

## Chapter 9

# The Contribution of Urban Domestic Waste Management to the Circular Economy: The Perspective of Six European Countries


**Maria de Fátima Nunes Serralha**

*Instituto Politécnico de Setúbal, Portugal*


**Zahra Mesbahi**

*St. Pölten University of Applied Sciences, Austria*

**Alexandra Anderluh**

 <https://orcid.org/0000-0001-7337-0799>  
*St. Pölten University of Applied Sciences, Austria*

**Nelson Carriço**

 <https://orcid.org/0000-0002-2474-7665>  
*Instituto Politécnico de Setúbal, Portugal*

**Beatriz Sara Santos**

*Instituto Politécnico de Setúbal, Portugal*

**Pamela Nolz**

*St. Pölten University of Applied Sciences, Austria*


**Dalma Radványi**

*Hungarian University of Agriculture and Life Sciences, Hungary*

**Sarah De Coninck**

*UC Leuven-Limburg, Belgium*

**Maira Leščevica**

 <https://orcid.org/0000-0001-9172-3607>  
*Vidzeme University of Applied Sciences, Latvia*

**Sergiu Valentin Galatanu**

*Poitehnica University Timisoara, Romania*

### ABSTRACT

*In line with the European community's goal, each EU Member State should recycle at least 60% of municipal waste or prepare them for reuse. In this chapter, the authors intend to show the waste management strategies implemented in six European countries, namely, Austria, Belgium, Hungary, Latvia, Portugal, and Romania. The methodology used was to analyse reports and publications on the management of urban waste and dialogue with some technicians of the municipalities. This knowledge of what is done in each country allows others to learn from the best and most innovative solutions and reflect on the various waste management forms implemented, according to environmental, economic, and social*

DOI: 10.4018/978-1-6684-6123-5.ch009

*perspectives. The analysis identifies several challenges to bring up in further research and projects, with the contribution of the different countries and the synergies that might be obtained. The authors intend to promote a decrease in consumption and an increase in reuse, separately collected waste and recycling, contributing to circular economic growth and the sustainability of the planet.*

## **INTRODUCTION**

The increase in the world population has caused a growing demand for raw materials, many of them scarce. The extraction and processing of natural resources have negative environmental impacts (e.g., loss of biodiversity and increase in water stress) but also contribute to total greenhouse gas emissions (GHG). In the current economy, we take materials from the earth, make products, and finally throw them away as waste in a linear process. As the urbanisation and industrialization of modern societies increase, so does the amount of municipal waste. If waste is not managed correctly, it negatively impacts our health and the environment and causes economic losses.

The European Union (EU) has adopted strategies to develop a sustainable, low carbon, resource-efficient, and competitive economy. Decoupling economic growth from environmental harm is a critical component of the European Green Deal (European Commission, 2020). Circular economy (CE) is a concept of decoupling economic growth from resource consumption (The Ellen MacArthur Foundation, 2022). CE policies aim to improve waste management and encourage a responsible production and consumption culture. CE has been a recurring theme on the international, European and national agendas, which aims to extend the life cycle of products so that they fit into the R's of circular economy: rethink, refuse, reduce, regift, recycle, repair and recover. Also reducing waste to a minimum is a key element to promote the decoupling of economic growth and the increase in resource consumption (Kaza et al., 2018).

In addition, one of the main building blocks of the European Green Deal is the new Circular Economy Action Plan (CEAP) (European Commission, 2020). The European Commission adopted the CEAP in March 2020. Some of the measures introduced under the new action plan include ensuring less waste and making the circular economy work for people, regions, and cities.

According to the World Bank, the world is expected to generate 2.59 billion tonnes of waste per year by 2030 (Kaza et al., 2018). However, global waste generation is expected to reach 3.40 billion tonnes by 2050 (Kaza et al., 2018). Therefore, waste management is a global issue. It also affects the three dimensions of sustainable development: social, environmental, and economic.

Almost every human activity generates waste. The amount of municipal waste generated per person in the EU is around 500 kg annually. About 48% of this amount is recycled yearly (European Environment Agency, 2022b). Although the percentage of waste recycled has increased, the amount of waste generated is also growing.

Considering waste as a resource is the first step toward sustainable waste management. Waste not only can be a health or environmental problem but also an economic loss. However, whether the waste is a problem, or a resource depends on how we manage it. Therefore, the EU Waste Framework Directive has created a five-step waste hierarchy for managing waste. According to this hierarchy, waste prevention and reuse are the preferred options, followed by recycling and energy recovery, and landfill disposal is the least preferable option and should be limited to the minimum (European Commission, 2022).

A key principle of EU waste policy is to advance waste management further and follow circular economy principles. Recycling is one of the most important ways to reduce the consumption of primary resources. Therefore, the EU has set two targets to achieve by 2030. First, each EU Member State should

## ***The Contribution of Urban Domestic Waste Management to the Circular Economy***

*Figure 1. The six European countries analysed in this chapter (own source)*



recycle at least 60% of municipal waste or prepare them for reuse. Second, to halve residual municipal waste that is landfilled or incinerated (European Environment Agency, 2022a). However, it is unlikely to achieve this goal by 2030 without reducing waste generation. Therefore, waste prevention is of the highest importance.

Waste prevention is actions taken before a substance, material, or product has become waste. The goal is to reduce the amount of waste, the waste-related harmful substances, and the undesirable effects on the environment and human health (European Environment Agency, 2022a). Waste prevention is challenging because it depends on behavioural changes and requires a whole new infrastructure to enable those changes.

The problems of waste generation and management increase as societies continue to develop. How much waste we generate is closely linked to our consumption and production patterns. Municipal waste accounts for about 10% of the total waste generated in Europe (European Environment Agency, 2021b). Although it is not high in amount, its prevention can reduce the environmental impact. Citizens play an essential role in waste management. Therefore, education and raising awareness in this regard play an indispensable role. For example, a large proportion of municipal solid waste is kitchen and garden waste. Such waste can be converted into a source of energy or fertiliser if it is collected separately (European Environment Agency, 2021c).

Improving waste management and achieving a circular economy in Europe requires joint efforts, starting with small steps. It is essential to intensify the exchange of knowledge, insights, and practical experiences to make the necessary changes.

In this chapter, the authors intend to show the waste management programs implemented in six European countries (Figure 1), showing the strategies implemented and the way they are contributing to sustainability.

## **WASTE MANAGEMENT PRACTICES IN SIX EU COUNTRIES**

### **Austria**

In Austria, starting at the end of the 19th century, the first attempts at waste recycling were considered. From 1950 onwards, the Austrian provinces began to include the issues of the waste collection into legal texts. At the end of the 1960s aesthetic and environmental concerns were incorporated into the waste laws. This was enforced due to many environmental catastrophes in the 1970s, which gave rise to an increased concern about environmental aspects, and due to the impact of the report “Limits of Growth” by the “Club of Rome” (European Environment Agency, 2022a).

Today, individual regional magistrate departments take care of waste management in specific regions. There are usually several municipalities in a province assigned to one of the Austrian waste associations. These are responsible for collecting the waste. At the state level, there are laws, such as the Waste Management Act (Abfallwirtschaftsgesetz, AWG), and from the individual provinces, the collection of municipal waste is regulated by directives, such as the provincial waste laws, whereby the organisation of the collection of municipal waste is subject to the municipalities (BMK, 2022a).

Companies have to take care of the disposal of commercial waste themselves, and for this purpose they commission companies to dispose of the waste. All households, on the other hand, are obliged to participate in the public waste disposal system of their municipality. The waste disposal fees are regulated by the individual municipalities and are included in the municipal taxes (Austrian Government, 2022).

