Recommendations for Improved Municipal Waste Management in Portugal

Part I: Baseline study for preparation for reuse and increased recycling of textile waste, bulky waste, hazardous household waste and C&D waste

THREE ROADS TO CIRCULAR ECONOMY: REDUCE, REUSE, RECYCLE (3R2CE)

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Executive summary

Portugal has requested support from the Structural Reform Support Service (SRSS) of the European Commission under Regulation (EU) 2017/825 on the establishment of the Structural Reform Support Programme ("SRSP Regulation"). The Commission has analysed the request in accordance with the criteria and principles referred to in Article 5 of the SRSP Regulation, following which the Commission has agreed to provide technical support to Portugal in the area of institutional, administrative and growth-sustaining structural reforms, with the objective to:

- to support the national authorities in enhancing their capacity to formulate, develop and implement reform policies and strategies and in pursuing an integrated approach ensuring consistency between goals and means across sectors;
- to support the efforts of national authorities to define and implement appropriate processes and methodologies by taking into account good practices and lessons learned by other countries in addressing similar situations.

The project 'Reduce – Reuse – Recycle: Three Roads To a Circular Economy – 3R2CE' has had the aim of developing and presenting strategies for three key areas of the circular economy. For each of the three key areas, a report has been developed. The report 'Baseline study for preparation for reuse and increased recycling of textile waste, bulky waste, hazardous household waste and C&D waste' are the second of the three roads to a circular economy, focusing on four municipal solid waste streams to increase circularity.

This report includes an assessment of the State of Play of the collection and treatment of four municipal solid waste streams in Portugal; an assessment of best practices for increased preparation for reuse and recycling of the four waste streams among EU Member States; and an assessment of stakeholder identified barriers to increased preparation for reuse and recycling in Portugal.

The report contributes to an increased understanding of relevant areas of intervention in Portugal, focusing on improvement potential for each of the four municipal solid waste streams in a regulatory, economic, cultural and technical context. EPR schemes were one of the most highlighted solutions to increased preparation for reuse and recycling, indicating that the Portuguese industries are welcoming to the solution.

Financing for this project has been made available as part of the Work Programme for the year 2020 for the Structural Reform Support Programme under Regulation (EU) 2017/825 as amended by Regulation (EU) 2018/1671.

Technical terms

Recycling	Any recovery operation in which waste materials are reprocessed into products, materials, or substances, fit new purposes or products[1]
Preparing for reuse	Checking, cleaning, or repair operations, by which products or their respective parts are prepared to be reused, without requiring any further pre-processing[2]
PRO	Non-profit producer responsibility organisation
Civic Amenity Centres	Civic amenity sites are waste sorting facilities run by the local authorities. Citizens can deliver their household bulky waste and consult employees that are on the site to assist and assure that citizens are sorting the waste into the correct recycling fractions[3]. Civic amenity sites can either be completely open to the public or open to the citizens of the municipality only. When limited to the citizens of the municipality, individual user cards can be issued, or ID control can be performed at the civic amenity, or the control can be connected to the registration number of the car. Monitoring the users of the civic amenity centres is useful for making statistics, but also has a security purpose, as the sites can be targets for thefts and break-ins[4].
MSW	Abbreviation for Municipal Solid Waste

[1] EEA (2022a): Reaching 2030's residual municipal waste target – why recycling is not enough.
[2] EEA (2022a): Reaching 2030's residual municipal waste target – why recycling is not enough.
[3] URBANREC (2019): New approaches for the valorisation of Urban waste into high added value RECycled products.
[4] Waste Sweden (2021a): Återvinningscentraler.

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1 Introduction

The Early Warning Report for Portugal on the implementation of EU waste legislation identified that "*In 2016, Portugal's municipal waste recycling rate (including composting) reported to Eurostat was 31 %, while its landfilling rate was 45 %. Based on an analysis of existing and firmly planned policies in waste management, Portugal is considered at risk of missing the 2020 target of 50 % preparation for reuse/recycling of municipal waste.*" It is also in danger of missing the 2025 preparation for reuse and recycling target of 55%.

Moreover, new requirements for EU Member States in the revised Waste Framework Directive for the separate mandatory collection of textiles and hazardous waste produced by households by 2025 set new challenges: how can Portugal reduce the generation of this waste? How should it be collected? What treatment solutions are in place for these waste fractions, and which collection and treatment solutions are economically and environmentally preferred?

To support Portugal in the attainment of EU waste targets and support the further development of waste management in Portugal, this project addresses four types of waste from households:

- **Textile waste**
  There are already successful national experiences in collecting post-consumer textile waste, either through municipalities or municipal waste management systems in partnership with charities or through high-street clothing stores that encourage the delivery of used clothing for reuse or recycling. However, there is currently no data on the collection quantity or the fate of the collected textiles. According to 2018 data, this stream represents 7% of total MSW production.
- **Household Hazardous waste** (for example, paints, varnishes, solvents or cleaning products)
  These should also be collected separately to avoid contamination of residual and recyclable wastes and ensure the environmentally sound management of that hazardous waste. Specific collection obligations exist for waste electrical and electronic equipment, waste batteries and accumulators, and medicines. About 15% of hazardous waste produced in Portugal is already separately collected. According to 2018 data, this stream represents 0,5% of total MSW production.
- **Bulky waste**
  Municipalities collect a significant share of waste furniture and mattresses separately from other mixed household waste streams. Still, it is not subject to differentiated treatment, so a substantial amount of materials is lost. According to 2018 data, this stream represents 1% of total MSW production.
- **Construction and demolition waste from households**
  Although this is not considered part of MSW, it often reaches the MSW management infrastructure, where any potential value is lost. It is not currently possible to determine the actual extent of the problem since C&D waste appearing in MSW is not identifiable in APA's statistics. Recycled C&D waste could be used to offset the extraction of raw minerals and thus reduce the associated environmental impacts.

In addition to establishing effective separate collection systems for textiles and bulky waste, it will be necessary to make consumers aware of more sustainable consumption, potential reuse and appropriate disposal in order both to help reduce the generation of these types of wastes and to ensure that the generated waste, to the greatest extent possible, is prepared for reuse and recycled to meet the 2035 landfill cap of maximum 10% of total urban waste generated.

The achievement of ambitious recycling and landfill diversion targets depends on the success of the general strategic approach and the governance model for each type of waste covered. National measures such as

separate collection or EPR schemes for specific waste streams can contribute to attaining municipal waste targets.

Material flows, good practices, barriers and options will be analysed for each of the four waste types. Following this, an in-depth co-creation strategy process will be conducted. The process suggested follows the CSP17 design thinking framework, supporting the Portuguese government and participating solution providers to co-create & pitch implementable solutions to the challenge(s). Recommendations and draft strategies will be prepared based on the findings and results.

The state of play report is developed using data provided by APA, statistics, reports, research, and oral and written input from a long list of stakeholder interviews and workshops.

The Portuguese Environment Agency (APA) publish annual data on the national generation of municipal solid waste (MSW) and the physical characterisation of the MSW according to the technical specifications of *Portaria no. 851/2009, of August 7*. This includes the categories of bulky waste, household hazardous waste and textile waste.

Decree-Law 102-D/2020 of December 10 introduces minimum rates for preparing to reuse textiles, electric and electronic equipment, furniture, and other waste streams for 2025, 2030 and 2035. Additionally, it establishes that by January 1st of 2025, regional waste management companies must provide a separate collection system for textile waste, bulky waste (including mattresses and furniture), hazardous waste, used cooking oil, and construction and demolition waste resulting from minor repairs in households.

The starting point of the State of Play Analysis was a review of the publicly available data for MSW production and management reported by the 23 regional waste management companies that cover all of Mainland Portugal. This analysis provided a better understanding of some waste streams.

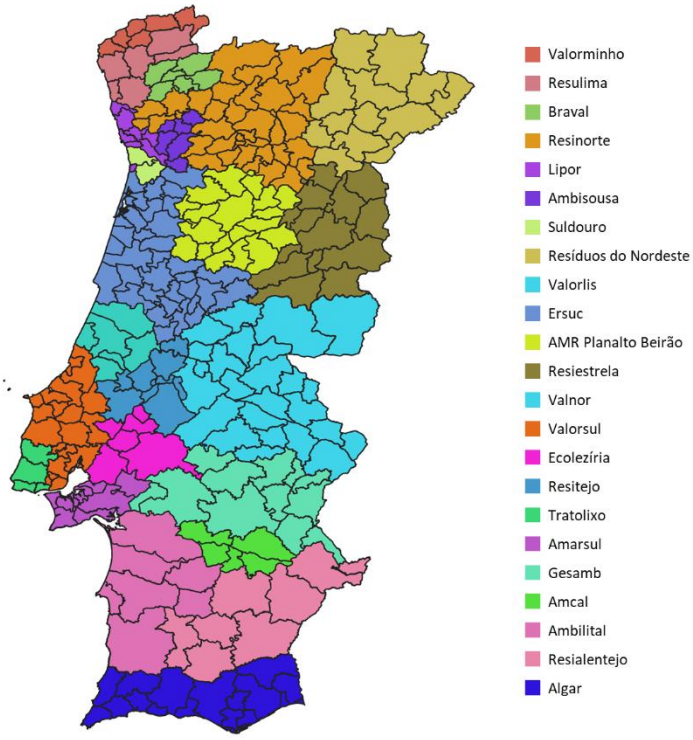


Figure 1. Map representing the distribution of MSW regional waste management companies in Mainland Portugal

To complement this analysis, a consultation process was carried out with relevant waste management companies to understand better the main barriers in the recovery and recycling of these waste streams and obtain quantitative data. The consulted entities were ESGRA, including Lipor, Cascais Ambiente, Amcal, EGF

and Porto Ambiente. In addition, professional and charitable collectors of used household textiles were consulted for the textiles stream.

Additionally, a benchmark analysis focusing on managing these waste streams in other European countries was carried out to provide a comparative yardstick for the estimated data or, when unavailable, to provide some additional input to the Portuguese study. In particular, the French producer responsibility organisations Eco-DDS (for hazardous chemicals) and Eco-mobilier (for furniture) were analysed to provide background information regarding waste generation, which could be applied to the Portuguese reality.

Statistical information of interest concerns domestic production, import and export data for the products that eventually become waste, waste statistics, results of picking studies of municipal waste streams, etc. Where possible, a mass-balance methodology has been applied to estimate generation.

Interviews will be carried out with representatives from municipalities, and the reuse and recycling value chain will be investigated for specific streams, e.g. charities engaging in the collection and sale of used textiles.

2 Waste amounts and treatment routes

2.1 Textiles

This waste/material stream includes all used textiles that typically find their way into municipal waste streams from households and small businesses, such as clothing and home textiles. Carpets and textile upholstery on furniture typically follow other pathways and are considered elsewhere (under Bulky Waste).

Portugal has a long history of collecting used clothes and other textiles - outside of municipal waste systems - for resale and reuses domestically or elsewhere. The definition when the used textile collection is defined as waste collection and the used textiles defined as waste differs from Member State to Member State (despite guidance in the Waste Framework Directive). This project includes textiles that third parties collect for reuse, recycling or other treatments (regardless of whether this collection is defined as a waste collection) and the textiles collected in municipal systems as part of mixed municipal waste.

2.1.1 Collection

Textiles are collected by a variety of both formal and informal actors in Portugal as well as through the mixed municipal waste stream.

Significant quantities of used textiles are collected via containers made public by organisations such as Ultriplo, Wippytex, Sarah Trading and Humana Portugal, operating under protocols with the municipalities and licensed as waste management operators. Churches and other local non-profit organisations facilitate further informal collection schemes, and some garment stores collect a minor amount through in-store collection [5].

Post-consumer textile waste collected by regional waste companies is primarily via mixed MSW collection systems. Some municipalities provide specific containers for separate clothes and other textile waste collection in civic amenity centres and other waste collection areas. The separate collection mainly covers urban areas, while collection in rural areas is minimal.

The national legislation has no specific definition for the textile waste stream. The scope of MSW management is determined by the material composition of waste classified in Chapter 20 of the European List of

[5] *According to the SILOGR platform (an information system for the licensing of waste management operations provided by APA) there are (2021-figures) 206 companies licensed to handle and treat textile waste (EWC 20 01 10 and 20 01 11), with focus on industrial waste.*

Waste (municipal wastes (household waste, and similar commercial, industrial and institutional wastes) including separately collected fractions). Textile waste falls under the following EWC codes:

- 20 01 10 – Clothes;
- 20 01 11 – Textiles.

There is no official data in Portugal for annual quantities of used textiles or textile waste collected via municipalities, waste collectors and other third-party collectors.

Annex A presents a calculation of the quantity of generated waste textiles based on a mass balance approach, estimating pre-COVID textile consumption in Portugal at over 120,000 tonnes per year, which can be seen as a reasonable ballpark figure for the volume of clothing and home textiles that is eventually donated and/or discarded in Portugal and will need to be treated circularly.

There are differing data and views on the amount of textile waste collected:

- WippyTex estimates[6] that all collectors' total used textile collection lies at approximately 15,000 tonnes, or 1.5 kg/capita (compared to 2.5 kg/capita of collection in Spain), 12,5 % of the average annual quantity of new textiles placed on the market. This is a low collection rate compared to countries such as Denmark and the Netherlands, with 43% and 45% of textiles placed on the market that are eventually separately collected. The remaining ca. 100,000 tonnes of anticipated used textiles are assumed to enter municipal mixed waste.
- According to waste composition data provided by APA, I.P. (2020)[7], approximately 176,000 tonnes of textile waste (including clothing and other textiles) were discarded in mixed municipal waste in Portugal in 2019. This estimate is based on picking study-based characterisation of MSW according to the methodology described in *Portaria* no. 851/2009, of August 7[8]. There is no data regarding the material composition (e.g., by type of fibre) of the textiles disposed of in the mixed waste. The 176,000 tonnes are far more than the calculated 120,000 tons of new clothing and home textiles placed on the market annually (based on the mass balance calculations presented in annexe A).

There are several possible explanations for this difference.

- Firstly, the definition of 'textiles' when carrying out waste sampling is broader than just clothing and home textiles used in the calculations. It may include carpets, duvets, and pillows.
- Secondly, textiles waste in MSW may also include waste from textile production, e.g. offcuts of material, yarns etc. In most EU Member States, such waste would be restricted to industrial waste streams and would not find its way into MSW. However, Portugal has a significant cottage industry of textiles, in which case such waste may be disposed of in the mixed household waste.
- Thirdly, sampling of MSW is carried out at specific periods of the year, which might coincide with periods when households go through their wardrobes and throw out unwished clothing, e.g. spring and autumn.
- Fourthly, and perhaps most importantly, waste-picking studies estimate percentages of waste fractions in MSW according to wet weight and not dry weight (see paragraph 4.5.1 in Portaria 851/2009). Textiles are highly absorbent, and therefore using wet weights will significantly overestimate the quantities of textiles ending in mixed waste.

[6] Luis Fernandes, personal communication, 4th August 2021

[7] APA (2020) Relatório Anual Resíduos Urbanos 2019.

[8] Diário da República (2009): Portaria n.º 851/2009, de 7 de agosto.

2.1.2 The Regional perspective

No publicly available data regarding textile waste generation is available at a regional level, as not all regional waste companies systematically report this data. The main conclusions of the analysis of data provided by regional companies are presented in Table 1. Moreover, it included estimated data for each region and the quantities declared by regional companies to APA in MRRU[9]

Table 1.

