic products and recycling of plastic waste were presented by the plastic producers. To sum up, solutions from Flextrus, Trioplast and Logoplaste were: investments in the plastic value chain that motivate circular economy; study of the recycling system, as well as, the market value differences between each plastic type; reduce multi-material plastic products; review the quality of raw material needed for some plastic applications; increase customer demand for recycled plastic by increasing the quality and traceability of the recycled plastic; increase correct source-sorting by educating consumers; improve sorted collection of plastic waste and implement regulation that demand a certain content of recycled plastic in plastic products.

## **5. Conclusion**

The Portuguese and Swedish waste management systems have been working towards reaching higher levels of the waste hierarchy. Nonetheless, a significant fraction is still going to the least preferred levels like landfill and energy recovery. This shows that there are still obstacles to overcome in order to reach higher levels of the waste hierarchy, as well as improve and encourage recycling, the waste hierarchy level that most significantly contributes to a circular economy of resources.

Over the years, Portugal and Sweden have been improving their plastic packaging waste recycling rates, which shows that both countries are working towards a circular economy of their plastic waste. Hence, nowadays plastic waste is starting to be seen more as a resource. However, the analysis and comparison of both countries' plastic packaging recycling systems revealed that there are still many improvements to be done if both countries want to reach future EU targets and fully integrate plastics into a circular life cycle.

Furthermore, the analysis of the recycled plastic market and feedback from the plastic producers made clear that there are still many problems in using this kind of raw material which affect its supply and demand. Some solutions were drawn and derived mainly from the producers' feedback. The main solutions were: a design that allows recyclability; regulation that obliges the use of a certain content of recycled material; a collection scheme that increases traceability of waste and technologies that contribute to better quality of the recycled plastics, with clear and transparent standards.

Naturally, there is not only one solution due to the complexity of the system and diversity of actors involved that influence the entire system performance. Hence, several solutions can be applied in both countries that should solve issues related to the collection, sorting and recycling of plastic packaging waste, as well as potentially increase the supply and demand of recycled plastics.

Even though there were some difficulties related to lack of published information and transparency of what was being reported at times, the main objective was fulfilled by answering the initial proposed questions at some extent.

Lessons from each country were pointed out. The lessons drawn from Sweden that can be implemented in Portugal were: landfill bans on organic and combustible waste and higher landfill taxes, as well as a deposit return system for PET. Lessons possible to extract from Portuguese practices were: an incineration tax on household waste, with the possibility of only applying it for recyclable waste or being dependent on the type of waste; sorting of the residual or unsorted waste to retrieve further plastic packaging waste, as well as sending non-packaging plastic waste for recycling. Likewise, these could be implemented in Sweden.

Nonetheless, more research should be done to complement this work. Focus should also be given in studying each country separately to allow for conclusions on how individually they can both contribute to an improved management of plastic waste, a global issue.

Finally, the recent strategy on plastics in a circular economy published by the European Commission and the EU directives published on 30th May of 2018 that establish 2025 and 2030 targets on waste, landfill and packaging waste should allow for better results in plastic packaging recycling and waste management, in a near future.

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