The costs incurred in Austria for recycling packaging, the so-called licence fees, are paid by the companies that put the packaging on the market and are usually included in the purchase price of the packaged product (WKO, 2022a). On the other hand, there is a deposit on returnable glass bottles, which can be returned to retailers to be refilled (Austrian Government, 2022). Used clothes, i.e. clean and wearable clothing and underwear, can be handed in at used clothes collections by charitable organisations; there are also official used clothes containers for this purpose (Austria Glasrecycling, 2022). Since 2005 electrical appliances and, since 2008, used batteries can be disposed of free of charge. There is even a 1:1 take-back in retail, where the dealers are obliged to take back old devices, if an equivalent, new device is bought at the same time. And for batteries, there is nowadays a collection point in almost every supermarket (Austria Glasrecycling, 2022).

In some waste material collection centres, fees have to be paid for the disposal of special waste, such as construction waste, bulky waste or hazardous waste. Such waste collection centres exist several times in a waste association and, depending on the area, in all larger municipalities. In these collection centres, citizens can bring their self-collected and separated waste. Depending on the municipality, certain types of waste are collected from households by the waste collection services of different companies. For garbage collection, garbage is collected and separated either in garbage cans or in large plastic bags, such as the yellow bag for plastic garbage. Glass is collected by Austria Glas Recycling (AGR) in certain communities or cities, and the cost of this is covered by the companies for “licensed” glass packaging (Austria Glasrecycling, 2022). In addition, there are other collection and recycling systems of companies such as Altstoff Recycling Austria AG, AGR Austria Glas Recycling GmbH, Bonus Holsystem für Verpackungen, GmbH & Co KG, European Recycling Platform (ERP) Austria GmbH, Interseroh Austria GmbH, Reclay UFH GmbH or the GUT GmbH (WKO, 2022b).

In 2019, the total amount of waste generated in Austria was approximately 71.26 million tons. The increase, which can be seen when looking back at past years, can be explained by a larger amount of

excavation materials and waste from the construction industry (BMK, 2021). There is no data yet for the year 2020 for the whole of Austria. However, based on the values of individual federal states, it is possible to compare 2019 and the pandemic year 2020. For example, in the province of Upper Austria, there was a 3% increase in the total amount of waste from 2019 to 2020, the amount of residual waste increased by 2%, and there was a 7% increase in the amount of biogenic waste collected separately and treated mainly in composting and biogas plants; there was a slight decrease in the amount of used/valuable materials collected (Land Oberösterreich, 2022). At least at first glance, there are no outliers in the amount of waste that can be attributed to home offices and quarantine of the COVID 19 pandemic.

In terms of waste treatment, the figures for 2019 are as follows: 41% of waste was materially recovered (recycled and backfilled), 7% was thermally treated in plants subject to the Waste Incineration Ordinance, 46% was landfilled, and 6% of waste was treated in some other way, for example by chemical-physical or mechanical-biological waste treatment plants. However, if we exclude the 42.02 million tons of excavated materials from the total waste generated in Austria in 2019 (about 71.26 million tons), 64% of the waste was recycled and 2% backfilled, 17% was thermally treated, 11% was landfilled, and 6% of the waste was treated in other ways (BMK, 2021).

The rate of plastic recycling in 2019 was 28%. A total of 0.92 million tons of plastic waste was generated, of which 20% was production waste and 80% was post-consumer waste (WKO, 2022a). In 2020, 1.3 million tons of wastepaper were collected in Austria. As the paper industry processed 2.6 million tons of recovered paper in Austria in 2020, recovered paper is also imported to Austria, as the recovered paper is an important source of raw material in paper production. The recycling rate for wastepaper in Austria in 2019 is 77.6% (Austro Papier, 2022). The recycling rate for glass was even expected to exceed 80%. To achieve this, more than 270,000 tons of waste glass were collected in 2020, or around 29.4 kilograms per person (Riedmann et al., 2021).

Approximately 4.5 million tons of the total waste generated in 2019 comes from municipal waste from households and similar establishments. Thus, an average of 507 kg of municipal waste was generated per capita. Of this, 1.7 million tons of mixed municipal waste were sent for treatment as residual or bulky waste via public waste collection, 648,200 tons were wastepaper, and 165,400 tons were accounted for by used plastics and composite materials. Of this around 52% - more than half of the approximately 4.5 million tons of municipal waste from households and similar establishments - was sent for material recycling in 2019. Around 43% was treated thermally and less than 5% was treated mechanically-biologically (BMK, 2021). Untreated municipal waste has not been landfilled since 2008, and biogenic material has not been allowed to be landfilled since the landfill ban came into force in 2004. This landfill ban is still being extended and by 2026 there will also be a gradual landfill ban for most mineral building materials (VOEB, 2022).

In general, the Austrian federal government is also making efforts to advance the circular economy, and in addition to the European Green Deal, there are also federal guidelines to avoid single-use plastic products (BMK, 2022b). For example, the ban on single-use plastic carrier bags, also known colloquially as the “plastic bag ban,” was put into effect in 2020 and a general ban on single-use plastic products was introduced in 2021. There will also be reusable beverage packaging quotas from 2024 and deposits on single-use beverage bottles in 2025 (BMK, 2022c). Generally, waste is also collected separately in public buildings, such as schools or train stations. This could be a motivation to also separate one’s own household waste, which is why public institutions have a role model function both for children and adults when it comes to waste separation.

## **Belgium**

In Belgium, household waste and industrial waste are collected differently. In addition, there are specific rules for waste from construction. Citizens can choose to bring their waste to the collection centres or have it collected from their homes. Waste collection is organised at the regional level (Vlaanderen, 2022). The Openbare Vlaamse Afvalstoffenmaatschappij (OVAM) is responsible for waste management and soil remediation in Flanders.

The categories of household waste being collected are glass, paper and cardboard, PMD (a combination of certain plastics, metal packaging and beverage packaging), food and gardening waste, electric and electronic appliances, small and hazardous waste and undifferentiated waste. All packaging from the PMD category is recycled within Belgium or neighbouring countries. Plastic waste is washed and ground up into pellets or granulates. The pellets and granulates are then melted or moulded into new products (Fost Plus, 2022a). With the growth of the number of plastics being recycled, it is important to have a large enough sales market. For this reason, an exploratory study on implementing the use of plastic recyclates in construction is being carried out by Centexbel-VKC (OVAM, 2022a).

White and coloured glass are collected separately at a collection point, not at home. Glass waste streams are purified and melted into new products (*Glas*, 2022b). Metal from the PMD category mostly contains steel and aluminium and is collected at home. Afterwards, steel and aluminium are magnetically separated, ground up, purified, melted, and made into new products (Fost Plus, 2022c). Paper and cardboard are collected at home or brought to collection points. Afterwards, it is sorted by quality, made into a pulp, purified, and removed of ink. The pulp is then crushed and dried. Depending on the desired end product, the pulp undergoes different processes (Fost Plus, 2022d). There are separate collection points for solar panels. Concerning car tyres, there are several possibilities to recycle these in an environmentally friendly way through garages, farmers or tyre centrals (Recytyre, 2022).

Municipalities can choose the prices for each waste stream being collected, within certain guidelines provided by the government (Vlaanderen, 2022). Municipalities have the choice to pay for waste collection by their own means, by asking for a flat rate tax or by asking for a variable cost price. When municipalities choose to ask for a variable cost price, the Flemish government provides a certain minimum and maximum rates for different waste streams, although some household waste streams, such as asbestos and small and hazardous waste, need to be collected for free. The government also recommends collecting glass, paper and cardboard for free, but this is not obligatory. Metal and textile waste are often collected for free as well, given the value of these waste streams.

Throughout the years there is a small decline in the amount of waste collected per citizen. However, in 2020 the amount of undifferentiated household waste for each Flemish citizen increased (from 143,5kg to 147kg) for the first time in 25 years (OVAM, 2022a). Given that the amount of industrial waste decreased in 2020 by 60,000 tons, the restrictions due to the COVID-19 pandemic could be to blame for the increase of undifferentiated household waste (OVAM, 2022a). A similar evolution can be seen in the amount of waste being littered and burned. In total there was a 4% decline in littering and burning waste in 2020, while the amount of household waste that was burned increased to 5% (OVAM, 2022a).