Table 1. Textile waste is collected annually by regional companies in Portugal

TEXTILES	
North 	Lipor has reported that 4.53% of the mixed MSW produced are textile waste[10]. According to APA, textile waste generated in North region was 78 000 t in 2019 (23 kg/inhabitant) and 70 437 t in 2020 (20 kg/inhabitant). It is important to note that declared quantities by regional companies in MRRU represent a minor percentage from the total amount (around 0.02%). The remaining amount of textiles waste generated is estimated, based on mixed waste composition data.
Central 	Regional companies report a textile waste production between 1.4% to 7% of MSW production[11,12,13]. According to APA, textile waste generation in this region was 31 189 t in 2019 (18 kg/inhabitant) and 38 485 t (22 kg/inhabitant) in 2020. Textile waste collected in special waste collection routes or delivered in infrastructures represented around 6% of total amount in 2019 and 11% of total regional textile waste amounts in 2020, values that are considerably higher than in other regions. The remaining amount is estimated, based on mixed waste composition data.
Lisbon and Vale do Tejo 	Regional companies in the region do not provide information regarding textile waste production. However, it is estimated 38 971 t (11 kg/inhabitant) of textiles waste generated in 2019 and 54 966 t (15 kg/inhabitant) in 2020, according to information provided by APA. Around 0.3% of the total amount was declared by regional companies in MRRU. The remaining amount is estimated, based on mixed waste composition data.
Alentejo 	Regional company Valnor[14] carried out a physical characterization of MSW in 2019. According to the report, 3.82% of the mixed MSW produced is textile waste (textile waste packaging accounts for 0.18% of the MSW produced). According to APA, textile waste generated in this region was 11 749 t (19 kg/inhabitant) in 2019 and 14 179 t (24 kg/inhabitant). Textile waste collected in special waste collection routes or delivered in infrastructures represented around 0.09% of total amount in 2019 and 0.04% of total amount in 2020. The remaining amount is estimated, based on mixed waste composition data.
Algarve 	Algar does not provide information regarding textile waste production. However, data provided by APA indicates that textile waste generation in this region was 11 199 t (26 kg/inhabitant) in 2019 and 10 167 t (23 kg/inhabitant). Only 0.1% of the total amount was declared by Algar and the remaining amount is estimated, based on mixed waste composition data.

2.1.3 Treatments routes

Primary information was gathered for this report from two of the most prominent collectors of used textiles in Portugal: WippyTex and Humana. WippyTex is a commercial collector and sorter of used textiles operating primarily in (northern) Portugal and Spain. Humana is a collector that uses the profit from collecting and

[9] *It includes the following operations: special waste collection routes, civic amenity centres, direct delivery, kerbside collection, door-to-door collection, and results of waste management operations. It includes the following EWC: 19 12 08 textiles; 20 01 10 clothes and 20 01 11 textiles.*

[10] Lipor (2021) Observatório de Resíduos.

[11] AMR Planalto Beirão (2020) Relatório de Gestão e Conta Gerência 2019.

[12] Ersuc (2021) Caracterização Física de Resíduos Urbanos do Sistema Multimunicipal do Litoral Centro – 2020.

[13] Resiestrela (2020) Caracterização de Resíduos 2019.

[14] Valnor (2019) Caracterização Física de Resíduos Urbanos do Sistema Multimunicipal do Norte Alentejano.

selling used textiles (at least partially) to fund social projects in Africa. Data on collection and treatment by the two organisations are presented in Table 2 below.

[15]	WippyTex	Humana
Quantity of used textiles collected	2000 tonnes in 2019; 1800 tonnes in 2020	3160 tonnes in 2019; 2890 tonnes in 2020
Method for estimates of quantities	Weighed centrally	Weighed
Includes shoes and bags?	Yes, estimated at 10% shoes, 3% bags by weight	Yes, estimated at 5%
Collecting primarily from	100% bring-banks on street (where other waste streams collected) or civic amenity centres. Primarily from households.	97% from bring banks (primarily households); 2.5% in own shops; 0.5% unsold collections from retailers
Numbers of shops and bring-banks	600 bring-banks	14 shops and 837 bring-banks/containers (121 on private sites, 716 on public sites).
Processing of collected textiles	All textiles are sold as 'original' to Whippytex's parent company in Spain for detailed sorting.	All collected textiles in Portugal are sent as 'original' for detailed sorting in Humana Spain's sorting centre or other Humana sorting centres located outside Portugal
Treatment of sorted textiles	60% exported for reuse outside EU (40% north Africa and South America, 20% sub-Saharan Africa); 30% recycled (industrial wipes 15%; 4-5% wool and acrylic for unravelling and reweaving in India; 10% padding for upholstery, acoustic panels etc.); 10% landfill in Spain.	54% reuse (14% reuse in Humana's own shops in Spain, Portugal and France; 40% reuse in Africa); 39% for recycling (downcycling) in Asia; (1.5% of this is non-textile waste recycling); 7% landfill in Spain.

Table 2 - Collection activities of two textile collection organisations

Both actors collect some thousand tonnes of used textiles each year, primarily from households via unmanned bring-banks, and both experienced approx. 10% drop in the collection between 2019 and 2020. This drop was not due to decreased collection efforts but rather (as deduced by both collectors) a result of households hanging on longer to their existing wardrobes due to reduced consumer optimism. It closed retail shops during the pandemic lockdowns. Both organisations export 100% of the collected textiles to sorting facilities in Spain that their respective partner organisations own.

Between 54% and 60% of the collected textiles are reused on European or global markets, primarily in Africa. 30% to 39% is recycled in various ways. Only 7% to 10% cannot be reused or recycled and is landfilled close to the sorting facilities in Spain. Thus, the circular economy functions relatively well for these *separately collected textiles.*

A third large collection organisation, Ultriplo, collected more than 6 000 tonnes of textile waste in 2018[16], including primarily clothes, shoes, toys and books. The company sends reusable collected goods to charity and exports the remaining materials to support operating costs. The materials that cannot be reused are sent to recycling (approximately 35%) and the landfill (circa 5%).

Other formal and informal streams for used textile collection, including charitable organisations, are not sufficiently characterised to estimate their magnitude.

Other relevant initiatives

Concerning waste prevention, it is vital to highlight the existence of a second-hand textile market on several online platforms, such as OLX, mycloma, RE.para, micolet, GIRO - clothes into causes, Decathlon second life

[15] Primary data sources: Personal communication with Luis Fernandes (Wippytex) and Pedro Andres (Texlimca) 4th August 2021; personal communication with Mariana Franzon and Rafael Mas (both Humana) 19th and 20th August 2021

[16] Capucho (2019): Portugueses deitam for a 200 mil toneladas de roupa por ano.

or 4useagain, where people can sell or buy used clothes. However, it is not possible to quantify the dimension of this market.

Several upcycling projects and initiatives have been implemented in the country to address the recovery and recycling of textile waste, such as:

Vintage for a Cause is a circular economy brand with social commitment, focused on reusing textile waste through upcycling while empowering unemployed women over 50.

T-Circular is a communication and awareness initiative developed under the scope of Lipor's Prevention Plan. It aims to give citizens the tools to make more conscious choices and adopt sustainable habits, mainly focused on textiles and conscious fashion.

2.2 Bulky waste

According to Decree-Law 102-D/2020 of December 10, bulky waste from households consists of used bulky objects that, due to their volume, weight, shape, or size, cannot be collected by usual methods. This waste stream includes furniture and mattresses but also electrical equipment. Bulky waste is a significantly heterogeneous waste stream consisting of large components that are often very difficult to handle, thus mostly incinerated or landfilled. The EEA define bulky waste as large items of waste material, such as appliances, furniture, large auto parts, trees, branches, stumps etc.[17]

2.2.1 Collection Methods

In Portugal, most municipalities collect bulky waste from households through an "on request" free service that covers all territory (urban and rural areas). In practice, residents request by phone call or a mobile app (when it exists) and arrange the location, date, and hour for collection with the municipality. Sometimes, the municipality collects the bulky waste directly from the household. In other cases, it is settled in a specific location for placing the bulky objects to be collected (primarily next to the closest drop-off container). Where this type of service is widely used to collect other waste streams (e.g. garden waste and WEEE), sometimes residents mix all fractions before collection. Hence, the municipality assures a first separation right on the collection vehicle (whenever possible). When arriving at the regional company, the bulky objects are sorted out again by material and potential existing recyclable components.

It is also widespread that municipalities offer an additional option for citizens who can deliver their bulky waste directly to the civic amenity sites. Although there isn't much information available about quantities of bulky waste collected through these two methods (on-demand and CA sites), the on-demand solution typically results in higher quantities because it is a more comfortable and immediate service to people. However, this does not necessarily mean lower illegal waste dumping rates. It is not uncommon to find a mix of bulky waste materials abandoned in public and private spaces or next to containers. Despite being an illegal procedure in most municipalities, this situation occurs both in urban and rural areas and is more likely to occur in quieter and less populated areas. Municipalities like Cascais or Oporto[18] consider that the lack of awareness of citizens is the main barrier to the increase of reuse and recovery of bulky waste, as existing collection procedures are mainly unknown to most citizens.

2.2.2 Generated Quantities

According to the data provided by APA, I.P. (2021)[19], approximately 220 000 tonnes of bulky waste was produced in Portugal in 2019, representing 4.38% of the total MSW production in the country. This estimate is

[17] EEA (2022b): Bulky waste.

[18] Primary data sources: Consultation meeting with Luís Capão and Sandra Rebelo – Cascais Ambiente (August 25, 2021) | Consultation meeting with Luís Assunção, Maria Guedes and Sofia Gomes – Porto Ambiente (September 7, 2021)

[19] APA (2020): Relatório Anual Resíduos Urbanos 2019.

based on the physical characterisation of MSW according to the analysis category of Bulky Waste defined in *Portaria* no. 851/2009, of August 7. Looking at the specific case of the municipality of Cascais, Cascais Ambiente separately collected around 23 kg/inhabitant of bulky waste[20] in 2019.

Regional companies commonly report the collection of bulky waste, as presented in Table 5, which includes data provided by APA on estimated quantities of bulky waste[21]Table 3.

Table 3. Bulky waste collected annually by regional companies in Portugal

BULKY WASTE	
North 	Regional companies reported a bulky waste production which varies between 0.2% to 5% of MSW production (it includes other waste streams other than mattresses and furniture)[22,23,24,25]. According to APA, bulky waste generated in this region was 37 931 t (11 kg/inhabitant) in 2019 and 34 684 t (10 kg/inhabitant) in 2020.
Central 	AMR Planalto Beirão reported a production of woods and mattresses received in their recycling yards of 1,314 tonnes, equivalent to almost 1% of MSW production[26]. According to APA, bulky waste generated in this region was 27 156 t (16 kg/inhabitant) in 2019 and 33 723 t (20 kg/inhabitant) in 2020.
Lisbon and Vale do Tejo 	Regional companies reported a bulky waste production which varies between 2% to approximately 7% of MSW production (it includes other waste streams other than mattresses and furniture)[27,28,29]. According to APA, bulky waste generated in this region was 212 578 t (59 kg/inhabitant) in 2019 and 265 215 t (74 kg/inhabitant), according to APA.
Alentejo 	Regional companies do not provide information regarding bulky waste production. According to APA bulky waste generated in Alentejo was 28 669 t (47 kg/inhabitant) in 2019 and 33 790 t (56 kg/inhabitant) in 2020.
Algarve 	Algar does not provide information regarding bulky waste production. According to APA, bulky waste generated in this region was 75 722 t in 2019 and 48 357 t in 2020. Considering these quantities and the population in the region, Algarve presents the higher value of bulky waste generated per inhabitant: 173 kg/inhabitant in 2019 and 110 kg/inhabitant in 2020.

2.2.3 Treatment routes

There is no available data regarding the treatment routes for this waste stream at the national level. However, it is known that a common practice for regional companies is to use mattresses in landfills to protect the lining from the impact of waste during operations as an alternative to used tyres. In contrast, some mattresses end in incineration with energy recovery.

[20] Primary data source: Cascias Ambiente, report that 4,968 t was collected.

[21] *This includes the following operations: special waste collection routes, civic amenity centers, direct delivery, curbside collection, door-to-door collection, and results of waste management operations. It includes the EWC 20 03 07 bulky waste.*

[22] Ambisousa (2020): Relatório Anual da Reciclagem 2019.

[23] Lipor (2021): Observatório de Resíduos.

[24] Resinorte (2020): Relatório e Contas 2019.

[25] Valorminho (2020): Resíduos Urbanos Rececionados 2019.

[26] AMR Planalto Beirão (2020): Relatório de Gestão e Conta Gerência 2019.

[27] Ecolezíria (2020): Relatório e Contas – Ano de 2019.

[28] Resitejo (2021): Dados Operacionais/Evolução ao Longo dos Anos.

[29] Tratolixo (2020): RC - Relatório & Contas 2019.

Regional company Resíduos do Nordeste started a project in 2013 where they dismantled 38 tonnes of mattresses from recycling yards[30]. The metal from the springs and structure of the mattresses were sent for recycling, whereas the textile was landfilled. However, there is no information regarding the continuation of this project.

The vast majority of the bulky waste collected by municipalities is anticipated to end in the disposal.

2.3 Hazardous household waste

Decree-Law 102-D/2020, of December 10, establishes that until January 1st of 2025, regional companies must provide a separate collection system for hazardous waste. However, no definition is provided for this waste stream resulting in significant uncertainty on what qualifies as hazardous household waste (HHW).

According to the European Commission[31], HHW includes various materials displaying diverse hazardous properties. Hazardous waste is defined in Article 3(2) of the Waste Framework Directive as 'waste which displays one or more of the hazardous properties listed in Annex III' of the Directive. Examples of this type of waste, typically generated by households, include paints and varnishes, garden pesticides, cleaning products, certain unused medicines, particular wastes from do-it-yourself house renovations and automotive maintenance.

2.3.1 Collection Methods

Although there is not a clear definition for HHW, there are several waste streams which could be classified as HHW, such as WEEE, batteries, and unused medicines[32], for which there are already specific collection and management schemes in place, managed by Valormed, the producer responsibility organisation for unused medicines and medicines packaging waste.

Hazardous household wastes can be delivered to the existing network of recycling yards and civic amenity sites. However, a significant share of household hazardous waste is believed to end in mixed residual waste.

Regarding hazardous waste, regional waste companies mainly report the production of waste electric and electronic equipment (WEEE) and batteries and accumulators (B&A) collected separately in recycling yards, which are sent to producer responsibility organisations for treatment.

Recently, drop-off mobile sites have been made available in some municipalities to collect specific hazardous waste streams, such as contaminated packages (with leftovers of paints and solvents), lightbulbs or toners/cartridges, anticipating the legal obligation of implementing separate collection systems by 2025.

There are two Producer Responsibility Organizations (PRO) responsible for WEEE: Eletrão – Associação de Gestão de Resíduos and ERP Portugal – Associação Gestora de Resíduos. Four entities are responsible for the batteries and accumulators waste system: Eletrão – Associação de Gestão de Resíduos, Valorcar - Sociedade de Gestão de Veículos em Fim de Vida, Lda., ERP Portugal – Associação Gestora de Resíduos and GVB – Gestão e Valorização de Baterias. WEEE and batteries are collected through drop-off points in retail outlets, municipal recycling yards, schools, and other public buildings. Unused medicines should be returned to a pharmacy under the Valormed producer responsibility scheme.

2.3.2 Generated Quantities

According to the data provided by APA, I.P. (2021), approximately 2,000 tonnes of hazardous household waste were produced in Portugal in 2019, representing 0.04% of the total MSW production in the country.

[30] Resíduos do Nordeste (2014): Desmantelamento de colchões desvia 38 toneladas de deposição em aterro.

[31] European Commission (2020a): Commission Notice - Separate Collection of Household Hazardous Waste (2020/C 375/01).

[32] Valormed (2022): About us.

This estimate is based on the physical characterisation of MSW according to the analysis categories defined in *Portaria* no. 851/2009, of August 7:

- Chemical products;
- Fluorescent tubes and low-energy bulbs;
- Batteries and accumulators;
- Other hazardous waste (it is not specified what this subcategory entails).

The European Commission estimates that the production of hazardous household waste ranges between 1 to 6 kg per inhabitant per year[33]. Considering these figures, the HHW production in Portugal could vary between 10.000 to 60.000 tonnes, significantly higher than reported by APA.

Data on hazardous household waste are obtained through quantity estimations and data collection from special waste collection routes, civic amenity centres, direct delivery, curbside collection, door-to-door collection, and results of waste management operations. The collection includes the following fractions from the European Waste Catalogue:

- 15 01 10* packaging containing residues of or contaminated by hazardous substances;
- 20 01 21* fluorescent tubes and other mercury-containing waste;
- 20 01 23* discarded equipment containing chlorofluorocarbons;
- 20 01 26* oil and fat other than those mentioned in 20 01 25;
- 20 01 27* paint, inks, adhesives, and resins containing hazardous substances.
- 20 01 33* batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries;
- 20 01 34 batteries and accumulators other than those mentioned in 20 01 33; 20 01 35* discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components;
- 20 01 36 discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35.