To get a more in-depth understanding of the recycling behaviour of households, OVAM organised a quantitative and qualitative research study concerning the recycling of household waste (OVAM, 2022b). More than 80% of respondents claim to consequently recycle waste into the different selective waste categories. 6% of respondents admit to burning waste (mainly garden and food waste or paper and cardboard) every once in a while. Categories that are recycled the least (16% to 36%) are food and garden

## ***The Contribution of Urban Domestic Waste Management to the Circular Economy***

waste, aluminium, small hard plastics and plastic foil or bags. Reasons respondents gave for sometimes not recycling properly were 1) being able to throw out food waste sooner, 2) not wanting to separate food waste from the packaging or 3) doubts about which category waste belongs to.

75% of respondents state that they try their best to minimise household waste by 1) recycling (80%), 2) selling things second hand or giving them away (70%), 3) buying second hand (40%) or 4) buying new goods with a long lifespan (40%). Other strategies mentioned in the qualitative research are consuming less, reusing, repairing, buying less packaging, and composting.

Respondents indicate that the most important motivating factors for recycling are doing the right thing, being part of the daily routine, contributing to the environment, having clear recycling guidelines, the reduced cost of selective waste streams and social or legal obligations. Barriers to recycling are thinking that most waste will become part of undifferentiated waste in the end, unclear rules concerning recycling, laziness, not having the space for different bins for each waste stream and thinking that they already recycle enough so it's okay to not recycle every once in a while, and not having enough waste of a specific category to fill an entire bag or bin.

More than 80% of respondents indicate that there are possibilities to be stimulated to improve their recycling behaviour. They propose decreasing the cost of selective waste streams, clear recycling guidelines, awareness, reward, or penalty systems and clearly indicated on the packaging how it should be recycled as possible stimulating factors. When it comes to waste prevention, offering composting bins, providing reusable grocery bags, organising second-hand markets, and providing a platform for the sharing economy as possible motivators that municipalities can provide.

In 2021, a new charter against littering in Flanders was launched (OVAM, 2022a). This led to several proposed actions such as:

1. **Working with littering reinforcers.** Littering reinforcers can address litterers and write out fines when necessary. During the World Championship cycling in September, these littering reinforcers were applied for the first time.
2. **Click-app.** With the Click app, people can scan and take pictures of the waste that they throw away. When they do this correctly, they earn circular coins that can be spent at local stores.

In addition to the charter on littering, there is the 'mooimakers' ('prettymakers') initiative organised by OVAM, the Union of Flemish Cities and Municipalities and Fost Plus. Mooimakers invests in communication and awareness, encouraging vendors to find alternatives to single-use packaging, reinforcing initiatives against littering and connecting with citizen projects (OVAM, 2022a).

Since 2020 single-use packaging has been prohibited in large-scale events in Flanders (OVAM, 2022a). The "Green Deal Differently Packaged" was created where several Flemish organisations and knowledge institutions engage themselves to look for alternatives to single-use packaging in the distribution sector. OVAM launched a campaign to raise awareness about single-use food packaging in November 2021. There was a special chip shop where citizens could get free french fries if they brought their own packaging. In addition, the shopcakes campaign was implemented at the same time to raise awareness concerning food waste. Shopcakes are small cakes made specifically to shop without hunger. If you shop when hungry, you often buy food that you don't need and ultimately goes to waste. Shopcakes are made from food that often goes to waste but makes you feel very saturated.

## **Hungary**

Hungary has a well-developed policy and legal framework for waste management. It is mainly driven by EU requirements and supported by quantitative targets and economic instruments. There are a lot of positive waste management trends: decoupling of waste generation from economic growth, increased recycling, and recovery rates, and decreased use of landfills. However, Hungary remains an average performer in some cases, like glass recycling. A good monitoring system was developed for waste management, more precisely waste generation, and treatment. At the national level, the Ministry of Agriculture is the main authority for waste management policies. It is also the lead ministry for the transition to a circular economy, however, this transition is perceived as an extension of waste management policies. There are ongoing efforts to include resource efficiency and a circular economy (OECD, 2018).

In Hungary landfilling was the dominant treatment of municipal solid waste for decades. When Hungary joined the European Union (EU) in 2004 the national waste management policy priorities have been primarily driven by EU waste legislation (Herczeg, 2013). The waste management strategy of Hungary is defined in National Waste Management Program (NWMP). National programmes and regional and local waste management plans were prepared according to various waste types.

According to EU legislation, Hungary needed to improve its waste management program and develop some aspects. The National Waste Prevention Programme identified needs related to recycling and recovery in several aspects, namely municipal waste, non-hazardous production waste, non-hazardous agricultural and industrial food waste, sewage sludge, hazardous waste, particularly high priority hazardous waste stream, packaging waste, biodegradable waste, waste tyres and construction waste (Herczeg, 2013). Considerable results were achieved in the field of supply, level of service, modernisation, re-cultivation, and selective collection, which are the basis for the developments of the coming period. The municipal waste management public service is now available in almost 100% of the settlements. Hungary collected 3,203,367 t residual municipal solid waste and separately 236,673.619 tons of municipal solid waste in 2019. The total waste generation decreased by 17%, while GDP increased by 3%, which is a good achievement. Municipal solid waste generation decreased by around 19% (OECD, 2018). The separately collected waste, i.e., packaging materials, undergoes the sorting plant technology to recycle materials. Biowaste is also separately collected and further treated in composting- or biogas plants. The residual fraction is also treated in mechanical-biological plants for the sake of energy- and material recycling.

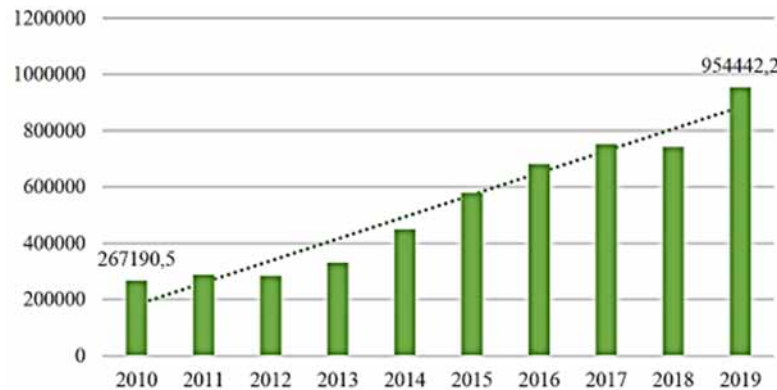
The main results for municipal solid waste management:

- The number of dwellings involved in the regular collection reached 93% rate, which means full coverage, and it is carried out by modern, closed, dust-free technologies.
- The implementation of the recultivation programme for old landfills is ongoing.
- The mixed municipal waste incinerator was upgraded, and its energy efficiency improved. In addition, the co-burning of the combustible components of municipal waste combined with energy recovery started for example in the Matra Power Plant and in some cement factories.
- Today, the selective collection system is available at more than 1 200 municipalities nationwide, for 55% of the population.
- Selective waste collection rates increased to 12% of the total volume of municipal solid waste. Taking into account the amount of organic waste collected separately, the rate exceeds 15%. Together with energy recovery in the capital, the overall recovery rate is 23-24%, which means more than 1 million tonnes of municipal waste.



## ***The Contribution of Urban Domestic Waste Management to the Circular Economy***

*Figure 2. Amount of recycled and reused municipal solid waste (in tonnes) in Hungary over time (Hungarian Central Statistical Office, 2022)*



- In the case of priority waste streams, the EU standards have been achieved. Separate waste collection systems were established for wastes belonging to the responsibility of the producers (batteries, electronic devices, fluorescent tubes, pharmaceuticals, tyres), thereby reducing the risk and quantity of mixed waste (European Environment Agency, 2013).
- The amount of municipal solid waste recycled has been raised over a decade. The amount of recycling and reuse of solid municipal waste in 2009 was 267,190 tonnes and increased to 954,442 tonnes in 2019 or by 350% in ten years (Figure 2.)

Hungary has recently implemented significant waste sector reforms. Still, the new plan must be adapted to the different social and economic environments, taking into account changes in production, the transformation of technologies, improved service levels, and the consequences of the economic crisis. Municipalities are still in charge of public waste management services such as waste collection, transportation, and treatment, as well as the operation and maintenance of waste management facilities. There were approximately 130 public service operators (European Commission, 2019). The emphasis is placed on waste prevention and stimulating selective waste collection and recycling in order to increase resource savings. In addition, the safety of treatment, recultivation, and the elimination of illegal waste disposal continue to play an important role.

Significant progress is most likely for residential household waste. The goal is waste reduction, collection network development, improvement of recycling rates and the further reduction of the share of disposal through incentives. A number of comprehensive measures are required for waste prevention – and for recycling, recovery and disposal – in the area of product, technology and infrastructure development. To improve waste management at the local level, environmentally appropriate behaviour has to be acquired from an early age, and waste management skills are taught in all educational institutions as part of the National Curriculum (European Environment Agency, 2013).

To sum up, Hungary was successful in developing proper municipal solid waste and wastewater management due to clear regulations, substantial financial support, integrated separative collection, the building of sorting plants, and mechanical-biological and biological (composting, biogas facilities) ones

for the treatment of municipal solid waste. It established an advanced wastewater network and treatment (Janetasari & Bokányi, 2022).

## **Latvia**

A waste management system (WMS) is a complex system involving numerous waste streams, collection schemes, treatment processes and various actors, and WMS in Latvia is recently experiencing more sustainable development trends like circular economy and increased material recycling.

In 2017, household and similar waste generators produced around 850,000 tons of waste. A large part of the generated domestic waste ended up in landfills. In 2018, 462,358 tons of domestic waste were produced representing 58.9% of the total amount of generated waste. It is the value locked in the unused materials, which is not only not returned to the national economy but causes economic losses as an unused opportunity in promoting employment, developing innovations and building the local economy. With the introduction of measures such as a natural resource tax on landfills as well as the gradual introduction of separate collection, recycling rates have gradually risen from 5% in 2004, 9% by 2010 to finally 41% by 2019 (European Environment Agency, 2021a). Landfill still accounted for 45% of municipal waste in Latvia in 2016 though that number is now steadily decreasing. Where the country used to have over 500 unregulated landfills in the 1990s since 2000 most have been closed or re-cultivated according to EU standards. The existing recycling infrastructure is well maintained due to EU funding (VARAM, 2021).

The waste management companies have established separate waste collection points (which include both – door-to-door collection and containers in publicly available places, as in Latvia they are not observed separately). Also, civic amenities were established throughout the country, which along with paper, metal, plastic and glass provide the possibility to turn over hazardous household waste, waste of electric and electronic equipment (WEEE) and other household waste types. Separate collection of specific waste types (e.g., WEEE, batteries, end-of-life vehicles, packaging) has been facilitated by the producer responsibility system implemented through nature resource tax. Several waste management regions facilitate separate waste collection by providing eco-bags and eco-boxes intended for a particular type of waste (paper, plastic, metal) to private houses which are emptied by the waste management company free of charge. Yet the situation differs from region to region and even from municipality to municipality. The State Waste Management Plan of Latvia for 2021-2028 prepared by the Ministry of Environmental Protection and Regional Development, aims to expand the system for the separate collection of waste, develop the institutional framework for waste management, create stronger waste management regions and implement the principles of circular economy in order to: substantially increase waste recycling and reduce waste disposable. In order to reduce waste generation and ensure more efficient management, achieve ambitious targets for waste recycling and reduce waste storage, the necessary resources should be planned, and a strong waste management repository developed. Developing action programmes and measures to achieve the environmental policy objectives for the reduction of waste generation, the separate collection and recycling of waste, and the reduction of waste stored in landfills. The proposed action lines are in line with the European Union's (EU) growth strategy, the European Green Course, as well as the New Circular Economy Action Plan "Towards a cleaner and more competitive Europe" (VARAM, 2021).

In the late 20th century, the terms "waste recovery" and "recycling networks" began to appear in the scientific literature to describe the management of consumer recyclable waste materials through chain

activity and involved stakeholders (Brouwer et al., 2018; Wilson et al., 2006). First of all, the topic of waste processing has become particularly relevant. It is increasingly common to hear that it is necessary to produce less and less waste and recycle it. The concept of zero waste has recently emerged in Latvia.

There is a need for the implementation of an improved waste management system that requires a significant and thorough planning stage, the results of which will significantly depend on the availability of detailed information on the possible waste flows and waste composition. The experimental results indicated that the unsorted municipal waste stream comprises up to 32.9% of recyclable materials and 29.2% of biodegradable wastes. Almost 60% of the waste currently being subjected to unsorted waste management systems in Latvia could potentially be source separated, ensuring higher quality of the recovered materials, and promoting circular value chains. The results from the recent research indicate a slight difference between waste composition in different waste management regions, noting that, in addition to the number of inhabitants and their habits, the local system in each waste management region may influence the composition of the collected wastes (Kubule et al., 2019).

The amount of unsorted waste in Latvia is higher than in other Baltic countries (2018), the amount of sorted waste was 25.2% of the total amount of waste (in Lithuania and Estonia, 52.5% and 28.0%, respectively (Eurostat, 2022)). Unsorted waste contains a significant amount of economically valuable materials - ferrous and non-ferrous metals, glass, plastic, and paper - and their reuse in the production of products would reduce the costs of both product production and raw material transportation since raw materials can be obtained locally due to waste sorting and recycling. Better separate collection and recycling of waste would reduce the country's dependence on imported resources and return the value of materials to the domestic economy. However, it needs better infrastructure. According to the Cabinet of Ministers Regulation No. 328 of June 13, 2017, on average, in the country, there is one separate collection point for 598 inhabitants, and one separate collection area for 14,816 inhabitants, which is not sufficient.

Used packaging constitutes a significant part of household waste. In 2017, more than 237,000 tons of used packaging were created in Latvia (Eurostat, 2022). More than 144,000 tons of material (60.88%) were processed (including regenerated and prepared for processing). By type of packaging, 38% of paper and cardboard, 5% of metal, 11% of plastic, 27% of glass and 19% of used wooden packaging were recycled.

On February 1, 2022, finally, there was a deposit system for beverage packaging in Latvia. As part of this, residents are able to hand over certain categories of beverage packages for recycling at sales points, container points and sorted waste collection points – plastic or glass bottles or cans of different volumes of beer, non-alcoholic and low-alcohol drinks. It will promote the development of circular economy solutions to replace these types of packaging and products with more environmentally friendly ones, as well as new behavioural/consumption practices in society.

## **Portugal**

In Portugal, the treatment of waste arising from professional activities is governed by general waste legislation; the responsibility for waste management, including waste costs, lies with the original producer of the waste. The original producer of the waste or the holder must ensure that the waste is treated and to do so may use 1) a dealer; 2) a licensed entity carrying out waste collection or treatment operations; or 3) a licensed entity responsible for systems managing specific waste streams. Entrepreneurs who collect or transport waste must deliver it to licensed waste treatment operators (ePortugal, 2022).

Urban domestic waste is an exception, whose collection and treatment constitute a public service provided by municipal or multi-municipal systems. This exception includes small retail, service and

catering establishments, school establishments, health care units, tourist developments, or other sources whose waste is similar in terms of nature and composition to that of households, and comes from a single establishment that produces less than 1,100 litres of waste per day (APA, 2022).

Therefore, waste management is based on a hierarchical organisation that promotes prevention in the first place, followed by reuse, recycling, recovery and, finally, disposal. The management of waste collection, transport and treatment is regulated at the level of municipal waste and non-urban waste (namely hospital and industrial waste, including hazardous waste). Some types of waste have a differentiated approach, in order to optimize their management - such as the following specific waste streams: construction and demolition waste, waste from batteries and accumulators, used oils, packaging and packaging waste, waste from electrical and electronic equipment, used tires and end-of-life vehicles.