The main conclusions of the analysis of data provided by regional companies are presented in Table 6. It is complemented with data provided by APA on estimated quantities based on mixed waste composition data and quantities declared by regional companies on MRRU.

Table 4. Household hazardous waste collected annually by regional companies in Portugal

HOUSEHOLD HAZARDOUS WASTE	
North 	Regional companies in the region only report WEEE and batteries and accumulators' generation. Lipor reported a hazardous waste production equivalent to 0.01% of MSW generation (although it refers to only fluorescent tubes and low-energy bulbs)[34]. In all region, it was generated 7 944 t of HHW in 2019 and 9 337 t in 2020, according to APA. It approximately corresponds to 2.5 kg/inhabitant. Around 70% of the total amount was estimated, based on mixed waste composition data.
Central	Regional companies in the region reported a hazardous waste production which varies between 0% to 0.01% of MSW generation (although it refers to only batteries and accumulators)[35,36].

[33] European Commission (2020a): Commission Notice - Separate Collection of Household Hazardous Waste (2020/C 375/01).

[34] Lipor (2021): Observatório de Resíduos.

[35] Ersuc (2021): Caracterização Física de Resíduos Urbanos do Sistema Multimunicipal do Litoral Centro – 2020.

[36] Resiestrela (2020): Caracterização de Resíduos 2019.

	According to APA, 2 120 t (1 kg/inhabitant) of HHW was generated in 2019 and 2 718 t (2 kg/inhabitant) of HHW was generated in 2020. Around 60% of the total amount was estimated, based on mixed waste composition data.
Lisbon and Vale do Tejo 	Regional companies in the region only report WEEE and batteries and accumulators' generation. However, according to data provided by APA for HHW generation in this region, it was 4 015 t in 2019 and 5 807 t in 2020, that corresponds to around 1.4 kg/inhabitant per year. Approximately 84% of the total amount was estimated, based on mixed waste composition data.
Alentejo 	Regional company Valnor[37] carried out a physical characterization of MSW in 2019. According to the report, 0.01% of the unsorted MSW collected are hazardous waste, however, this quantity refers only to batteries and accumulators. On the other hand, the characterization of the plastic and metal packaging separately collected indicated that there was no hazardous waste present (according to categories defined in the *Portaria*). For this region, data provided by APA indicates that 2 369 t of HHW generated in 2019 and 2 999 t in 2020. It corresponds to approximately 4 kg/inhabitant per year. Around 63% of the total amount was estimated, based on mixed waste composition data.
Algarve 	Algar does not provide information regarding hazardous waste generation. However, according to APA, for this region HHW generation was 838 t in 2019 and 1 128 t in 2020, that corresponds to approximately 2 kg/inhabitant per year. Estimated quantities based on mixed waste composition data represents almost 70% of the total amount.

2.3.3 Treatment routes

No consistent data is available regarding the treatment routes for the HHW apart from WEEE and B&A handled in the EPR systems.

2.3.4 Good practices in Portugal

Initiative to implement collection centres for household hazardous waste[38,39]

The municipality of Lisbon defined its strategy and action plan for municipal solid waste management in the Municipal Plan for Waste Management 2015-2020. The first strategic objective of the Plan was to expand its waste collection network. One of the defined measures was the creation of collection centres for small quantities of hazardous waste to remove them from the unsorted waste stream.

The waste streams include paints, varnishes, solvents, paint thinners, pesticides, expired chemical products, and mercury thermometers. These waste streams would then be sent to treatment and recovery with the regional company Valorsul.

However, the implementation of the collection centres is still under development, as stated in the Plan's monitoring report in 2020.

Mobile collection points for household hazardous waste[40,41]

Certain municipalities are providing mobile collection points for the separate collection of different waste streams. Porto municipality and regional company Lipor have started collecting household hazardous waste not accepted in the municipality's recycling yards, such as contaminated packages (with leftover paints and solvents), CDs, and DVDs. At the base of this collection model is an itinerant container which will be made

[37] Valnor (2019): Caracterização Física de Resíduos Urbanos do Sistema Multimunicipal do Norte Alentejano.

[38] Câmara Municipal de Lisboa & Direção Municipal de Higiene Urbana (2016): Plano Municipal de Gestão de Resíduos do Município de Lisboa | 2015-2020.

[39] Câmara Municipal de Lisboa & Direção Municipal de Higiene Urbana (2020): Relatório de Monitorização do Plano Municipal de Gestão de Resíduos.

[40] Condeixa Município (2021): Eco.Rupi – o novo ecoponto móvel chegou hoje a condeixa.

[41] Porto Ambiente (2021): Ecocentro móvel para deposição de resíduos perigosos já está na rua.

available in different areas and for a certain period. This mobile container will also receive lightbulbs, toners, batteries, accumulators, and WEEE.

The Condeixa municipality, located in the country's central region, has a new mobile container for collecting hazardous household waste, allowing the recovery of 15 different waste streams. This container will be made available in a different parish of the municipality every week. The collected waste streams are small WEEE, paint cans, electrical wiring and batteries.

2.4 Construction and demolition waste

According to the EU Commission, construction and demolition waste (C&D waste) includes all the waste produced by the construction and demolition of buildings and infrastructure, as well as road planning and maintenance. Article 3(2) of the Waste Framework Directive defines waste generated by construction and demolition activities.

2.4.1 Collection Methods

According to Article 49 of the General Regulation of Waste Management, established in Decree-Law 102-D/2020 of December 10, municipalities and regional companies are responsible for C&D waste that results from minor repairs and DIY works in households by the owner or tenant. These entities are then responsible for the collection, transport and/or handling of this waste stream.

Municipalities and regional companies can provide a collection service for this waste stream (by demand) or allow citizens and companies (exempt from licensing) to deposit their C&D waste in municipal recycling yards. However, finding C&D waste next to containers or even at illegal deposits in more remote areas is common, representing a cost to urban cleaning services.

Although C&D waste source segregation is mandatory[42,43], in general, collection services provided by municipalities or regional companies do not require source segregation by fractions. Moreover, these collection services usually provide a restricted number of big bags (1m^3 or 1.5 m^3, maximum) to contain all C&D waste generated in minor repairs in households. Regional companies often use fractions such as inert C&D waste (e.g., mixtures of concrete, bricks, tiles and/or ceramics) as landfill cover or to improve access in landfills. Besides this, some recycling yards are licenced to receive C&D waste, and some of them impose maximum quantities of C&D waste to be delivered by producers (inhabitants or small companies), such as the 1m^3 in São João da Madeira municipality[44] or the 1 ton per day quantity limit by GESAMB[45]. Generally, C&D waste collection is a free service provided by municipalities. Still, some municipalities restrict quantities to collect, and a fee is applied if some volume or weight exceeds[46]. In some municipalities, such as Cascais, this service is not often used[47].

2.4.2 Generated Quantities

Even though the C&D waste resulting from minor household repairs is the responsibility of municipal systems, it is not classified as municipal solid waste. Therefore, it is not considered in the data reporting

[42] *Legal framework for C&D waste establishes the exception for producers that do not have conditions for source segregation at the construction site/where they are generated. However, producers must assure C&D waste is segregated in a licensed operator.*

[43] Diário da República (2008): Decreto-Lei 46/2008, 1.a série—N.o 51—12 de Março de 2008 – Ministério do Ambiente, do ordenamento do território e do desenvolvimento regional.

[44] São João da Madeira municipality (n.d.): Normas de funcionamento do ECOCENTRO Municipal de S. João da Madeira.

[45] Construção Circular (n.d.): Ecocentros para os seus RCD.

[46] Primary data source: Identified < 1 ton C&D waste – free of charge, > 1 ton C&D waste – fee through conversation with Luís Assunção, Maria Guedes and Sofia Gomes – Porto Ambiente (September 7, 2021).

[47] Primary data source: Consultation meeting with Luís Capão and Sandra Rebelo – Cascais Ambiente (August 25, 2021)

provided by APA. APA provides estimates for C&D waste production in Portugal, having reported in 2018 and 2019 a production of approximately 2.5 million tonnes of this waste stream[48,49] (including C&D waste that falls under the responsibility of municipalities), but this includes all types of C&D waste, including the waste generated in construction and demolition of buildings. Under the responsibility of municipalities, C&D waste managed by regional companies was 63 409 t in 2018 and 58 068 t in 2019, less than 3% of the total amount of C&D waste generated in Portugal, as reported by SGRU to APA. Regarding C&D waste classification, it is essential to note that mixed construction and demolition wastes (EWC 17 01 07 and 17 09 04) represent approximately 83% of C&D waste managed by SGRU. Soil and stones (EWC 17 05 04) represent around 16% of the total amount managed by SGRU. Annual reporting on data collection is done by 23 SGRUs, which can be consulted in table 8. There is, however, no disaggregated data SGRUs. Therefore it is impossible to do a regional analysis of the data[50].

Table 8. C&D waste collected annually by regional companies in Portugal

CONSTRUCTION AND DEMOLITION WASTE COLLECTION	2018	2019	2020
17 01 01 Concrete	654	897	142
17 01 02 Bricks	-	3.7	0.6
17 01 03 tiles and ceramics	36	61	24
17 01 07 mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	45 682	44 893	28 596
17 02 01 Wood	25	39	54
17 02 02 Glass	9.5	29	31
17 02 03 Plastic	11	20	16
17 03 02 bituminous mixtures other than those mentioned in 17 03 01	232	37	73
17 04 05 iron and steel	2.6	-	-
17 04 07 mixed metals	0.8	-	-
17 05 04 soil and stones other than those mentioned in 17 05 03	9 772	5 868	9 328
17 06 04 insulation materials other than those mentioned in 17 06 01 and 17 06 03	4.4	95	3.9
17 08 02 gypsum-based construction materials other than those mentioned in 17 08 01	5.2	18	99
17 09 04 mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	6 975	6 127	5 491
Total (t)	**63 409**	**58 088**	**43 858**

The main conclusions of the analysis of data provided by regional companies are presented in

CONSTRUCTION AND DEMOLITION WASTE	
North	Regional companies have reported the production of C&D waste (for which they are responsible) of between 0.005 to 0.045 t/inhab[m].

[48] APA (2019): Resíduos de Construção e Demolição – Resultados 2018 e evolução 2016-2018.

[49] APA (2021): Resíduos de Construção e Demolição.

[50] Primary data source: Consultation with APA the 22nd of November 2021.

	
Central 	AMR Planalto Beirão has received approximately 1,900 tonnes of C&D waste in their recycling yards, equivalent to 0.006 t/inhab.
Lisbon and Vale do Tejo 	Amarsul reported the production of C&D waste (for which it is responsible) of 32,452 tonnes, equivalent to 0.041 t/inhab.
Alentejo 	Regional companies have reported the production of C&D waste (for which they are responsible) of between 0.02 to 0.07 t/inhab".
Algarve 	Algar reported the production of C&D waste (for which it is responsible) of 5,185 tonnes, equivalent to 0.012 t/inhab.

Table 5. The data collected does not only refer to C&D waste produced by citizens, as municipalities can also receive C&D waste from large producers (industrial waste).

CONSTRUCTION AND DEMOLITION WASTE	
North 	Regional companies have reported the production of C&D waste (for which they are responsible) of between 0.005 to 0.045 t/inhab[51,52,53,54].
Central 	AMR Planalto Beirão has received approximately 1,900 tonnes of C&D waste in their recycling yards[55], equivalent to 0.006 t/inhab.
Lisbon and Vale do Tejo 	Amarsul reported the production of C&D waste (for which it is responsible) of 32,452 tonnes, equivalent to 0.041 t/inhab[56].
Alentejo	Regional companies have reported the production of C&D waste (for which they are responsible) of between 0.02 to 0.07 t/inhab[57,58,59].

[51] Resulima (2020): Relatório e Contas 2019 – Valorizar o Ambiente é cuidar do Futuro.

[52] Resinorte (2020): Relatório e Contas 2019.

[53] Suldouro (2020): Relatório e Contas 2019 – Valorizar o Ambiente é cuidar do Futuro.

[54] Valorminho (2020): Resíduos Urbanos Rececionados 2019.

[55] AMR Planalto Beirão (2020): Relatório de Gestão e Conta Gerência 2019.

[56] Amarsul (2020): Relatório e Contas 2019 – Valorizar o Ambiente é cuidar do Futuro.

[57] Ambilital (2015): Relatório e Contas Anuais Excercício 2015.

[58] AMCAL (2015): Relatório de Gestão – Ano Económico de 2015.

[59] GESAMB (2020): Relatório de Sustentabilidade – 2019.

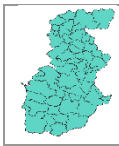
	
Algarve 	Algar reported the production of C&D waste (for which it is responsible) of 5,185 tonnes, equivalent to 0.012 t/inhab[60].

Table 5. C&D waste collected annually by regional companies in Portugal

2.4.3 Treatment Routes

No robust data is available regarding the treatment routes for this waste stream at the national level. Further, very little academic literature has been written on treatment routes for C&D waste in Portugal in the past ten years. The regional companies that reported collecting or receiving C&D waste indicated that this waste stream was used as landfill cover or for access routes to landfills.

The few construction and demolition waste recycling initiatives reported on have primarily been promoted near urban centres[61]. In 2013, the latest available reporting, only one recycling plant was working on C&D waste, Ecolabor, a privately owned recycling plant by Trianovo. Trianovo utilises collection, separation and crushing approaches to sell the separated materials to other recyclers. They supply graded fill aggregate, mainly crushing concrete, bricks, and mixed fines. Ecolabor was, in 2013, equipped with an air blower to separate the light C&D materials from the heavy aggregates, a jig table to isolate different grain sizes, and a portable fine separate mounted on an excavator[62]. This is the only identifiable recycling plant for construction and demolition, and it is unclear whether Ecolabor is still functioning.

A cost-benefit analysis was made in 2013 on the various costs – initial acquisition of new equipment, set up costs, operating, maintenance, labour and waste transport, disposal costs, etc., of implementing additional recycling plants in Portugal. The analysis showed that the return-on-investment period was around two years, arguably illustrating an attractive business model. The national benchmark was eight years as a reference for economic viability. The study concluded that investment in a large-scale high-level C&D waste recycling facility in Portugal is a multi-million Euro enterprise, but has a high-profit potential, hereof the fast return of investment[63]. While new technology, approaches, and economic conditions have developed since 2013, the cost-benefit analysis indicates a market potential for improvement of preparation for the reuse and recycling of C&D waste. Due to the establishment costs, publicly supported programmes or even state-owned recycling plants could improve the possibility of implementing more recycling plants.

[60] Algar (2020): Relatório e Contas 2019 – Valorizar o Ambiente é cuidar do Futuro.

[61] Coelho & de Brito (2013a): Economic viability analysis of a construction and demolition waste recycling plant in Portugal – Part 1: location, materials, technology and economic analysis.

[62] Coelho & de Brito (2013b): Construction and demolition waste management in Portugal.

[63] Coelho & de Brito (2013a): Economic viabilityt analysis of a construction and demolition waste recycling plant in Portugal – Part 1: location, materials, technology and economic analysis.

WASTE MANAGEMENT IN FIGUEIRA DA FOZ[64]	
Governmental/private entity: Municipality of Figueira da Foz	**Period:** 2016 -
The municipality developed procedures for the management of C&D waste for private and public construction works, which were identified as best practices by the Portuguese Environmental Agency.	
Private construction works The municipality created a mechanism to operationalize and supervise the current legislation on C&D waste management, namely by altering the Urban Regulation. In the project appraisal stage, it is mandatory to provide an estimate on the production of C&D waste (quantities and types) in order to obtain a construction license (the municipality developed a simulator in excel to aid in this matter). When concluding a construction work, it is also mandatory to provide evidence of the correct C&D waste management, which needs to be coherent with the previously provided C&D waste production estimate, to obtain a building use license. The municipality mandates that metal containers or big bags are made available in construction sites for storing C&D waste. Additionally, for construction works that produce less than 1-1.5 m^3 of C&D waste, the parishes provide big-bags, which are collected and then sent to companies licensed for their treatment.	**Public construction works** Public tenders require the prevention and management plan for C&D waste. In any construction site it is mandatory to provide evidence of the correct management of C&D waste in order to carry out the proceedings (defined in Terms of Reference). The municipality also states to raise awareness of employees from Public Works and Urban Planning through visits to contaminated sites and to recycling and treatment facilities. One of the practices implemented in public works is the use of recycled aggregate in pavement foundations and trench filling.
The municipality has also been focusing on cleaning illegal C&D waste dumping sites (in 2017/2018, they treated circa 11,100 tonnes, representing a cost of 180,000 €).	