The entity responsible for the implementation of environmental and waste management policies in Portugal is the Portuguese Environment Agency - APA, which aims to ensure the planning and management of waste, to prevent or reduce its production, the character of harmful and possible adverse impacts. It also seeks to promote efficiency in the use of resources, based on the principles of the waste hierarchy and CE, as well as to protect and enhance the environment.

The APA, in addition to the aforementioned objectives, ensures and monitors the execution of the national strategy for waste, also carries out the operational and administrative control of waste transfers in national territory, and ensures the collection and treatment of waste information, guaranteeing the validation of the information necessary for the application of the economic and financial regime of waste management, the so-called Waste Management Fee (TGR). This fee is applied by each municipality, in the collection and disposal of undifferentiated waste in landfills, that is, those residues that are not separated for recovery. In 2022, has been applied the value of 22€ per ton.

Regarding urban waste, the entities responsible for the municipal, inter-municipal or multi-municipal management system ensure the selective collection of the following fractions of waste:

- islands with paper/cardboard (packaging and non-packaging) and metal, plastic and glass packaging;
- used cooking oils.

The selective collection of bio-waste is being planned (with a target of implementation from the beginning of 2024) and of textiles, furniture waste and other bulky waste and hazardous waste (from 2025).

Based on these future targets, users of municipal waste management services are subject to the waste tariff, which is charged by the service provider, to cover the respective costs. The waste tariff should encourage the increase in adequate waste separation, and from 2026, it should no longer be adjusted to the water consumption of each user, as it is nowadays, and should be applied to the amount of waste collected, measured in units of weight, or estimated by its volume.

APA has recorded since the beginning of its activity the production of municipal waste per capita in Portugal. From 2019 to 2020 there was a decrease of 0.05%, from 5,281 million tons to 5,279 million tons, respectively. Thus, for 2020 the daily production of municipal waste was 1.40 kg per inhabitant, corresponding to an annual capititation of 512 kg per inhabitant (APA, 2022).

Regarding the collection of municipal waste, undifferentiated collection, unfortunately, continued to be, in 2020, the one with the highest percentage (79%).

Concerning the amount landfilled, a decrease was observed, as in 2018 and 2019 the percentages were, respectively, 58.3% and 57.7%. However, in 2020, this positive trend suffered an inversion, with

an 8% increase compared to the previous year. The justification for this could be the lockdowns decreed by the government during the Covid-19 pandemic situation.

With the pandemic situation that was suffered, we also analyzed the results provided by APA regarding the values of the destination of waste for recycling and composting, obtained by the Eurostat methodology, in which these final destinations, both directly and indirectly, had the same repercussion as the destination to landfill, retreating in 2020 in relation to the years 2018 and 2020.

In this way, there is an increasing need to implement measures to improve the management of urban waste, not only in Portugal but all over the world. Even though there has been an increase in the amount of infrastructure for selective collection since 2020, we must continue to develop campaigns to raise awareness of the importance of waste separation. Currently, in some municipalities in Portugal, such as the regions of Setúbal and Porto, a form of awareness-raising is being carried out by companies, namely, the Amarsul and Suldouro Groups, which are investing in a door-to-door collection of packaging (paper and plastic) and organic waste of domestic origin, the latter of which will become a mandatory measure from 2023.

In other places, for example, in the municipality of Maia, the Lipor company developed a pilot project of a PAYT (pay-as-you-throw) system where citizens only pay for the undifferentiated garbage they produce/do not separate, instead of paying based on water consumption.

A system for depositing disposable plastic bottles and aluminium cans is also in place, which allows consumers to receive a discount voucher for each plastic bottle and aluminium can that is placed in a machine, ensuring its forwarding for recycling. With this initiative, the objective is to recycle more than 90% of the bottles and avoid their release into the environment. Several companies and environmental associations have developed apps to help citizens know where they should put their waste and how to sort it out.

Therefore, new challenges will continue to appear, mainly due to the obligations established by the European Community, which require new investments in infrastructure, in particular for waste recovery. In what concerns recycling, there should occur an efficiency increase in waste collection and sorting. As for organic recovery, efforts will be intensified to avoid sending biodegradable waste to landfills, which will require a strong investment in biological treatment technologies.

Another important aspect is the identification of improvement opportunities in the way production of urban solid waste is managed at production at all stages of the economic system, intending to guarantee, in the long term, a stabilization of the demand for natural resources and of the final volume of waste to be landfilled. There is a need to continue to raise awareness and emphasize the important role of the citizens, which is decisive for the success of these present and future goals, assuming increasingly responsible conduct, so that all these fundamental factors collaborate in the pursuit of sustainable development of a CE.

## **Romania**

Romania is at the bottom of Europe in terms of recycling, with a rate four times lower than the European average. By 2020, Romania should have reached a 50% recycling rate. This target has been missed, as only 14% of municipal waste was recycled, making Romania the second-lowest recycling rate country in the EU, above Malta with only 6.5%. A shameful percentage, considering that the European average is 47%, the highest rate being in Germany, 67%. The next threshold must be reached by 2025 when Romania must have a 55% recycling rate, a hard-to-reach target for Romania, which is still struggling with

the closure of illegal landfills and illegal waste imports. Another challenge for Romania is to reduce the amount of municipal waste stored by up to 10% by 2035. At present, Romanians deposit 70% of the waste they produce, while the European average is 24% and the rest is recycled (Friedrich Ebert Stiftung, 2022).

Waste management activities in Romania are based on Law 211/2011 on waste, republished, which implements a series of directives of the Council of Europe. The amendments to the waste management process is closely related to the European Union legislation in the field of waste that has as its main legislative instrument the Waste Framework Directive. It starts with prevention, followed by preparation for reuse, recycling, and recovery and ends with the disposal. The main goal of waste management is to prevent as much as possible the generation of waste, to use the generated waste as a resource, and minimise the amount of waste that ends up in landfills.

Romania relies on agencies at three levels to manage waste: the Ministry of Environment (MoE) and Ministry of Administration and Interior (MAI), the County Councils, and municipalities, which must ensure that all non-complying landfills and illegal dumps are closed, existing municipal landfills rehabilitated or extended, and new landfills constructed where needed. Moreover, according to Law 211/2011, local authorities are obliged to ensure separate collection of at least paper, metal, plastic and glass and to achieve, by 2020, the 50% preparation for reuse and recycling target (European Commission, 2011).

The municipality of Timisoara is located 571 km from the country's capital. Timisoara is the capital of Timiș County, it is the largest city in the western part of Romania, with a population of 323734 according to the Timis Regional Directorate of Statistics on 01.07.2020. According to the 2011 census, the city's residents were grouped into more than 21 ethnic groups and 18 religions, reflecting two major features of the population, namely interculturality and a high degree of tolerance.

SC RETIM Ecologic Service SA is a company established in 1997 following the association of the Timișoara Local Council with the German company RWE. The company holds an ANRSC Class I License for the public sanitation service of municipalities and is TÜV certified according to the quality, environment, occupational health and safety integrated management system. The society places special emphasis on civic and ecological education actions, especially among students (RETIM, 2022)

Through RETIM Ecological Service SA, waste stored/abandoned in the public domain of the municipality of Timișoara, in the amount of 12,764.45 tons, was collected and transported to the Ghizela Non-hazardous Waste Repository (RETIM, 2022).

TransClean S.R.L provides the services of collection, transport, and storage/utilization of plant waste and construction waste from demolitions, redevelopment, and rehabilitation activities, abandoned in the public domain of the municipality of Timișoara (Transclean, 2022). Likewise, 4,774.24 tons of vegetable waste and 677.16 tons of abandoned construction waste were collected, transported, and stored in the public domain.

In order to prevent the abandonment of waste and the sanctioning of citizens, the Timișoara City Hall together with RETIM Ecologic SA has opened four free collection points for vegetable waste, bulky household waste and waste resulting from construction and demolition, where citizens of Timișoara can voluntarily deposit their waste in order to avoid the fines for abandoning waste on public domain. Starting from January 2022, polystyrene and cardboard waste from the packaging of bulky items or household appliances can be handed in free of charge at RETIM centres. In accordance with the provisions of HCL 405 of 19.07.2019 approving the Prevention Plan and measures regarding the avoidance and reduction of the quantities of waste abandoned on the public domain within the radius of the Municipality of Timișoara, the quantities collected free of charge in these four centres are:

## ***The Contribution of Urban Domestic Waste Management to the Circular Economy***

1. Vegetable waste, in maximum quantities of 3 cubic meters per month;
2. Bulky and household waste, in maximum quantities of 5 m<sup>3</sup>/month;
3. Waste from homes, generated by their interior/exterior remodelling activities, in maximum quantities of 1 m<sup>3</sup>/month (RETIM, 2022).

The waste sorting station of Timișoara municipality operates within the framework of the “Integrated Waste Management System in Timiș County”, which serves the municipality of Timișoara and 9 peri-urban municipalities (Dumbrăvița, Ghiroda, Giarmata, Giroc, Moșnița Nouă, Ortisoara, Remetea Mare, Șag, Sânmihaiu Romanian), starting from November 1, 2018 (Primăria Municipiului Timișoara, 2022).

Through the Waste Sorting Station SSDM, the following categories of waste are managed: residual waste from household waste from the population (wet fraction) taken from the urban and rural environment and recyclable waste from the population (dry fraction) taken from the urban and rural environment: paper/cardboard, glass, PET, other types of plastic, metal.

At the Waste Sorting Station in 2020, a quantity of 79,017.00 tons of household waste (wet fraction) was processed from the population in the urban environment, and 2,925.58 tons were used as energetic waste (Colterm, 2022).

The amount of recyclable waste (dry fraction) from the urban population, processed at the sorting station, is 16,384.192 tons, of which a quantity of 2,211.96 tons was recovered through recycling, as follows:

- Paper/cardboard in the amount of 1674.32 tons;
- Glass in the amount of 74.33 tons;
- PET in the amount of 399.38 tons;
- Metal in the amount of 18.96 tons;
- Other types of plastic in the amount of 44.98 tons

For the collection of glass waste from the population, a number of 350 bell-type containers (green) are placed in the public domain, in several locations, including all the neighbourhoods in the municipality of Timișoara. Through the Partnership Agreement concluded between the Municipality of Timișoara and the Caritas Federation of the Diocese of Timișoara, 30 special containers are placed for the collection of used clothing and other used textile products from the population. The locations of the containers are established by Caritas in partnership with the representatives of Timișoara Municipality to avoid obstructing pedestrian visibility. The collection action has both a charitable purpose, to support people in need, and an ecological purpose.

## **CHALLENGES RELATED TO WASTE MANAGEMENT IN EUROPE**

There are several societal challenges related to waste management in Europe and worldwide. The amount of waste is increasing in many countries as their population increases in purchasing power. The waste management authorities are continuously requesting to separate different types of waste, for example, coffee capsules, medicines, electronic devices, batteries, used cooking oil, and textiles. One great challenge is how to do this separation in cities where the apartments have very little space to store all the separated waste until the collection is made, or the streets are narrow to have public bins or containers

for all types of waste. It is urgent to reduce the amount of waste produced by changing the consumers' behaviour for buying according to their real needs.

Another challenge is the bulky waste generated every year in each country. The main goal of the households is the cheapest and most practical way to get rid of the unneeded bulky waste. How might we reuse vast quantities of second-hand, good-quality bulky waste with reuse potential (ex. doors, windows, pieces of wood)? Repair services are essential to the process of reusing bulky waste, and local authorities may be able to provide support. The "Repair Network Vienna" is a meaningful example for the prevention of waste in a sustainable and resource-efficient economy through reuse and repair support services. The Repair Network Vienna, founded in 1999, consists of about 80 member companies and provides a hotline for inhabitants to quickly identify appropriate repair services for their needs. According to the network, the members carry out more than 50.000 repairs per year, which corresponds to about 750 tons of waste prevented every year (Stadt Wien, 2018).

The European pattern of textile consumption has increased textile waste since the clothes and fabric shops sell them very cheaply, and people's consumption habits have changed over time. In the current fast fashion economy, clothes are bought to be used a few times and then thrown away. In some countries, there are already containers for collecting textiles. These textiles are made of different materials which are not yet recyclable and most of them are disposed of in landfills or incinerated. So, textile waste prevention and innovative recycling methods are needed. A big challenge is how to change people's habits of consumption and closet replacement and elimination. The SDG Watch Europe campaign "Wardrobe Change", for example, asks EU leaders to take urgent action in the textile industry sector to change how clothes are made, sold, worn – and re-worn (SDG Watch Europe, 2022).

Electrical and electronic equipment is one of the growing rapid waste streams. These types of equipment comprise a complex mixture of different materials, some of which are hazardous. Some types of equipment have rare and expensive resources that can be recycled if the waste is properly managed. Some countries need to improve the collection, treatment, and recycling of electrical and electronic equipment. For electronic waste, an initiative called StEP (Solving the E-waste Problem) was founded in 2004 as an independent, multi-stakeholder platform. The StEP aims at designing strategies that address the management and development of environmentally, economically, and ethically sound e-waste resource recovery, reuse, and prevention (StEP, 2022).

When it comes to municipal waste, the six countries analysed in this chapter, present different recycling rates as shown in Figure 3.

One of the main reasons for the low rate of municipal waste may be the lack of people's literacy concerning waste management in their countries. The influence of individual and socio-demographic characteristics (age, gender, education level, and occupational status), contextual variables (rural or urban, country of origin), and the awareness about environmental importance have an impact on literacy concerning waste management. The challenge here is how to increase people's literacy and communicate better and increase the rate of reuse and recycling for a sustainable and resource-efficient economy.

## **CONCLUSION**

The EU waste policy states to advance waste management further and to follow more circular economy principles – to recycle at least 60% of municipal waste or prepare them for reuse, and to decrease by halve residual municipal waste landfilled or incinerated, by 2030. This illuminates need for waste reduc-



*Figure 3. The recycling rates of municipal waste per EU country (European Environment Agency, 2021)*



tion and waste prevention. Waste prevention can be challenging due to the consumer behaviour, waste management systems and a completely new infrastructure to enable those changes.

This chapter analyses the waste management strategies and approaches in six European countries, namely, Austria, Belgium, Hungary, Latvia, Portugal, and Romania. Research performed reflects the various waste management forms implemented, according to each country environmental, economic, and social perspectives, also showing some very innovative solutions. The authors intend to promote a decrease in consumption and waste generation, and an increase in reuse, separately collected waste and recycling, contributing to circular economic growth and the sustainability of the planet. Knowing what is done in different countries allows us to learn from the best examples and reflect on the various waste management forms implemented according to environmental, economic, and social perspectives. The identified and described examples can be adapted and implemented in countries with less efficient waste management systems.

It can be seen that all countries analysed align or are trying to align themselves with European norms on waste management. The main categories of household waste that are collected by the six countries are glass, paper and cardboard, PMD (a combination of certain plastics, metal packaging and beverage packaging), food and gardening waste, electric and electronic appliances, small and hazardous waste, and undifferentiated waste. However, each country is in different degrees of implementation, due to greater or increased involvement of the population and incentive policies implemented by local authorities and governments, in some cases with the use of support from the European Union to improve waste system collection and recycling.