It is important to note that the last amendment to Decree-Law 102-D/2020, of December 10[65], also anticipates the development of a study (by December 31, 2022) that analyses the possible environmental benefits and performance improvement opportunities for an EPR scheme dedicated to C&D waste.

2.5 Summary

An overall challenge identified throughout the analysis of the state of play is the lack of robust, generalisable data on the collection, quantities, and treatment of the four waste streams. From a planning perspective, this poses a significant challenge, as robust data provide solid indicators for improvement potential, underutilised facilities, opportunities for collaboration, etc. However, the data collection for this project has provided an overview of the definition, system description, (estimated) generated quantities, and utilised treatment routes in Portugal, shown in table 9:

Table 6. Summary of the state of play of textile, HHW, bulky waste and C&D waste management

WASTE STREAMS	DEFINITION	SYSTEM DESCRIPTION	GENERATED QUANTITIES	TREATMENT ROUTES
TEXTILE WASTE	No specific definition, falls within MSW definition	Unsorted MSW collection system	Approximately 3.5% of MSW production	Mainly incineration and landfill

[64] Município da Figueira (n.d.): A Gestão de RCD's no Concelho da Figueira da Foz.

[65] Diário da República (2021): Portaria n.º 52/2021, de 9 de março.

HOUSEHOLD HAZARDOUS WASTE	No specific definition, falls within MSW definition	Unsorted MSW collection system and Plastic/Metal waste packaging separate collection system	0.04% of the total MSW production, according to *Portaria*'s definitions	Treated as other unsorted municipal waste (MBT, landfill or incineration)
BULKY WASTE	Bulky objects from households includes furniture, mattresses, electrical equipment	Collected on demand by municipalities or sent to municipal recycling yards by citizens	Approximately 4.4% of MSW production (it includes other waste streams other than mattresses and furniture)	Mattresses are mostly deposited in landfills, but in some cases, they are used to protect the lining in landfills
CONSTRUCTION AND DEMOLITION WASTE	C&D waste that results from small repairs and DIY works in households by the owner or tenant	Collected on demand by municipalities or sent to municipal recycling yards by citizens and companies (exempt from licensing)	Between 0.005 to 0.07 t/inhabitant	Mostly deposited in landfills, but are also used as landfill cover and for access routes to landfills

3 Good waste management practices in the EU

A review of recent reports and research will form the basis for an account of EU good practices within the separate collection and treatment of the four waste streams, focusing on the best results in enabling preparation for reuse and recycling of the materials[66]. These good practices can also include examples of separate collection, reuse, and recycling within Portugal since this may occur in some municipalities/regions. Separate collection systems will be strengthened over the coming years (as stipulated in the revised WFD). Still, comparing collection results between areas and countries is a complex exercise. Similar systems can lead to mixed results depending on economic incentives, legal enforcement, customised facilities, and the amount and relevance of engaging communication[67]. Also, national endeavours to strengthen preparation for reuse and recycling (for example, national initiatives to establish recycling industries for specific material types) will be investigated. The survey will include identifying existing Extended Producer Responsibility systems for the four waste streams in the Member States[68]. The Portuguese practices will be benchmarked against the good EU practices. A toolbox for innovative models to solve municipal waste issues in other EU Member States will be prepared.

3.1 Textile waste

There are no requirements for the EU member states to report the quantities of separately collected textiles, nor any standardised mapping or classification methodology. Therefore, data on collected, reused, and recycled textiles are incomparable. A slight majority of EEA and EU member states (16 out of 30) have already included measures that address textile waste. The measures include voluntary agreements, suggested marked-based incentives and stringent regulatory market interventions. Agreements and partnerships on measures focus on raising awareness, and regulatory measures focus on reducing chemicals in textiles[69].

3.1.1 Extended producer responsibility systems

Extended Producer Responsibility (EPR) is an environmental policy approach that aims to drive and incentivise producers to develop a sustainable production system and product design to make them durable and easier to repair and recycle, develop innovative recycling techniques, and markets for recycled products[70].

In the EU Strategy for Sustainable and Circular Textile, the Commission state that it is to propose harmonised EU rules on EPR for textiles with eco-modulation of fees as part of the revision of the Waste Framework Directive 2023. The Commission will propose that a significant share of contributions to EPR schemes will be dedicated to waste prevention measures and reuse preparation. Requirements on preparation for the reuse of separately collected textile waste from households and similar waste are being considered by the Commission[71].

[66] *Relevant studies include the new EU Guideline for separate collection of municipal waste (partly prepared by the consultant); Assessment of separate collection schemes in the 28 capitals of the EU; Support to selected Member States in improving hazardous waste management based on assessment of Member States' performance;*

[67] Dubois et al. (2020): Guidance for separate collection of municipal waste.

[68] *The consultant has carried out investigations on the feasibility and potential set-up of such systems that can feed into this section, for example: Watson et al (2015): EPR systems and new business models - reuse and recycling of textiles in the Nordic region.*

[69] Gëzet et al. (2021): Progress towards preventing waste in Europe — the case of textile waste prevention.

[70] Monier et al. (2014): Development of Guidance on Extended Producer Responsibility – Final report.

[71] European Commission (2022): Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – EU strategy for Sustainable and Circular Textiles.

3.1.1.1 France

Since January 2007, all legal entities presenting new clothing, linen and footwear (CLF) products in the French market are responsible for recycling or proper disposal of their products. Since the 1st of January 2020, curtains and indoor blinds in the fabric have entered the scope of the products concerned, the obligation can be accomplished in two ways: by setting up an individual take-back programme approved by the French public authorities or by financially contributing to an accredited producer responsibility organisation (PRO). The PRO has the power to, amongst other things, implement initiatives such as encouraging eco-design through modulated fees[72,73].

Refashion (formerly ECO TLC) is the only accredited PRO to manage and drive sustainable improvements in the national post-consumer textiles collection and recycling. Refashion is a non-profit company with associates representing the textile value change[74]. Apparel manufacturers, importers and distributors can fulfil their EPR liability by registering as members of Refashion and making them visible online[75]. Refashion accounts for 95% of the market. No producers have attempted to establish a separate take-back programme for its products, and the remaining 5% are free-riders [76].

Each member of Refashion pays an annual fee calculated based on the quantities of textiles and footwear items it has marketed in the prior year, and those items size[77]. There are three standard fee scales for clothing, household linen and footwear[78].

	CLOTHING (incl. fabric sold by the meter)				FOOTWEAR				HOUSEHOLD LINEN (incl. fabric sold by the meter)			
Fee scale code	VSI	SI	MI	LI	VSI	SI	MI	LI	VSI	SI	MI	LI
2022 standard fee scale for goods placed onto the market in 2021	0,006	0,011	0,021	0,063	0,016	0,029	0,045	0,063	0,010	0,019	0,034	0,071
Eco-modulated fee scale (for products that are eligible according to criteria and required supporting evidence, see the eco-modulations information sheet below)												
Eco-modulation 1 (EM1)	0,0030	0,0055	0,0105	0,0315	0,0080	0,0145	0,0225	0,0315	0,0050	0,0095	0,0170	0,0355
Eco-modulation 2 (EM2)	0,0030	0,0055	0,0105	0,0315	0,0080	0,0145	0,0225	0,0315	0,0050	0,0095	0,0170	0,0355
Eco-modulation 3 (EM3)	0,0045	0,0083	0,0158	0,0473	0,0120	0,0218	0,0338	0,0473	0,0075	0,0143	0,0255	0,0533
Minimum contribution	120,00											

The eco-fee scale for items placed into the 2022 market[79]

To encourage marketers to provide more sustainable and better eco-designed products, the fees are eco-modulated so that the marketers can obtain discounts by fulfilling eco-criteria. Three criteria respectively encourage the durability of the products, integration of post-production offcut recycled materials and integration of post-consumer recycled materials[80,81]. However, the eco-modulation of fees does not have a

[72] Bukhari et al. (2018): Developing a national programme for textiles and clothing recovery.

[73] Eunomia & Zero Waste Scotland (2020): How to reduce waste and carbon emissions caused by mattresses: A review of global Extended Producer Responsibility schemes.

[74] Refashion (n.d.a): For a 100% circular textile industry.

[75] Refashion (n.d.b): Textile & footwear industry stakeholders.

[76] Watson et al. (2020): Towards 2025: Separate collection and treatment of textiles in six EU countries.

[77] Refashion (2020): Annual report 2020.

[78] Refashion (2020): Annual report 2020.

[79] Refashion (2022): 2022 Eco-fee Placed onto the market in 2021 – The Essentials.

[80] ECOTLC (2019): Annual report #2019.

[81] Refashion (n.d.c): What is Eco-modulation?

significant effect, as the administrative burden associated with documentation is higher than the eventual savings in EPR fees[82].

The fees received are used to promote a more circular textile industry, for example, by supporting industrial sorting operators to increase collection and recycling rates, maintaining transparent material and financial flows, funding research and development projects to identify solutions and improve current processes and encoring local authorities to raise awareness among the general public[83]. In 2020, Refashion collected €34.5 million in Eco fees[84].

Refashion aims to collect 50% of the material put on the market. The agreement also sets targets for the minimum density of accredited collection points to meet collection targets. The target for 2019 was one collection point per 1500 people. To meet reuse and recycling targets, EcoTLC supports sorting operations and R&D in recycling technologies[85].

3.1.1.2 Sweden

In 2019, The Swedish Government ordered a comprehensive report on EPR and how it could be introduced in the Swedish textile context. The report published In December 2020 presented a concrete proposal for a law on EPR. This law is expected to come into force on the 1st of January 2022[86].

The purpose of the new EPR scheme is to place responsibility for waste management and recycling textiles on the producers and to ensure a separate collection of textiles for reuse and recycling. The scheme will obligate producers to ensure their products are dealt with in a licensed collection system. In the system proposed, it is the Swedish Environmental Protection Agency as the licensing body, which will supervise the body that operates the licensed collection system. The producers will, therefore, only be obligated to notify the Environmental Protection Agency that their products are dealt with in a licensed system. The EPR scheme will not be fully enrolled in 2022. Responsibility for collecting textile waste is not proposed to be transferred to the licensed collection systems until January 2024. This is because time is needed for the collection system to expand and for all producers to enter into contracts with a licensed collection system[87].

Charities play a central role in the current textile collection system in Sweden. Today several charities are hired by municipalities and companies to collect reusable textiles and textile waste. Charities collect about 38 000 tonnes of textiles and textile waste annually in Sweden[88]. The inquiry proposes that the existing system is retained, so existing practices of collection of textiles can continue.

The EPR scheme is proposed to apply to clothes, household and interior textiles, bags, and accessories. The scheme will exclude furniture, professional textiles, filters, fabric by the metre, mattresses, and shoes[89].

[82] Sachdeva et al. (2021): Extended Producer Responsibility and Ecomodulation of Fees – Opportunity: Ecomodulation of Fees as a Way Forward for Waste Prevention.

[83] Refashion (n.d.d): What are eco-fees?

[84] Refashion (2020): Annual report 2020.

[85] Sachdeva et al. (2021): Extended Producer Responsibility and Ecomodulation of Fees – Opportunity: Ecomodulation of Fees as a Way Forward for Waste Prevention.

[86] Losman (2019): Extended producer responsibility for textiles – part of the circular economy.

[87] Losman (2019): Extended producer responsibility for textiles – part of the circular economy.

[88] Losman (2019): Extended producer responsibility for textiles – part of the circular economy.

[89] Losman (2019): Extended producer responsibility for textiles – part of the circular economy.

3.1.1.3 The Netherlands

In the Netherlands, the introduction of EPR on textiles is underway. This was announced by the State Secretary for Infrastructure & Water Management in May 2021 in a letter to the House of Representatives. The EPR for textiles is expected to be enacted in the Netherlands on the 1st of January 2023[90]. The new EPR scheme will be a part of the Dutch Textile Pact illustrated below, which consists of CSR industry Agreements and a sector plan for sustainable textiles introduced in 2019.

The Dutch Textile Pact (Modint, 2021)[91]

Roughly translates to 1) Dutch Sustainable Textile Pact, 2) CSR Agreement on Clothing and Textile, and 3) Sector Plan on Circular Textiles

The structure of the Dutch Textile Pact is built on industry cooperating, industry and trade associations and governmental entities. The cooperation has facilitated an efficient and effective implementation of international guidelines for sustainable textile management and the perception of joint responsibility[92].

The upcoming EPR for textiles in the Netherlands is to ensure that manufacturers of clothing will be responsible for the collecting, recycling, reusing and end-of-life handling of the products they bring to market, as well as the costs of the logistics of the system. Municipalities are responsible for the collection and costs of managing end-of-life textiles from their residents. It is the aim that the EPR will provide a financial incentive for the production of clothing of higher quality, which will make it easier for clothing to be reused and recycled[93]. The scheme is still being composed in greater detail, and it is still unclear how exactly the collection of textiles will be carried out in the future. The EPR will, in principle, apply to all parties marketing clothes on the Dutch market, but it is being investigated how to support small businesses in the transition phases[94,95].

The decision to introduce EPR on textiles is, among other things, based on the Dutch trade organisations Modint and INretail's proposal on EPR and an extensive report on EPR conducted by the independent research by Rebel Group[96].

3.1.1.4 The United Kingdom

In the Waste Prevention Programme, the British Government initiate cross-sectoral actions to minimise waste in seven critical sectors among these textiles. This programme includes a step to resource efficiency, design and manufacturing for prolonged lifespan, and repair and reuse. The programme builds on the British Resources and Waste Strategy and further entails governmental consultation with textile industry stakeholders by the end of 2022 on an EPR scheme. The EPR scheme is developed to ensure industry contributions to recycling costs. It is expected that the EPR scheme will boost the reuse, collection, and recycling of textiles,

[90] The Government of the Netherlands (2021): Modeketens in 2023 verantwoordelijk voor afgedankte kleding.
[91] Modint (2021): Vervolg op het Nederlandse convenant: The Next Generation Agreement (NGA).
[92] Modint (2021): Vervolg op het Nederlandse convenant: The Next Generation Agreement (NGA).
[93] The Government of the Netherlands (n.d.a): Fashion chains must collect discarded clothing.
[94] The Government of the Netherlands (2021): Modeketens in 2023 verantwoordelijk voor afgedankte kleding.
[95] The Government of the Netherlands (n.d.a): Fashion chains must collect discarded clothing.
[96] Kort et al. (2021): Naar én UPV voor textiel – Kaders en doelstellingen, kosten en opbrengsten en rollen en verantwoodelijkheden.

thereby reducing the sector's environmental impact. It is further expected that implementing an EPR Scheme in the UK will function as a driver for the utilisation of sustainable fibres in the production of textiles and support more sustainable business models such as rental scheme[97].

The British textile industry has made progress for sustainable production and consumption through the Sustainable Clothing Action Plan, a voluntary agreement coordinated by WRAP, a climate action non-governmental organisation. The British government intends to galvanise industry action through a new voluntary agreement implemented in 2021, Textile 2030, which aims to reduce the textile sector's environmental impact through science-based targets[98].

Assistance on preparation for upcoming EPR scheme in the UK (WRAP, n.d.)[99]

Under the new voluntary industry agreement Textile 2030, WRAP have provided textile industry actors with guidance on the upcoming EPR scheme. The guide includes an introduction to EPR, drawing on the lessons learned from the already implemented EPR scheme on packaging in the UK. The guide further provides a section on anticipating policy measures. At last, the guide provides an overview of preparing for an EPR scheme in the UK, relevant resources, and a free 30-minute call for business leaders, as illustrated in the picture above[100]. Ensuring that industry actors are well informed on the aspects, consequences, and options of EPR schemes enables better grounds for collaboration, willingness, and efficient implementation practice of the principles of EPR.