Analysing the separation for recycling and making an analogy with the number of years that each country has already been concerned about this subject and the policies applied, it is perceived that Austria is the country that has earlier demonstrated concern and applied policies for collection of municipal waste such as the provincial waste laws, whereby the organisation of municipal waste collection is subject to the municipality's costs. Entry into the European community has helped countries to increase the separation % of waste through the implementation of European policies, as happened in Hungary where landfilling was the dominant treatment of municipal solid waste for decades, but in 2004 the national waste management policy priorities became driven by EU waste legislation.

Then, for circular economy growth compliance and implementation of waste management improvements must be promoted, for example, the application of tax revenues, recycling fees for waste produced

by the municipality, private investments, promoting more employability, gross value added related to CE, and patents related to recycling.

The analysis identifies several challenges to bring up in next research and projects. One of the main challenges is future changes in consumer's behaviour from generation of different types of waste to reduction by raising citizen's awareness of the problem in general and in details. These research and developments should primarily include food, medicine, and textiles, due to the large volumes produced and the possible scarcity of these products in the near future.

The future research will contribute to building a sustainable future, including reflection on consumption and waste recycling and reuse processes, and raising citizens' awareness of the problem to develop transformative social action.

## ACKNOWLEDGMENT

The authors want to acknowledge the E<sup>3</sup>UDRES<sup>2</sup> alliance for supporting this research. This research was supported by the ERASMUS+ Programme [101004069].

## REFERENCES

APA. (2022). *Waste*. Relatório do Estado do Ambiente. [https://rea.apambiente.pt/environment\\_area/waste?language=en](https://rea.apambiente.pt/environment_area/waste?language=en)

Austria Glasrecycling. (2022). *Glas entsorgen*. [Dispose of glass]. AGR.. <https://www.agr.at/glasrecycling/glas-entsorgen>

Austrian Government. (2022). *Abfallentsorgung/Müllabfuhr*. [Waste disposal/garbage collection] Österreichs digitales Amt. oesterreich.gv.at [https://www.oesterreich.gv.at/themen/bauen\\_wohnen\\_und\\_umwelt/umzug/5/Seite.180301.html](https://www.oesterreich.gv.at/themen/bauen_wohnen_und_umwelt/umzug/5/Seite.180301.html)

Austro Papier. (2022). *Positionen—Altpapier*. Austropapier. <https://austropapier.at/positionen-altpapier/>

BMK. (2021). *Die Bestandsaufnahme der Abfallwirtschaft in Österreich—Statusbericht 2021*. [Taking Stock of Waste Management in Austria—Status Report 2021] Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie. [https://www.bmk.gv.at/dam/jcr:04ca87f4-fd7f-4f16-81ec-57fca79354a0/BAWP\\_Statusbericht2021.pdf](https://www.bmk.gv.at/dam/jcr:04ca87f4-fd7f-4f16-81ec-57fca79354a0/BAWP_Statusbericht2021.pdf)

BMK. (2022a). *Allgemeines zur Abfallwirtschaft*. [General information on waste management.]. Österreichs digitales Amt. oesterreich.gv.at - [https://www.oesterreich.gv.at/themen/bauen\\_wohnen\\_und\\_umwelt/abfall/1/Seite.3790060.html](https://www.oesterreich.gv.at/themen/bauen_wohnen_und_umwelt/abfall/1/Seite.3790060.html)

BMK. (2022b). *Europäischer Green Deal*. BMK. [https://www.bmk.gv.at/themen/klima\\_umwelt/eu\\_international/euop\\_greendeal.html](https://www.bmk.gv.at/themen/klima_umwelt/eu_international/euop_greendeal.html)

BMK. (2022c). *Kunststoffabfälle in Österreich*. [Plastic waste in Austria.]. BMK. [https://www.bmk.gv.at/themen/klima\\_umwelt/kunststoffe/kunststoffabfaelle.html](https://www.bmk.gv.at/themen/klima_umwelt/kunststoffe/kunststoffabfaelle.html)

## ***The Contribution of Urban Domestic Waste Management to the Circular Economy***

Brouwer, M. T., Thoden van Velzen, E. U., Augustinus, A., Soethoudt, H., De Meester, S., & Ragaert, K. (2018). Predictive model for the Dutch post-consumer plastic packaging recycling system and implications for the circular economy. *Waste Management (New York, N.Y.)*, 71, 62–85. doi:10.1016/j.wasman.2017.10.034 PMID:29107509

Colterm. (2022). *Deseuri—Colterm S.A.* [Waste—Colterm S.A.]. Colterm. <https://www.colterm.ro/anunturi/protectia-mediului/1078-deseuri>

ePortugal. (2022). *Gestão de resíduos—EPortugal.gov.pt.* [Waste management—EPortugal.gov.]. ePortugal. <https://eportugal.gov.pt/cidadãos-europeus-viajar-viver-e-fazer-negocios-em-portugal/bens-e-mercadorias-em-portugal/gestao-de-residuos>

European Commission. (2022). *Waste Framework Directive*. EC. [https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive\\_en](https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en)

European Commission. (2011). *Country factsheet Romania* [File]. EC. <https://www.eea.europa.eu/themes/waste/waste-prevention/countries/romania-waste-prevention-country-profile-2021/view>

European Commission. (2019). *The EU Environmental Implementation Review 2019 Country Report—Hungary*. EC. [https://ec.europa.eu/environment/eir/country-reports/index\\_en.htm](https://ec.europa.eu/environment/eir/country-reports/index_en.htm)

European Commission. (2020). *A new Circular Economy Action Plan*. EUR-Lex. <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020DC0098&from=EN>

European Environment Agency. (2013). *Waste—National Responses (Hungary)* [SOER 2010 Common environmental theme (Deprecated)]. EEA. <https://www.eea.europa.eu/soer/2010/countries/hu/waste-national-responses-hungary>

European Environment Agency. (2021a). *Waste recycling in Europe*. EEA. <https://www.eea.europa.eu/ims/waste-recycling-in-europe>

European Environment Agency. (2021b). *Municipal waste management across European countries*. European Environment Agency. <https://www.eea.europa.eu/publications/municipal-waste-management-across-european-countries>

European Environment Agency. (2021c). *Waste: A problem or a resource?* European Environment Agency. <https://www.eea.europa.eu/publications/signals-2014/articles/waste-a-problem-or-a-resource>

European Environment Agency. (2022a). *Reaching 2030's residual municipal waste target—Why recycling is not enough—European Environment Agency* [Briefing]. EEA. <https://www.eea.europa.eu/publications/reaching-2030s-residual-municipal-waste/reaching-2030s-residual-municipal-waste/>

European Environment Agency. (2022b). *Europe is not on track to halve non-recycled municipal waste by 2030—European Environment Agency* [News]. EEA Europa. <https://www.eea.europa.eu/highlights/europe-is-not-on-track>

European Parliament & Council of the European Union. (2008). *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance)*. EUR-Lex. <https://eur-lex.europa.eu/eli/dir/2008/98/oj/eng>

European Parliament, & Council of the European Union. (2018). *Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste*. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32018L0851>

Eurostat. (2022). *Statistics*. Eurostat. [https://ec.europa.eu/eurostat/databrowser/view/sdg\\_11\\_60/default/table?lang=en](https://ec.europa.eu/eurostat/databrowser/view/sdg_11_60/default/table?lang=en)

Fost Plus. (2022a). *Plastic verpakkingen*. Fost Plus. <https://www.fostplus.be/nl/recycleren/plastic-verpakkingen>

Fost Plus. (2022c). *Metalen verpakkingen*. [Metal packaging.] Fost Plus. <https://www.fostplus.be/nl/recycleren/metalen-verpakkingen>

Fost Plus. (2022d). *Papier—Karton*. Fost Plus. <https://www.fostplus.be/nl/recycleren/papier-karton>

Friedrich Ebert Stiftung. (2022). *Monitor Social*. Monitor Social. <https://monitorsocial.ro/>

Glas. (2022b). Fost Plus. <https://www.fostplus.be/nl/recycleren/glas>

Herczeg, M. (2013). *Municipal waste management in Hungary*. European Environment Agency. <https://www.eea.europa.eu/publications/managing-municipal-solid-waste/hungary-municipal-waste-management/view>

Hungarian Central Statistical Office. (2022). *Központi Statisztikai Hivatal 2020*. [Central Statistical Office 2020.]. KSH. <https://www.ksh.hu/?lang=en>

Janetasari, S. A., & Bokányi, L. (2022). Challenges on creation of sustainable municipal waste and wastewater management in Indonesia using experience of Hungary. *IOP Conference Series: Earth and Environmental Science*, 1017(1), 012028. doi:10.1088/1755-1315/1017/1/012028

Kaza, S., Yao, L. C., Bhada-Tata, P., & Van Woerden, F. (2018). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. World Bank. doi:10.1596/978-1-4648-1329-0

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127, 221–232. <https://doi.org/10.1016/j.resconrec.2017.09.005>

Kubule, A., Klavenieks, K., Vesere, R., & Blumberga, D. (2019). Towards Efficient Waste Management in Latvia: An Empirical Assessment of Waste Composition. *Environmental and Climate Technologies*, 23(2), 114–130. doi:10.2478/rtuct-2019-0059

## ***The Contribution of Urban Domestic Waste Management to the Circular Economy***

Land Oberösterreich. (2022). *Land Oberösterreich—Entwicklung der Abfallmengen 1990 bis 2020*. [Province of Upper Austria—Development of waste volumes 1990 to 2020.] Land Oberösterreich. <https://www.land-oberoesterreich.gv.at>

OECD. (2018). *OECD Environmental Performance Reviews: Hungary 2018*. Organisation for Economic Co-operation and Development. [https://www.oecd-ilibrary.org/environment/hungary-2018\\_9789264298613-en](https://www.oecd-ilibrary.org/environment/hungary-2018_9789264298613-en)

OVAM. (2022a). *Jaarverslag 2021*. OVAM. [https://jaarverslag.ovam.be/sites/default/files/2022-05/OVAM\\_jaarverslag\\_2021-JB.pdf](https://jaarverslag.ovam.be/sites/default/files/2022-05/OVAM_jaarverslag_2021-JB.pdf)

OVAM. (2022b). Preventie- en sorteergedrag van de Vlaamse Bevolking. Samenvatting.... [Prevention and sorting behaviour of the Flemish Population. Summary]. OVAM. [www.vlaanderen.be. https://www.vlaanderen.be/publicaties/preventie-en-sorteergedrag-van-de-vlaamse-bevolking-samenvatting-kwantitatieve-en-kwalitatieve-bevraging-2021](https://www.vlaanderen.be/publicaties/preventie-en-sorteergedrag-van-de-vlaamse-bevolking-samenvatting-kwantitatieve-en-kwalitatieve-bevraging-2021)

Primăria Municipiului Timișoara. (2022). *Acasă—Primăria Municipiului Timișoara*. [Home—Timișoara City Hall.] PMT. <https://www.primariatm.ro/>

Recytyre. (2022). *Waar naartoe?* [Where to go?] Recytyre. <https://www.recytyre.be/nl/waar-naartoe>

RETIM. (2022). *Acasă—RETIM SA*. RETIM. <https://retim.ro/>

Riedmann, C., Schwarzenhofe, H., Huemer, C., & Reidelshöfer, K. (2021). *Nachhaltig und sicher: Glasrecycling in Österreich*. [Sustainable and safe: glass recycling in Austria.]. OIT. <https://www.oesterreich-isst-informiert.at/verantwortung/nachhaltig-und-sicher-glasrecycling-in-oesterreich/>

Stadt Wien. (2018). *Repair Network Vienna*. Reparatur Netzwerk. <https://www.reparaturnetzwerk.at/repair-network-vienna>

StEP. (2022). *Organisation*. StEP Initiative. <https://www.step-initiative.org/organisation-rev.html>

The Ellen MacArthur Foundation. (2022). *What is a circular economy?* Ellen MacArthur Foundation. <https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>

Transclean. (2022). *Transclean*. <http://transclean.ro/>

VARAM. (2021). *Minister Plešs: State waste management plan will ensure the development of the sector* [Pinister Pless: State waste management plan will ensure the development of the sector.]. Vides aizsardzības un reģionālās attīstības ministrija [Ministry of Environmental Protection and Regional Development]. <https://www.varam.gov.lv/en/article/minister-pless-state-waste-management-plan-will-ensure-development-sector>

Vlaanderen. (2022). *Afvalinzameling en sorteren* [Waste collection and sorting]. Vlaanderen. [www.vlaanderen.be. https://www.vlaanderen.be/afvalinzameling-en-sorteren](https://www.vlaanderen.be/afvalinzameling-en-sorteren)

VOEB. (2022). *Erreichung der EU-Klimaziele: Recyceln statt Deponieren*. [Achieving EU climate targets: recycling instead of landfilling.] VOEB. <https://www.voeb.at/service/voeb-blog/detail/show-article/erreichung-der-eu-klimaziele-recyceln-statt-deponieren/>

S. D. G. Watch Europe. (2022). *Wardrobe Change*. SDG Watch Europe. <https://www.sdgwatcheurope.org/wardrobe-change/>

Wilson, D. C., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. *Habitat International*, 30(4), 797–808. <https://doi.org/10.1016/j.habitatint.2005.09.005>

WKO. (2022a). *Abfallwirtschaft im Betrieb*. [Waste management in the company.] WKO. [https://www.wko.at/service/umwelt-energie/Abfallwirtschaft\\_im\\_Betrieb.html](https://www.wko.at/service/umwelt-energie/Abfallwirtschaft_im_Betrieb.html)

WKO. (2022b). *Information zur Verpackungsverordnung*. [Information on the Packaging Ordinance.] WKO. <https://www.wko.at/service/umwelt-energie/information-verpackungsverordnung.html>

## KEY TERMS AND DEFINITIONS

**Composting:** Process for transforming organic waste into fertilizers and/or energy. The compound that results from this process is a highly nutritious material and can be used in gardens, vegetable gardens and orchards.

**Municipal Waste:** mixed waste and separately collected waste from households, including paper and cardboard, glass, metals, plastics, biowaste, wood, textiles, packaging, waste electrical and electronic equipment, waste batteries and accumulators, and bulky waste, including mattresses and furniture.

**Recover:** One of the points of the 7R policy proposed by the circular economy, where food scraps and other organic materials can be reinstated into nature, through organic composting; this is the best process for transforming organic waste into fertilizers.

**Recover:** One of the points of the 7R policy proposed by the circular economy, where food scraps and other organic materials can be reinstated into nature, through organic composting; this is the best process for transforming organic waste into fertilizers.

**Recycle:** One of the points of the 7R policy proposed by the circular economy, where each material must be conditioned on a specific collector to be recycled, according to its nature; people can separate materials anywhere and take them directly to recycling centres or look for collecting services that pass-through neighbourhoods.

**Reduce:** One of the points of the 7R policy proposed by the circular economy, that suggests people to consume less amounts of goods, by using products with greater durability and packaging in the right measure.

**Refuse:** One of the points of the 7R policy proposed by the circular economy, that suggests people not to opt for products from companies that do not respect nature or harm the environment, giving preference to those who benefit society and produce with low impact on the environment.

**Regift:** One of the points of the 7R policy proposed by the circular economy, which can also be named reusing, that proposes to people to give someone a product that is no longer useful for them; in alternative, that given object can gain totally different functions from the original one and remain very useful.

### ***The Contribution of Urban Domestic Waste Management to the Circular Economy***

**Repair:** One of the points of the 7R policy proposed by the circular economy, that suggests people to fix products in poor condition, instead of just buying a new one.

**Rethink:** One of the points of the 7R policy proposed by the circular economy, that refers to the need of consumers to think about their habits, choosing to buy only what they really need.

**Separately Collected Waste:** Waste that is collected for a specific purpose separately from mixed waste, sorting it according to its nature (plastics, paper and cardboard, glass, etc).