3.1.2 Civic Amenity Sites

Civic amenity sites can complement a practical source separation collection system, supplementing adequate infrastructure for door-to-door collection. Well-operating civic amenity sites are easily reachable and well-connected to the road network. The local authorities define the size, the location, the number of collected waste factions and other operational parameters. Clear instructions for citizens and small businesses are essential, as they facilitate proper disposal and support measures for preparation for reuse and recycling[101].

3.1.2.1 France

The SYELOM is a syndicate managing waste collection and treatment for 30 municipalities in western France. There is a lack of civic amenity sites in the territory. The SYELOM aims to increase recovery and recycling, provide better service for the citizens, and increase awareness of selective collection's impact. The objectives are set by regulation and the regional waste management plan on illegal dumping and recycling[102].

The SYELOM facilitate the implementation of a network of mobile civic amenity sites for the municipalities, called ‘ma déchèterie mobile’, translating to ‘my mobile civic amenity site’. ‘Ma déchèterie mobile’ consists

[97] The Government of the United Kingdoms (2021): Government unveils plans for wide-ranging Waste Prevention Programme.
[98] The Government of the United Kingdoms (2021): Government unveils plans for wide-ranging Waste Prevention Programme.
[99] WRAP (2021a): Getting ready for Extended Producer Responsibility (EPR) – Guide for Fashion Brands.
[100] WRAP (2021a): Getting ready for Extended Producer Responsibility (EPR) – Guide for Fashion Brands.
[101] European Commission (n.d.a): Civic amenity sites – Green Best Practice Community.
[102] R4R (2014): Good practices – A network of Mobile Civic Amenity Sites.

of temporary collection installations in public spaces. The locations are fixed, and the local authorities decide available seven times a month and opening hours. At the mobile civic sites, eight factions can be sorted:

- Cardboard;
- Ferrous and non-ferrous metals;
- Mixed bulky waste;
- Gardening waste;
- Construction and demolition waste;
- WEEEs;
- Textiles, and;
- Wood.

The services provided are free for the citizens living in the given municipality, and the municipalities provide technical services upon request. Commercial waste, however, is strictly forbidden at the mobile civic amenity sites. Communication material and collaboration with local authorities have been critical elements in promoting the service to facilitate a smooth transition from the door-to-door collection of the mentioned fractions[103].

3.1.2.2 Sweden

In Sweden, the collection of textiles has historically been done by charitable organisations. Currently, most of the textile collections are carried out with bring banks placed in urban settings, recycling stations, shopping centres and civic amenity centres, which the municipalities facilitate in most parts. The municipalities can permit one or more collectors to collect textiles on public land, which is very widespread. Another general approach is municipalities contracting charities to collect textiles in civic amenity centres. The textile waste collected by the municipalities is sold to for-profit sorting companies. Donations to charity organisations occur as well[104].

A few municipalities offer a curbside collection of reusable and recyclable textiles in coloured bags for optical sorting. The municipalities offering Curbside collection reported a collection of 50% of the textile quantities usually found in improperly separated household waste after only one year with this collection method[105].

Pre-Covid-19, the Swedish Government planned to implement a chemical tax on clothing and footwear to increase the quality of recycled materials and reduce the environmental impact of the waste products. Due to the pandemic, the implementation was postponed and later dropped by the Swedish Government since implementation entails too many practical difficulties regarding private import from countries outside Europe[106].

3.1.3 Doorstep & curbside collection

Historically, waste management has primarily concerned larger cities in Portugal, leading to the misconception that door-to-door collection schemes are not worth the trouble in rural areas. Implementation of a two-month pilot test of door-to-door collection of recyclable waste in rural areas of Portugal showed that this is not the case. The pilot test showed that the annual per capita waste collection more than tripled with the implementation of the door-to-door collection, and an overall 79% capture rate for dry recyclable waste was achieved. However, the door-to-door collection scheme was discontinued due to a lack of financial incentives for the pilot municipality[107]. The pilot test provides insights into the importance of governmental support and enforcement structures for implementing improved collection practices and the need for financial incentives through punishment or reward.

[103] Ma déchetterie (n.d.): Déchèterie Mobile.

[104] Watson et al. (2020): Towards 2025: Separate collection and treatment of textiles in six EU countries.

[105] Watson et al. (2020): Towards 2025: Separate collection and treatment of textiles in six EU countries.

[106] SGS (2021): Sweden Repeals Proposal for Chemical Tax on Clothing and Footwear Products.

[107] Vaz et al. (2021): Benefits of introducing door-to-door separate collection in rural and low populated areas.

3.1.3.1 Denmark

In 2022 a political agreement on a reorganisation of the waste sector was passed, with requirements to the municipalities focusing on the streamlined waste collection of 10 household waste fractions, including textiles. The political agreement entails implementing collection schemes for textiles, ensuring that charitable organisations gain access to reusable textiles[108].

Textile waste is collected in two separate waste streams: reusable and recyclable textiles. Charitable-, voluntary- and private companies collect textile waste suitable for reuse through pick-up schemes or at Civic amenity sites in containers protecting the textile waste from, e.g. mould due to rain. The recyclable waste fraction is collected in a municipal collection scheme. Suppose citizens dispose of reusable textiles through the municipal waste collection scheme. In that case, the municipality must ensure these textiles are separated and sent to preparation for reuse (e.g. for cleaning)[109]. The separate collection of textiles is the responsibility of the municipalities. While some already have implemented the collection schemes, all Danish municipalities must implement textile collection in medio 2023 at the latest[110].

Municipalities are required to follow one of the following options for textile collection for every type of residence in Denmark:

- Collection of bags with recyclable textiles in connection with the bulky waste collection or 'order for collection' schemes
- Pick up textile waste in durable bags and put it in containers for paper and cardboard. Paper and cardboard are not put in bags when disposed of, enabling easy separation of the textile and paper and cardboard waste.
- Household collection in a container located within walking distance from homes. Municipalities can permit charitable organisations to facilitate the collection, but the municipality should provide unique bags for the textile waste to ensure proper separation from other waste fractions.
- Collection in a separate container, which the Danish Government recommends for multi-story housing, where the quantities are sufficient for separate containers[111].

Pictograms used for communication of new waste fractions[112]

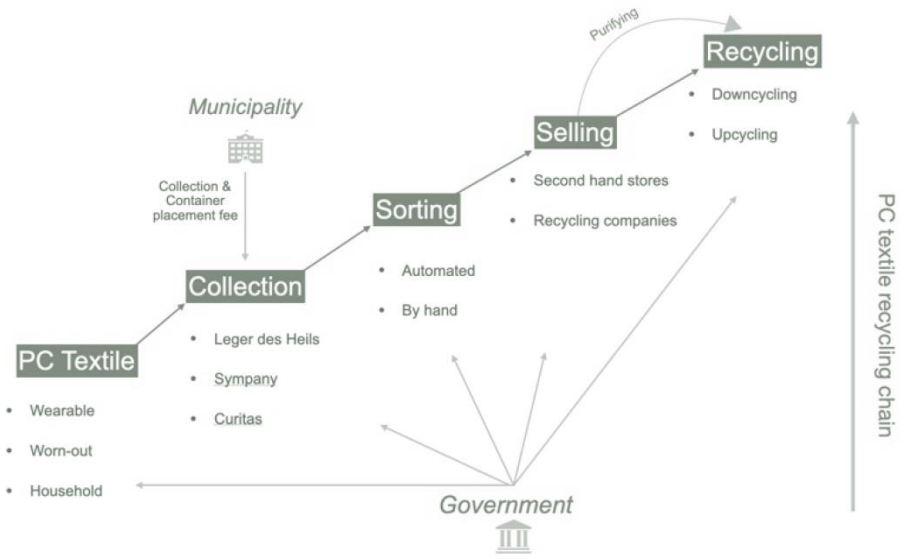
A national waste pictogram system has been developed to ensure streamlined guidance for citizens on proper disposal methods and to reduce contamination of the ten collected waste streams. An extended version is utilised at civic amenity centres, providing a visual aid for disposing of 88 waste fractions. The pictograms have been implemented in 90 out of 98 municipalities in Denmark, and the remaining eight municipalities are currently working on implementation[113].

[108] DAKOFA (2020): Husstandsindsamling af tekstil i 2022.
[109] DAKOFA (2022): Høring: Tekstilaffald og mere om piktogrammer i nye vejledning om sortering og indsamling.
[110] The Danish Ministry of Environment (n.d.): Affaldspiktogrammer og korrekt sortering – om pikogrammerne.
[111] DAKOFA (2022): Høring: Tekstilaffald og mere om piktogrammer i nye vejledning om sortering og indsamling.
[112] The Danish Ministry of Environment (n.d.): Affaldspiktogrammer og korrekt sortering – om pikogrammerne.
[113] Dansk affaldsforening (n.d.): Det fælles piktogramsystem.

3.1.3.2 The Netherlands

In the Netherlands, there are several options for returning old clothes and textiles, both facilitated by governmental entities, private initiatives, NGOs, and recycling companies. Some supermarkets or shopping centres have collection containers as well. Generally, the Netherlands are a good part of the way towards 55% preparation for reuse and recycling when it comes to textiles. 45% of all textiles are collected separately from other waste in the Netherlands. 53% of the collected textiles are reused, and 33% of the textile are recycled[114].

According to the central government of the Netherlands, all municipalities must facilitate the collection of separated waste, where an option for textiles should be available as well[115]. Municipalities can provide sorting and recycling companies with permits against a fee, and the companies are obliged to pay additional fees per kilo of textile they collect. For a fee, the collection and sorting companies can put up permanent containers for collection in urban areas[116]. A few times a year, charities and collection companies can be permitted by a municipality to collect textiles door-to-door. In this case, citizens receive a unique collection bag for the textiles[117].



The Dutch recycling chain (Chan et al., 2020)[118]

When textiles have been collected by Dutch municipalities or textile collection and recycling companies, they are sent to sorting centres. The textiles are sorted either by hand or by automated sorting methods. The textiles of high quality suitable for reuse are removed from the waste stream during sorting and sent to second-hand stores and other selling points. A variety of different methods at the sorting centres further separate the remainder. The recyclable textiles are sent for either upcycling or downcycling, processed by mechanical or chemical recycling processes[119].

[114] Chan et al. (2020): Improving Dutch Post-consumer textile recycling – A multi-criteria analysis of Scandinavian downstream mixed textile recycling techniques for suitable application in the Dutch context.
[115] The Government of the Netherlands (n.d.b): Waar kan ik oude kleding en textile inleveren.
[116] Chan et al. (2020): Improving Dutch Post-consumer textile recycling – A multi-criteria analysis of Scandinavian downstream mixed textile recycling techniques for suitable application in the Dutch context.
[117] The Government of the Netherlands (n.d.b): Waar kan ik oude kleding en textile inleveren.
[118] Chan et al. (2020): Improving Dutch Post-consumer textile recycling – A multi-criteria analysis of Scandinavian downstream mixed textile recycling techniques for suitable application in the Dutch context.
[119] Chan et al. (2020): Improving Dutch Post-consumer textile recycling – A multi-criteria analysis of Scandinavian downstream mixed textile recycling techniques for suitable application in the Dutch context.

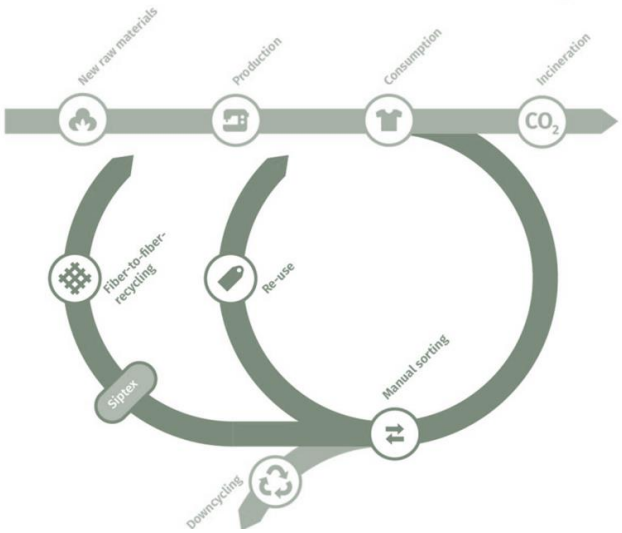
3.1.4 Sorting technologies

While many EU member states still utilise sorting by the hand of textile waste, implementing collection schemes for textiles will increase the waste flow, challenging manual sorting. Automated sorting makes it much more possible to recirculate textile waste, enabling the management of large waste streams and producing sorted textiles better adapted to different recycling practices[120]. Furthermore, automated sorting can reduce the costs of sorting textile waste, as labour costs can be significantly reduced.

3.1.4.1 SIPTex

The Swedish innovation platform for textile sorting (SIPTex) is a facility at the South Scania Waste Company (Sysav) in Malmö, Sweden. Its large-scale facility sorts textiles by colour and fibre composition using near-infrared light and optical spectroscopy (NIR/VIS). SIPTex is part of a project funded by the Swedish innovation agency, Vinnova. IVL Swedish Environmental Institute led the project. It is carried out with a broad consortium of partners from the entire textile value, research institutes, and authorities[121].

The fast high-quality sorting of textiles which SIPTex provide is an essential step towards high-quality textiles, fibre-to-fibre recycling and the establishment of large-scale circularity of textiles. The facilities receive pre-consumer textiles waste from industry, pre-sorted textiles such as hotel bedsheets and sorting residues such as damaged clothing not fit for reuse. It is the world's first automated sorting plant for post-consumer textiles on an industrial scale. The capacity is large as 24000 tonnes per year can be sorted. SIPTex uses optical sensors to determine the fibre and colour of the textiles. The textiles are illuminated, and the light is reflected differently depending on the material. Sensors detect and calculate the type of fibre. Compressed air blows the fabric to end up in a suitable container. The plant can be programmed to sort out three different flows simultaneously. When the textiles have been sorted into various colours and fibres, they are sold and ready to be recycled[122].



3.1.5 Recycling technologies

The choice of materials and the design of textile products influence not only the environmental and climate impacts of the products but also the available options at the end of life. The EEA argues that circular business models need to be systematically scaled, and supported by policies, to enable sustainable sourcing of synthetic and natural fibres, including the recycling and reusing of materials[123]. EEA emphasise that safe and clean material cycles can be supported in the member states by:

- Publicly demanding sustainable fibres, which can be promoted by education;
- Regulating and targeting policy options at quality and safety requirements;
- Implementing labelling and industry standards[124].

[120] IVL (2016): Automated sorting will increase recycling of textiles.
[121] Sysav (n.d.): How Siptex functions.
[122] Sysav (n.d.): How Siptex functions.
[123] EEA (2019): Briefing - Textiles in Europe's Circular Economy.
[124] EEA (2019): Briefing - Textiles in Europe's Circular Economy.

3.1.5.1 Re:newcell: Circulose®

The Swedish textile recycling company Renewcell uses a unique technology to chemically recycle textiles by producing the branded dissolving pulp cellulose called Circulose ®. It is a biobased equal-quality replacement for virgin materials like cotton, oil and wood that can be utilised to produce various types of regenerated fibres such as viscose, lyocell, modal and acetate. In contrast to other types of cellulose made from wood, Circulose® is made of 100% textile waste[125]. The company operates in an international market and exports its entire production to customers abroad[126].

Circulose® is made from both used garments and textile production waste. It is primarily produced from cotton, but viscose and other textiles with a high cellulosic content can also be used. The process is very similar to processes used in the pulp and paper industry but has been adapted to facilitate the use of cellulose textiles instead of timber. The textiles are mechanically shredded, de-buttoned and de-zipped. The shredded textile is then chemically de-coloured and turned into a slurry. Contaminants and other non-cellulosic content are separated from the slurry. The heart of Renewcell's technology is the ability to separate closely tangled cotton fibres from each other, which makes them available for regenerated fibre production. Finally, the slurry then is dried and cut into sheets[127].

Renewcell was founded in 2012 and opened a demonstration plant in Kristinehamn, Sweden, in 2017. The facility has a production capacity of 4,500 tonnes per year. Renewcell is currently establishing its first plant at a commercial scale in Sundsvall. It is expected to be commissioned in the summer of 2022 and will first have a production capacity of 60,000 tonnes per year. Renewcells' operational goal is to reach a production capacity of 250,000 tonnes per year in 2026 and 360,000 tonnes per year in 2030[128].

3.1.5.2 Wolkat: mechanical recycling

Wolkat is a group of textile recycling companies which collect and sort for both reuse and recycling and recycle and re-create textile products. This way, they can control the entire recycling chain and process 25,000 tonnes of textile waste per year[129]. Wolkat's headquarter is based in Tilburg, Netherlands, and they have facilities in Tangier, Morocco, where textile waste is sorted, cleaned, and recycled. The recycling process begins with manually removing buttons, labels, and zippers. Textiles are then sorted by colour and fibre type. The textile is mechanically chopped and fiberised. The materials are spun into several types of quality yarns. Wolkat produces recycled textiles in their weaving plant as well as producing felt, which can be used in mattresses, geotextiles, isolation and in the car and furniture industry[130].

3.1.5.3 Aquafil: ECONYL®

The international Aquafil Group launched their ECONYL® Regeneration System in 2011, a technology used to produce a particular type of nylon entirely from pre- and post-consumer waste. The Aquafil Group produces polymers used in the plastic moulding industry to produce fashion accessories and carpet yarn for manufacturers. It supplies clothing yarn and synthetic fibres for European apparel, underwear, and sportswear brands. Aquafil is committed to its ECONYL® project, which currently represents around 37 % of its revenue, but is planned to reach 60 % in 2025. Their regeneration plant in Ljubljana, Slovenia, produces the regenerated ECONYL® from nylon acquired from textile waste. Aquafil has created an internationally structured network for collecting nylon waste based on partnerships with institutions, companies, organisations and public and private consortiums worldwide. The two main streams of waste nylon used to produce ECONYL® are carpets and fishnets. At first, the nylon is separated from the other waste, shredded, and prepared.

[125] Renewcell (2022): We make fashion circular.
[126] Renewcell (2022b): Annual report – 2021.
[127] Renewcell (2022b): Annual report – 2021.
[128] Renewcell (2022b): Annual report – 2021.
[129] Constantinou & Holmgaard (2020): Research and identification of textile plants in the Nordic countries & Europe – focusing on fiber-to-fiber recycling in the fashion & textile industry.
[130] Wolkat (n.d.): Wij werken aan – Impact met recycling.

Aquafil uses fishnets from the oceans rescued by volunteer divers and nets from the aquaculture and fish industries. Aquafil has two carpet recycling facilities in the United States, each processing up to 36 million pounds of carpet annually. The waste carpets are broken down into three main components polypropylene, calcium carbonate and nylon. The polypropene can be used in injection moulding production and calcium carbonate in the road or concrete construction. The nylon is broken down into building blocks in Ljubljana's depolymerisation plant. Then it is polymerised into new nylon and spun into a range of yarns[131,132,133].

3.1.5.4 Södra: OnceMore®

The Swedish forest owner association and forest industry group, Södra, 2019 introduced a new recycling process called OnceMore®. The process combines cellulose from wood fibres with cellulose from fibres from textile waste to create high-quality dissolving pulp, which can be used in textile production. It is the first industrial-scale recycling of textile waste of blended fibres. In the OnceMore® process, pre- and post-consumer textile waste of polycotton blends (one of the world's most widely used textile types) is first cut into small pieces; then, the polyester is degraded and removed. The cellulose from the cotton is then mixed with wood cellulose. Södra is making significant investments in expanding production and developing the process. In 2019 the OnceMore® pulp consisted of 3 % recycled textile, but the content has today been increased to 20%, and Södra has a target of 50% recycled textile content set for 2025. Södra plans to be able to process 25,000 tonnes of textile waste per year by 2025[134].

3.1.6 Potential benchmarks for textile waste

A separate collection of textiles for reuse is typical throughout Europe – primarily operated by the private section as a business or charitable activity. Scandinavian countries, in particular, collect a larger share of anticipated end-of-life textiles than their counterparts in Portugal.

Few countries have introduced extended producer responsibility for textiles, and only the French model has been in place for long enough to draw conclusions and lessons. The system provides a valuable funding stream to support the collection of used textiles, although the eco-design component appears largely ineffective.

Similarly, few countries have specific collection systems for textile waste, and those that do have only recently begun, so the experience is limited.

BENCHMARKS[135]	INDICATORS[136]
National standards for monitorisation of municipal solid textile waste production and management	Common indicators for municipal solid waste management and yearly statistical reporting
At civic amenity sites textile waste is collected separately	Share of civic amenity sites with textile containers
At civic amenity sites product exchange areas, aimed at fostering reuse, are available	Share of civic amenity sites with product/material exchange areas aimed at fostering reuse
For municipalities with at least 1000 residents, there are at least one civic amenity site in the territory	Easy accessibility of civic amenity sites Number of civic amenity sites per 100 000 residents
Monitorisation standards for performance of EPR schemes for textile products	Monitoring and statistical reporting of EPR activities of textile producers, importers, and retailers
Reinforced quantified and documentable waste prevention targets	Systematic textile waste statistics and quantification of reinforced incentive actives

[131] Aquafil (2015): Environmental product declaration for ECONYL® bcf reprocessed yarns.
[132] Aquafil (2022): Sustainability Report 2021.
[133] Econyl (n.d.): Some see trash. Others see treasure.
[134] Sodra (n.d.): Let's make a sustainable future together.
[135] European Commission (n.d.a): Civic amenity sites – Green Best Practice Community.
[136] European Commission (n.d.a): Civic amenity sites – Green Best Practice Community.

Systematized and reinforced Green Public Procurement	Green Public Procurement that upholds standards for durability, eco-design, declaration of CO_2e emissions from the production and use-phase

3.2 Bulky waste

Separate collection of bulky waste, and other waste streams, are a pre-condition for fostering an increase in preparation of reuse and recycling and ensuring that the recycling and reuse of high quality[137]. Following the 2018 Waste Framework Directive (Directive (EU) 2018 of the European Parliament and of the Council amending Directive 2008/98/EC on waste), bulky waste fractions such as furniture were included. Under article 3, furniture was included in the list of continued materials. Under article 9, requirements for the measure to encourage repair and reuse of furniture as a part of waste prevention activities[138]. As bulky waste is a very heterogeneous waste stream, different approaches for preparation for reuse and recycling might be dependent on the bulky waste fraction. Therefore the separate collection of bulky waste as an overarching waste category is insufficient for preparation for reuse and recycling. Further separation and sorting of the bulky waste can accommodate a higher reuse and recycling rate.

3.2.1 Extended producer responsibility and take-back systems

There are no obligatory EU requirements for EPR or take-back systems for bulky waste. However, the amended Waste Framework Directive 2018/851 did reinstate the importance of waste prevention under the waste hierarchy. Under article 9, furniture is highlighted as a high-priority group for encouragement for preparation for reuse. EPR schemes are recognised for promoting the separate waste collection, meeting municipal waste recycling targets and reducing landfill utilisation. Further, EPR schemes can be utilised as a critical instrument to promote reuse, waste prevention and eco-design[139]. While the on-request collection of bulky waste, currently utilised by most Portuguese municipalities, could still facilitate the collection of citizen-produced bulky waste, such as trees, branches etc., EPR schemes could enable an economically viable solution to support more significant preparation for reuse and recycling, of factions such as furniture, appliances, and mattresses.

Some furniture stores already offer take-back of old furniture when delivering new furniture to the consumer. Businesses such as IKEA offers takeback of furniture in many EU countries, including Italy, Germany, Sweden, France, and Spain[140]. Since 2020, IKEA also offers to buy back many types of furniture, including sofas, bed frames and wardrobes. The furniture is repurchased at 30-50% of the original price, which is given as a voucher to the seller. If the used furniture is unsuitable for retail, IKEA will offer to recycle it for free. The buy-back model is an effort to move up the circular ladder from recycling to reuse[141,142]. Whether or not buy-back options should be allowed under EPR schemes depends on the decree-law associated, as EPR, in most cases, would entail that the producer is responsible and, therefore, responsible for the financial burden of waste management.

3.2.1.1 France

In France, the 2010 law on National Environmental Commitment stipulates that all legal persons manufacturing, importing, or placing furniture items on the market are responsible for collecting and processing

[137] European Commission (2015): Assessment of separate collection schemes in the 28 capitals of the EU.
[138] EC (2019): Study on investment needs in the waste sector and on the financing of municipal waste management in Member states.
[139] Pouikli (2020): Concretising the role of extended producer responsibility in European Union waste law and policy through the lens of the circular economy.
[140] IKEA (2021): Buy back.
[141] WRAP (2021b): Mattress collection and take back from households for recycling.
[142] URBANREC (2019): New approaches for the valorisation of Urban waste into high added value RECycled products.

waste from products provided at the end-of-life stage. The National Environmental Commitment set out the principle for the French interpretation of EPR[143], which was applied to the furniture industry specifically after a law in 2011 on the Prevention and Management of Waste Furniture was published[144]. The EPR scheme in France was implemented to relieve local authorities of all or part of the costs associated with waste disposal and to transfer waste management financing from the taxpayers to the consumers and/or users, building upon the polluters pay principle. The EPR scheme has facilitated that the costs of furniture products reflect the end-of-life costs in the sales prices[145]. The law on Prevention and Management of Waste Furniture set ambitious targets for reuse and recycling: a reuse and recycling target of 45% for household furniture and a 75% reuse and recycling rate for commercial furniture[146].

In practice, two PROs manage the French EPR schemes for furniture: Écomobiler, which has the responsibility for household furniture waste, and Valdelia, which has the responsibility for non-household waste. Écomobiler and Valedia do, however, share the same objective: encourage reuse based on solid partnerships with local authorities[147].

The French EPR scheme is based on the financial approach to EPR systems. This is illustrated through eco-fees, which were introduced to apply the EPR scheme to the sector for imported furniture in France. The fee is calculated by the importer and added to the sale price of the product. The collected fees are transferred to Écomobilier, which uses the collected fees to help businesses working in France to organise the collection, recycling, and recovery of used furniture[148]. The weight and dimensions of the product determine the eco-fee. The pricing scale differs between furniture, bedding, and seats. The fee is unchanged throughout the distribution chain to ensure that it is clearly understood by the final consumer[149].

In 2016, under the Écomobilier scheme, eco-modulation criteria concerning furniture design were introduced. The level of modulation reflects the design of a product and its consequential impact on the environment - so a lower levy is charged to manufacturers where they meet environmental product criteria. Companies that comply with the criteria get a fee reduction of about 20%[150]. The French EPR scheme further facilitates eco-design implementation and the development of durable products.

3.2.1.2 Belgium, Flanders

Waste governance is primarily carried out at a regional level in Belgium, and no national waste prevention programme is in place. However, the country's three regions (Brussels, Flanders, and Wallonia) have three separate programmes. Flanders is the country's largest producer of municipal solid waste, producing around 60% of all municipal solid waste in Belgium. The first waste management plan was introduced in 1986 in Flanders. Since then, governmental entities have set ambitious targets and landfill bans, which have led to increasing quantities of waste collected separately[151].

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[143] Ecomobilier (n.d.): How to comply with French regulation governing Extended Producer Responsibility (EPR).

[144] Rreuse (2013): Extended Producer Responsibility and the role of reuse activities: Opportunities for a resource efficient, socially inclusive waste management system.

[145] Valdelia (n.d.): Valdelia: an Extended Producer Responsibility System for non-household furniture waste.

[146] Rreuse (2013): Extended Producer Responsibility and the role of reuse activities: Opportunities for a resource efficient, socially inclusive waste management system.

[147] Valdelia (n.d.): Valdelia: an Extended Producer Responsibility System for non-household furniture waste.

[148] Eco-mobilier (2018): Note D'Information à L'Attention des Fabricants de Mobilier Européens et Internationaux – La reglementation française sur la collect4e et le recyclage des meubles: quelles sont les obligations de vos clients, fabricants, importateurs et distributeurs français?

[149] Eco-mobilier (2018): Note D'Information à L'Attention des Fabricants de Mobilier Européens et Internationaux – La reglementation française sur la collect4e et le recyclage des meubles: quelles sont les obligations de vos clients, fabricants, importateurs et distributeurs français?

[150] EEB (2019): Circular economy opportunities in the furniture sector.

[151] Eunomia (2021): Support on EPR schemes for mattresses and textiles for Greece – Final report.

Despite the regional approach to waste management plans, Belgium introduced an EPR policy at a national level for 11 waste streams. The Plan de géstion des resources et des déchets was implemented in 2019 and entailed a national circular economy action plan focusing on resource efficiency and recovery. EPR schemes for mattresses have been identified as one of the waste streams of interest. EPR schemes for mattresses were exclusively done in Flanders, and a national implementation was addressed by governmental entities in Flanders in 2012. The other regions did not have the same drive for implementation. Still, in January 2021, EPR schemes for mattresses were implemented nationally, operated by the PRO Valumat- Valumat collaborates with municipalities and inter-municipal waste associations to collect end-of-life mattresses[152].

Three sector federations in Belgium established Valumat: Fedustria (federation for the textile, wood, and furniture industry), Comeos (federation of trade and services), and Navem (federation of furniture trade). The PRO was established to take on organisational and financial responsibility for ensuring that manufacturers and importers followed the waste management requirements of mattresses. Now, manufacturers and importers must either join a PRO or organise their own waste collection plan, which must be agreed upon by the governments of Brussels, Flanders and Wallonia. A fee must be paid at the point of sale of a mattress. All eco-contributions to a scheme are backdated to its implementation, meaning that an organisation joining Valumat are liable for all mattresses put on the market the year they join the PRO. Retailers do not have any obligations under the EPR policy and are not mandated to engage in take-back schemes. However, retailers are financially compensated by Valumat if they engage in take-back schemes[153].

3.2.1.3 The United Kingdom

The Waste Prevention Programme includes bulky waste in the seven key sectors of the British Government's initiate cross-sectoral actions to minimise waste. Bulky waste is the first area of focus, and in a British context, the term bulky waste covers a vast range of products generally described as any items over 25 kg that cannot fit in household bins. Therefore products such as mattresses, wardrobes, fridges, sofas, and garden furniture will be covered under the upcoming EPR scheme[154].

The driver for implementing an EPR scheme is related to the significant challenges with the current system in the UK. Bulky waste streams from households can be disposed of properly, as many local authorities offer a chargeable bulky waste collection service and disposal options at household waste recycling centres. This does, however, come with a downside, as the citizens must be willing or able to pay service fees or the availability of transportation options to the household waste recycling centres. As these options are not viable for enough citizens in the UK, an increase in charity furniture collections has been seen, as well as utilisation of P2P sales through online platforms[155].

The EPR scheme will be composed to facilitate acknowledgement and funding support for the reuse sector, funding for the recycling of bulky waste, improvement of collection and take back schemes from producers, help for local authorities on funding waste collection and reduce the burden for the consumer, and the creation of a system ensuring punishment for malpractice and illegal dumping[156].

3.2.2 Civic amenity sites and circulation parks

Most civic amenity sites accept bulky waste for reuse to some extent. In some sites, it is possible also to collect items for direct reuse, while other amenity sites pass on the collected items to specific reuse or charity organisations[157]. Trends for circulation parks have been rising in Europe, in addition to civic amenity sites. Circulation parks that assist the transition towards a circular economy are established in, for example,

[152] Eunomia (2021): Support on EPR schemes for mattresses and textiles for Greece – Final report.
[153] Eunomia (2021): Support on EPR schemes for mattresses and textiles for Greece – Final report.
[154] Valpak (2021): Can EPR help do some heavy lifting with bulky waste?
[155] Valpak (2021): Can EPR help do some heavy lifting with bulky waste?
[156] Valpak (2021): Can EPR help do some heavy lifting with bulky waste?
[157] Waste Sweden (2021a): Återvinningscentraler.

Sweden, Denmark, Italy, Austria, France, Poland, Estonia, and Germany[158,159,160,161]. The concept has continued to grow in the past few years. Circulation parks are larger civic amenity sites with more functions that allow recycling and value preservation of the delivered waste. Typically, circulation parks only receive waste for recycling and reuse. Items unsuitable for direct reuse can be repaired or refurbished in workshops located within the park and sold in second-hand stores. When repair and refurbishment are not possible, the materials will be recycled and utilised as a material input to produce new products. Finally, materials and items that cannot be reused are recycled in fractions for further recycling treatment[162].

3.2.2.1 Denmark

In Denmark, there are three different approaches to managing bulky household waste. Curbside collections are available in most municipalities, where citizens can put bulky waste on the sidewalk one day a month. Pick-up services are also available in most municipalities. At last, every civic amenity site provides a disposal point for bulky waste, often separated into smaller sub-fractions. No pickup- or disposal fees are involved for the citizens, as these are paid through taxation[163]. Offering many options for the disposal of bulky waste ensures higher collections rates by accommodating, e.g. elders, citizens without a car, etc.

In the past few years, circulation parks have been implemented around Denmark. A circulation park, REUSE, explicitly focusing on reuse, has been established in Aarhus. This circulation park has open access for the public to pick up reusable items for free. Reusable items from the other civic amenity centres in the municipality are transported to the circulation park, resulting in a collection of all reused items available for the users in one place. The items are sorted and displayed in categories; this makes it easy for the user to get an overview of available items. The circulation also offers the collecting or sorting of specific items for different arrangements, such as cultural institutions or organised theatres or events. Aarhus municipality has reported a pick-up rate of 90% of the reusable items from the circulation park, facilitating improved utilisation of the bulky waste[164,165]. To upcycle products only suited for recycling, REUSE has started offering repairs of items to increase preparation for reuse further. A mobile repair workshop circulates between the circulation park and the city of Aarhus, where volunteers of all ages offer their help to repair garments, furniture, bicycles, cell phones etc. The mobile repair workshop provides grounds for increased preparation for reuse and increases awareness of waste reduction, reuse, and recycling[166].

Recycling initiatives are also available, facilitated through the Danish civic amenity sites and circulation parks. In Copenhagen, a recycling initiative called the Test Laboratory has been implemented at the civic amenity site Sydhavn Genbrugscenter (The Reuse-center of Sydhavn). Sydhavn Genbrugscenter is a collaboration between Copenhagen's municipality, responsible for waste collection, and a private company, facilitating the Test Laboratory. The Test Laboratory consists of a workshop for entrepreneurs who use recyclable materials collected at the civic amenity site. The workshop is a shared space where entrepreneurs access machinery and tools for developing circular business ideas. The entrepreneur buys the materials cheaply and uses them for prototypes, art projects, etc. The primary material utilised at the workshop is wood, e.g., furniture. Sydhavn Genbrugscenter further facilitates events open for citizens to promote awareness of options for the reuse and recycling of waste materials[167].

3.2.2.2 Spain

In Spain, household waste and recycling are the responsibility of the municipalities under the Law 7/1985 of 2 April 1985 and Law 22/2011 of 28 July 2011. Bulky waste is collected either through civic amenity sites or curbside collection. In some municipalities, some municipalities also offer pickup services on demand[168].

Environmental points for recycling[169,170]

[169] URBANREC (2019): New approaches for the valorisation of URBAN bulky waste into high added value RECycled products.
[170] Consorcio Valencia Interior (2021): My environmental account.

The Valencia region of Spain participated in the URBANREC project founded by the European Commission through the Horizon 2000 Research and Innovation Programme. Through collaboration with project partners, the Spanish partners developed a strategy to increase reuse in the Valencia region. One of the actions implemented on account of the strategy development was a reuse container, which was installed at a civic amenity site in Llíria in 2018. The reuse container was provided by the Fundació Tots Units, a social economy company which manages the materials and products available for reuse. While the reuse container has contributed to raising awareness on reusable materials, a lesson learned from the implementation was that citizens are tempted to take the materials without payment if there is no control of extradition[171].

> An economic incentive for use of the civic amenity sites has been implemented in the Valencia region, where citizens get a discount on their next visit when they deliver bulky waste to the site. The system works through "environmental points" that citizens attain when they deliver waste to the civic amenity sites. By using the points, citizens can get up to 50% reduction of the tax that otherwise is applied to waste disposal. The points are rewarded to a personal identification card.

3.2.2.3 Belgium, Flanders

In Flanders, Belgium, bulky waste beside mattresses is collected through civic amenity sites or curbside collection. Civic amenity sites are, however, the most used collection approach, as over 90% of bulky waste is collected there[172]. Flanders was also part of the URBANREC project and have one of Europe's most developed collection schemes for reusable bulky waste. Flanders have recorded their advancement in reuse and recycling by obtaining high-added-value products from bulky waste. The collection network is well organised and facilitated by collaboration between waste management companies and local and regional authorities. The collection network includes reuse centres and shops[173], further supported by taxes and tariffs for landfills and a complete landfill ban on recyclable and incinerable waste. In addition to this, they have introduced fees for mixed bulky waste. The fees do not apply for bulky waste sorted into fractions. The fees work as incentives for proper disposal practices and increased recycling[174].

Collaboration is one of the critical elements to the success stories in the Flemish region, and most of the municipalities have grouped into municipal associations, totalling 27 inter-municipal waste management associations[175]. In the province of West Flanders, an association of eleven municipalities, IMOG, is responsible for waste collection in the region. Collection-on-demand is one of the offers of bulky waste disposal that citizens can make use of. A truck collects bulky waste once a month, and citizens can order pick-up via telephone until one day before the pick-up date. IMOG has also developed an app through which the citizens can demand the collection of bulky waste. In the app, citizens can also find information on the most optimal way to dispose of their bulky waste, whether it is recycling or reuse[176].

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[160] Urbanwins (2021): Alelyckan Recycling Park in Gothenburg.

[161] Interreg (2020): Reuse and repair centres: Moving out from the shadow of recycling.

[162] Urbanwins (2021): Alelyckan Recycling Park in Gothenburg.

[163] Larsen et al. (2011): Bulky waste quantities and treatment methods in Denmark.

[164] Affaldvarme (2021): Reuse

[165] Reuse (2021): Genbrugsguiden.

[166] Kredsløb (n.d.) : Brug REUSE.

[167] Sydhavn Genbrugscenter (n.d.): Testlaboratorium.

[168] European Commission (2014a): Capital factsheet on separate collection.

[169] URBANREC (2019): New approaches for the valorisation of URBAN bulky waste into high added value RECycled products.

[170] Consorcio Valencia Interior (2021): My environmental account.

[171] Crespo (2020): URBANREC: recovering urban bulky waste to create high added-value recycled products.

[172] URBANREC (2019): New approaches for the valorisation of URBAN bulky waste into high added value RECycled products.

[173] Cordis (n.d.): EU regions pilot a circular economy approach to bulky waste management.

[174] URBANREC (2019): New approaches for the valorisation of URBAN bulky waste into high added value RECycled products.

[175] ZeroWasteDunbar (2014): How does Flanders achieve a 73% diversion rate?

[176] Colas, G. (2019): Mobile app on bulky waste for reuse and recycling.

Civic amenity sites in the IMOG region are also affected by digitalisation, as a customer portal service is utilised to collect data on recycling patterns with a specific focus on bulky waste. Data is collected when the citizens utilise the civic amenity site, made possible by providing individual cards to access and pay for bulky waste collection. While the data collected is anonymised, some data is transferred to the customer portal, such as gender, age, address, date of visits, types of waste brought in and quantities. This data is utilised to define specific communication and educational activities targeting groups of citizens that could improve their disposal practices[177].

3.2.3 Doorstep and curbside collection

Doorstep and curbside collections are facilitated differently around Europe. One version of these collection approaches is a set time frame for collecting the waste, for example, monthly. Another approach is collection-on-demand, where citizens can call in or fill out a form when they need collection. Collection on demand is used in Dresden, Germany, where a fee is charged for collection[178]. This is also the primary collection method in Luxembourg[179]. The city of Heidelberg utilises the time frame approach, where the waste is collected for free at regular intervals[180]. However, in Heidelberg, the citizens also must fill out a registration form before the collection takes place. For example, the doorstep collection is also used in Sweden, Denmark, and Belgium[181]. Curbside collection is through containers placed on the curbside of streets or in the courtyard at apartment complexes that are not as utilised for bulky waste due to the heterogeneous and often large volume of the products. In many European countries, citizens can dispose of their bulky waste besides containers used for curbside collection of other waste streams. Curbside collection can be on-demand or at regular times during the year, like doorstep collection. The curbside collection model is used inter alia in Spain, Poland, Germany, France, Sweden, and Denmark[182,183, 184].

3.2.3.1 The Netherlands

In the Netherlands, household waste is managed at a municipal level. Each household is charged an annual garbage tax, the afvalbelasting, to decrease the cost of collection and treatment for the municipalities. The municipalities publish a calendar on their websites, displaying waste collection days throughout the year. Addresses and other information on bulky waste disposal sites and recycling centres are also provided on the municipal website[185].

Bulky waste, which cannot be collected in household waste bins, can either be dropped off at local civic amenity sites or brought to local collection points, afvalspunten. Many Dutch municipalities offer a pickup service for large bulky waste items when citizens cannot bring the bulky waste to a waste collection point. The pickup service is organised either by phone or online and will, in most municipalities, be covered by the garbage tax. However, in some municipalities, an additional fee can be applied for pickup services for bulky waste[186].

Bulky waste from garden maintenance, such as tree stumps or large branches, is sorted in a separate bin at each household. If it is impossible to fit the large garden waste in the bin, the bulky waste is taken to the local collection points, afvalspunten. If the garden waste is too large for the collection points, curbside

[177] URBANREC (2019): New approaches for the valorisation of URBAN bulky waste into high added value RECycled products.

[178] Dresden (2020): Dispose of bulky waste.

[179] Ville de Luxemburg (2021): Loose waste collection on demand.

[180] Stadt Heidelberg (2021) Bulky waste?

[181] Interreg Europe (2021a): Mobile app on bulky waste for reuse and recycling.

[182] URBANREC (2019): New approaches for the valorisation of URBAN bulky waste into high added value RECycled products.

[183] City of Gothenburg (2021): Hyr container för grovavfall.

[184] Frederiksberg municipality (2021): Affald fra villager og rækkehuse.

[185] ExpatiHolland (n.d.): Trash & Recycling in Holland.

[186] ExpatiHolland (n.d.): Trash & Recycling in Holland.

collection is offered. Citizen is responsible for tying together branches and other safety hazards. Until the bulky waste has been collected, the citizen disposing of the bulky waste are liable for any injuries sustained while the bulky waste is on street[187].

3.2.3.2 Sweden

Each of the 290 municipalities in Sweden must ensure that household waste is transported, recycled, or disposed of. Municipalities are free to organise waste management themselves. About 60% of the Swedish municipalities collaborate with other municipalities on waste management, and 40% have organised their own systems. The inter-municipal collaborations are done in various forms, such as municipal associations, joint political boards, and municipal-owned enterprises. In some of the municipalities, waste collection and treatment are carried out by private contractors[188].

Most municipalities in Sweden offer a combination of bulky waste disposal at civic amenity sites and door-step collection. In the City of Gothenburg, citizens can rent containers for bulky waste in addition to the other bulky waste sorting possibilities. Different-sized containers are available, and there is a fixed price for transport, emptying the container and treating the material. As possible, the collected waste is retrieved for reuse in the circulation parks, and the rest is recycled to the extent possible. Reusable items are sorted and sold directly in second-hand stores located in the circulation parks[189,190]. Circulation parks can be a successful way to promote reuse, as illustrated by Alelyckan Kretsloppspark, the circulation park in Gothenburg, where 70% of the disposed of products are reused[191].

In Stockholm, a pop-up reuse centre circulates between different city sites during the summer. The pop-up reuse centres accept any bulky waste that the citizens can carry. However, more oversized items must be delivered at the regular civic amenity site or collected through doorstep collection. In the pop-up reuse centre, there is a section for direct reuse, where citizens can pick up items for their own household[192].

Pay-as-you-throw is applied in some municipalities in Sweden as a way to promote recycling. With this approach, the user pays for the weight or volume delivered for recycling. This is done in Karlskrona, where the charge is lower when delivering a car-load bulky waste than a trailer load of bulky waste[193].

3.2.4 Sorting and recycling technologies

Recent developments in robotic sorting enable the automatic detection of recyclable materials in the waste stream. Machine sorting allows for less manual waste handling, which can be financially beneficial and for health reasons. The technique is in use for building and construction waste in Sweden[194]. Although few examples have been found where robotic sorting is currently used for sorting bulky waste, pilot studies and development projects have been composed as described in the best practice examples.

3.2.4.1 Denmark

The largest waste collection company in Denmark, Vestforbrænding, undertook pre-studies to establish a robotic sorting system for the automatic sorting of bulky household waste. They found that the examined system would have been able to sort recyclable bulky waste from the waste stream. Tests performed in a robotic facility in Finland showed a potential 50% reduction of bulky waste treated by combustion.

[187] ExpatiHolland (n.d.): Trash & Recycling in Holland.
[188] Naturvårdsverket (n.d.): Municipal waste management in Sweden.
[189] City of Gothenburg (2020): Kretloppsparken Aleyckan.
[190] Knivsta municipality (2020): Knivsta kretslopppspark.
[191] Urbanwins (2021): Alelyckan Recycling Park in Gothenburg.
[192] Stockholm Vatten och Avfall (2020): Pop-up återbruk.
[193] URBANREC (2019): New approaches for the valorisation of URBAN bulky waste into high added value RECycled products.
[194] ZenRobotics (2021): Wind powered robotic sorting.

Recyclable materials that can be detected through this method include wood, plastic, metals, textiles, and cardboard[195].

The project has not yet been completed due to a lack of financing. A partnership between stakeholders was established in Denmark to find barriers to bulky waste recycling in the region where Vestforbrænding is responsible for the waste collection. Another aim of the partnership was to diverge bulky waste suitable for reuse. The partnership was established through workshops with relevant stakeholders in which new forms of cooperation that promotes recycling could be developed. Barriers that could stand in the way of increased recycling were identified in the first workshop. The following workshops were then used to find solutions and establish partnership and contract models that supported the new common goals. The project concluded that successful contracts contributing to increased recycling require trust building, time, and dialogue between the contract parties in the development process and collaborative methods to establish incentives for increased recycling[196].

Experience from partnerships between municipalities, waste collection contractors and other relevant stakeholders has shown that the partnership approach can support higher recycling rates. Through dialogue, trust building and collaboration, stakeholders can set common goals, which can be implemented through incentive structures and contract requirements that bring more successful waste collection[197].

3.2.4.2 Germany

A project composed by Bremen University and funded by the European Regional Development Fund in 2009 has found a solution to increase efficiency in sorting bulky municipal and construction waste by developing an automated waste-processing system. Heavy and bulky municipal and construction waste are mostly sorted manually while sorting technology for lightweight municipal waste has been successfully implemented for quite some time[198]. At Bremen University's Robotics Innovation Centre, the development of a concept supporting the automated sorting of bulky waste was facilitated through the above project: The Robotergestützte Sortierung von großstückigem Abfall (ROSA), roughly translated to Efficient sorting of bulky wastes with robots. An automated waste processing system was developed using various sensors, such as cameras, 3D laser range finders and near-infrared material sensors. Combining the data from the different types of sensors with an intelligent analysis approach makes it possible to identify individual objects in agglomerations of waste, enabling guidance of the machinery in the system. Waste handlers and or robotic manipulators are from there able to sort the bulky waste stream[199]. The results of the project are not available.

In 2021, a report from ECOBULK on automated sorting technologies tested in Germany was published. Four sorting technologies were applied to the material supply chain of ECOBULK, FLYING BEAM®, AUTOSORT, X-TRACT and AUTOSORT FLAKE from the company TOMRA. Waste materials used for the testing came from the German bulky waste collection centres. In the tests, the target materials were PVC, non-ferrous metals, wood, and residue. The test results showed that combining sorting technologies provided successful results and enabled higher rates and quality of recycling[200]. As illustrated below, Autosort and Autosort Flake were utilised as sorting technologies for the ECOBULK value chain for the bulky waste plastic fraction:

[195] The Danish Environmental Agency (2020): Ressourceudnyttelse af storskrald ved robotsortering: Faglig afrapportering af arbejdspakke 1.

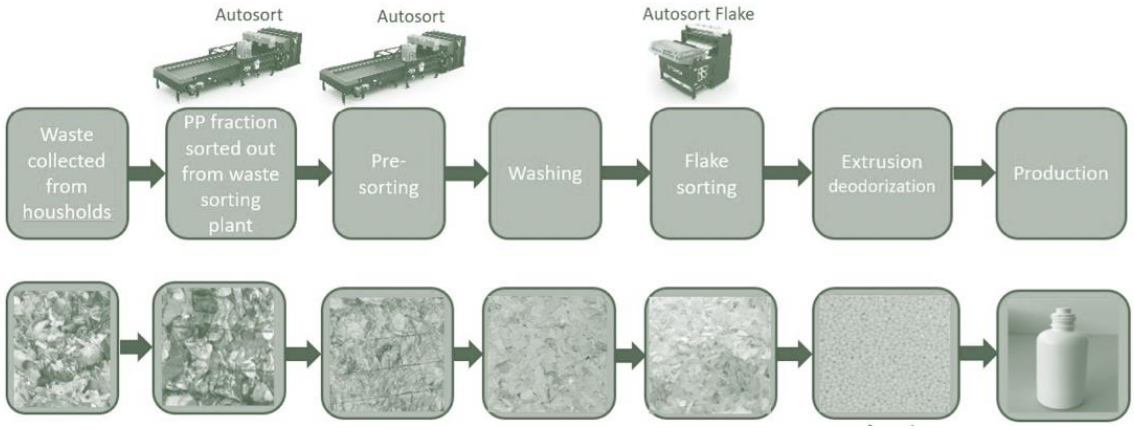
[196] The Danish Environmental Agency (2020): Ressourceudnyttelse af storskrald ved robotsortering: Faglig afrapportering af arbejdspakke 1.

[197] Vestforbrænding (2015): Partnerskab for storskrald.

[198] European Commission (n.d.b): Eco-Innovation.

[199] European Commission (n.d.b): Eco-Innovation.

[200] Ecobulk (2018): Solutions for the final sorting of bulky waste – Deliverable D5.3.



Process chain for recovering plastic (ECOBULK, 2021)[201]

The project's testing phase showed that NIR and x-ray sensor-based technologies could separate the target materials successfully. For all five bulky waste fractions, pre-treatment was necessary. The pre-treatment included crushing, screening, ballistic separation, and metal separation. The primary recovered materials were wood, rigid plastics, flexible plastics, metals, and fibres[202].

3.2.5 Benchmarks for bulky waste

EPR schemes for bulky waste have been implemented in a few European countries for specific bulky waste fractions such as furniture and mattresses.

Economic support to regional and local entities for separate collection and improved preparation for reuse and recycling can provide a faster and more thorough implementation process.

Collaborations –inter-municipal collaboration, local and regional collaboration, international collaboration, or municipalities collaborating with companies and citizens - can increase separate collection, preparation for reuse, and recycling.

Multiple disposal options for bulky waste support reducing illegal dumping and increasing citizens' visibility.

BENCHMARKS[203]	INDICATORS[204,205]
National standards for monitorisation of municipal solid bulky waste production and management	Common indicators for municipal solid waste management Minimum requirements for separate collection
Reuse of bulky waste is favoured over recycling	Targets for preparation of reuse and targets for recycling are specific and separate
Multiple waste collection methods can accommodate urban and rural areas	Share of municipalities offering multiple approaches to waste collection
At civic amenity sites product exchange areas, aimed at fos-tering reuse, are available	Share of civic amenity sites with product/material exchange areas aimed at fostering reuse
For municipalities with at least 1000 residents, there are at least one civic amenity site in the territory	Easy accessibility of civic amenity sites Number of civic amenity sites per 100 000 residents
Reinforced quantified and documentable waste prevention targets	Systematic bulky waste statistics and quantification of rein-forced incentive actives

[201] Ecobulk (2018): Solutions for the final sorting of bulky waste – Deliverable D5.3.
[202] Ecobulk (2018): Solutions for the final sorting of bulky waste – Deliverable D5.3.
[203] European Commission (n.d.a): Civic amenity sites.
[204] European Commission (n.d.a): Civic amenity sites.
[205] EEB (2015): EEB Position Paper on the EU Circular Economy Package.

Systematized and reinforced Green Public Procurement	Green Public Procurement that upholds standards for durability, eco-design, declaration of CO_2e emissions from the production and use-phase

3.3 Household hazardous waste

The Waste Framework Directive addresses household hazardous waste and provides additional requirements for labelling, record keeping, monitoring and control obligations from the "cradle to the grave". The Directive further bans mixing hazardous waste with other categories of hazardous and non-hazardous waste[206]. In 2020, the Commission Notice on Separate Collection of Household Hazardous Waste 2020/C 375/01 was published, providing guidelines for the EU member states. Hereunder, it was addressed that about two-thirds of household hazardous waste, separately collected in the EU member states, is collected at civic amenity sites. The remaining third is mainly collected through periodic pick-up, particularly at mobile collection points[207]. Processes in the member states for collection and treatment of household hazardous waste are primarily managed as illustrated below:

Household hazardous waste production and management (EC, 2020)[208]

Some household hazardous waste continues to divert from the appropriate disposal routes and is discarded in residual waste or, to a smaller extent, disposed of in household drainage resulting in significant health and environmental risks[209], e.g. ending up in water reservoirs or treatment plants.

The guidelines on household hazardous waste do not address waste streams covered by other Union waste legislation, such as batteries, WEEE, waste oil or end-of-life vehicles, as specific collection and management schemes already exist. However, the guidelines process the household hazardous waste captured under the category 'other', which has a relatively high environmental significance despite being a rather small faction[210].

3.3.1 Extended Producer Responsibility systems

In the European Union, EPR schemes for batteries and WEEE are mandatory within the context of the WEEE Directive 2012/19/EU and the Batteries Directives 2006/66/EC, which puts the responsibility of the financial burden of collection, recycling, and responsible disposal of WEEE and batteries on the producers of the products. Principles regarding the implementation of EPR schemes are further covered by the Waste

[206] European Commission (n.d.c): Hazardous waste.
[207] European Commission (2020c): Commission Notice Separate Collection of Household Hazardous Waste 2020/C/375/01.
[208] European Commission (2020c): Commission Notice Separate Collection of Household Hazardous Waste 2020/C/375/01.
[209] European Commission (2020c): Commission Notice Separate Collection of Household Hazardous Waste 2020/C/375/01.
[210] European Commission (2020c): Commission Notice Separate Collection of Household Hazardous Waste 2020/C/375/01.

Framework Directive 2008/98[211,212]. Some EU member states have implemented additional EPR schemes for other household hazardous waste streams, such as tyres, waste oils, farm plastics, medicines and medical waste, photo-chemicals, refrigerants, pesticides and herbicides, lamps, light bulbs, and chemicals[213]. In Portugal, EPR schemes are in place for WEEE, batteries, tires, and waste mineral oils, facilitated through PROs. The conditions established by the EPR policies have increased the quantity and quality of hazardous waste recovered and recycled[214].

3.3.1.1 Switzerland

Take-back obligations for waste batteries were introduced in Switzerland in 1986 and regulated under the Substances Ordinance. A voluntary mechanism was introduced in 1991 to finance the increasing costs of the treatment of waste batteries, which shifted to an obligatory Advance Recycling Fee (ARF) for producers in 2011 to align national regulation with the Batteries Directive 2006/66/EC.

Today, all producers of batteries, vehicles and appliances containing batteries must finance the net costs from collection, treatment, and recycling of the batteries they place on the market, the costs required for administrative work by the Federal Office of the Environment, and the costs needed for communication, and raising awareness of the waste collection, treatment, and recycling. For industrial and automotive batteries, the fee to ARF can be waived if the industries or companies can provide evidence of environmentally sound disposal that thoroughly covers the end-of-life costs of battery disposal. If the fee to ARF is waived, the producers are still obliged to cover administrative costs incurred by the centralised compliance scheme, INOBAT, which is the PRO responsible for coordinating the collection, treatment and reporting of waste batteries in Switzerland[215].

All producers must report the quantity of batteries placed on the market to an independent organisation commissioned by the Federal Office of the Environment. The Federal Office of the Environment commissions a suitable private company to coordinate the collection, administration, and utilisation of ARF every 5th year. The commissioned company are obliged to submit an annual report on the pollutant contents of the batteries, the return rate of batteries, utilisation of ARF, and a list of exempted producers[216].

In 2019, the collection rate of batteries was 63,68%, equalling 1,75 kg per capita collected. The structure of the scheme is evaluated to have a high awareness creation potential and a medium satisfaction level among stakeholders[217].

3.3.1.2 France

France has implemented Extended Producer Responsibility schemes for multiple factions of household hazardous waste, hereunder batteries, WEEE, end-of-life vehicles, unused medicines, vehicle tires, household chemicals, and sharp self-administration medical devices used by patients[218].

For expired pharmaceutical products and medical products. The collection of pharmaceutical products is coordinated by an organisation, “Cyclamed”, that organises cooperation between stakeholders in the supply chain and runs communication campaigns to increase public awareness. The network consists of 21.000

[211] European Commission (2014b): Development of Guidance on Extended Producer Responsibility (EPR).
[212] Monier et al. (2014): Development of Guidance on Extended Producer Responsibility – Final report.
[213] European Commission (2014b): Development of Guidance on Extended Producer Responsibility (EPR).
[214] Niza et al. (2014): Extended producer responsibility policy in Portugal: a strategy towards improving waste management performance.
[215] Inobat (n.d.): Batterien gehören zurück.
[216] FOEN (n.d.) Batteries.
[217] Ahlers et al. (2021): Analysis of Extended Producer Responsibility Schemes – Assessing the performance of selected schemes in European and EU countries with a focus on WEEE, waste packaging and waste batteries.
[218] Vernier (2021): Extended producer responsibility (EPR) in France.

pharmacies, 190 laboratories and 200 distributors through which pharmaceutical waste is collected. A collection rate of 62% of unused medication has been achieved through this system[219,220].

Potentially infectious medical products are coordinated through another organisation, "DASTRI". They primarily organise collection of sharp medical objects, which are collected in needle boxes that they distribute to the public. The needle box containers can be handed in at pharmacies connected to the DASTRI network. This model has contributed to an 83% collection rate of sharp medical objects[221].

3.3.2 Civic amenity sites and itinerant systems

3.3.2.1 Sweden

The most common collection method for hazardous waste is through civic amenity sites, where citizens are responsible for the delivery of their household hazardous waste. Two thirds of the hazardous waste collection from European households is through civic amenity sites[222]. The waste is sorted into fractions, and if needed, the citizens have the option to consult on-site staff. Civic amenity sites are usually equipped with suitable materials for the safe handling and storing of hazardous waste. In 2015, there were three civic amenity sites per 10.000 inhabitants across EU capital cities[223].

The system of hazardous waste collection through civic amenity sites is widely used in Europe, for example in Sweden[224], Slovenia[225], and Finland[226].

Mobile civic amenity sites are collection points that move regularly. One of the main ideas is to increase the accessibility of collection, typically for citizens that do not have access to a car. The mobile sites are typically built up by containers or trucks that can easily be transported, and they can either be staffed or unstaffed.

A pop-up reuse and recycling station in Stockholm collects some fractions of hazardous waste for recycling, including, for example, batteries and paint buckets[227]. A similar concept has been used in another part of Sweden, in Boden Municipality, a truck designated for the hazardous waste collection was set up next to a pop-up reuse station[228]. In Paris, France, staffed "Trimobiles" are used to collect household hazardous waste. These circulate between 30 locations in the different city parts, where they stay for half a day each time and and contribute to easy access to sorting facilities for the citizens[229]. The Trimobiles are estimated to collect 65% of all household hazardous waste in the areas where they are present.

3.3.2.2 Denmark

Kolding municipality in Denmark has established access to hazardous waste sorting at four civic amenity sites 24 hours a day through an app, which allows citizens to sort their waste at any time of the day. Citizens must register to the service, and afterwards, they can acquire access to the hazardous waste container at the civic amenity site through an app or SMS. The app opens a part of the building where hazardous waste can be deposited, and where an empty box is available for waste. When the waste has been placed in the

[219] Laubinger (2022): Management of pharmaceutical household waste – Guidance for efficient management of unused and expired medicine.

[220] OECD (2022): Management of Pharmaceutical Household Waste: Limiting Environmental Impacts of Unused or Expired Medicine.

[221] Dastri (n.d.): Les missions.

[222] European Commission (2020b): Separate Collection of Household Hazardous Waste.

[223] European Commission (2015): Resource efficiency and circular economy in Europe – even more from less.

[224] Waste Sweden (2021b): Farligt avfall från hushåll.

[225] European Commission (2015) : Resource efficiency and circular economy in Europe – even more from less.

[226] Vaarallinenjate (2021): Farligt avfall.

[227] Stockholm Vatten och Avfall (2021): Pop-up återbruk.

[228] Boden Municipality (2020): Popup-återbruk och mobil.

[229] Paris (2021): Avec le Trimobile, déposez vos petits encombrants.

box, it is transported into another room via a conveyor belt, limiting access to the deposited hazardous goods[230].

The round-the-clock sorting service was introduced in 2019. Kolding municipality has 94.000 inhabitants; in 2020 26.000 people had signed up for the service[231].

To facilitate a more flexible approach to waste collection and enable citizens to dispose of potentially hazardous waste whenever it occurs, Kolding municipality provides 24-hour access to their civic amenity sites - also for the hazardous waste, even during hours when the site is unmanned. This is achieved through using a mobile app to gain access first to the civic amenity site and then further to unlock the hazardous waste repository. Users must be registered, which minimises the possibility of abuse within the system of unwanted visitors[232].

In Odense, Denmark, the "environmental truck" visits the local civic amenity centres every 6th weekend. The environmental truck is designated for the disposal of hazardous waste only, and it is an offer for the citizens in addition to the two local civic amenity sites that always accept hazardous waste[233]. A truck is also used for hazardous waste collection in Brussels, Belgium. However, the Belgian truck is much more mobile, covering about 100 pick-up sites. The truck stops at many locations throughout the city; every location is covered every month or every second. The truck stays for about 45 minutes at each stop and is estimated to collect about 0,4 kg hazardous waste per capita[234]. A mobile collection method has also been set up in Nice, France, where an electric vehicle regularly stops at 274 collection points for household hazardous waste[235]. In Romania, a waste tram has recently been introduced. The tram runs through the city on weekends and collects electronic waste at tram station[236].

3.3.2.3 Estonia

Old shipping containers are used to collect hazardous waste in Tallinn, Estonia. These are placed centrally in the cities. The containers have been equipped with storage for different fractions of hazardous waste. In the 13 years following the introduction of the local collection containers, the hazardous waste collection increased from 0,04 kg/capita/year to 0,4 kg/capita/year in Tallinn.

3.3.2.4 Finland

In Helsinki, Finland, containers for hazardous waste collection (and collection of other waste fractions) are placed permanently at supermarkets and other local shops. The containers have the same opening hours as the shop they are connected to. In the metropolitan area, there is a total of 50 containers that can be accessed for free. Most hazardous waste fractions, including paints, oils, and spray cans, can be delivered at these sites. However, electronic waste, pharmaceutical waste and impregnated wood must be delivered directly to a civic amenity centre or pharmacy. The containers are not staffed, but the local police assist in looking after sites[237,238].

[230] Fors (n.d.): App'en 'Mit Affald'.

[231] Interreg Europe (2021b): 24-hour service for handing in hazardous waste.

[232] Kolding Municipality (n.d.): Kør på genbrugspladsen døgnet rundt med Genbrug 24-7.

[233] Odense Renovation (2021): Aflever farligt affald I miljøbilen.

[234] European Commission (2020b): Separate Collection of Household Hazardous Waste.

[235] ACR+ (2021): Hazardous Waste in Nice (France).

[236] Central Municipal de Colectare Iași (2021): Tramvaiul Reciclării.

[237] European Commission (2020b): Separate Collection of Household Hazardous Waste.

[238] HSY (2021) Insamlingsplatserna för hemmets farliga avfall

3.3.3 Doorstep and curbside collection

In door-step collection, hazardous waste is collected from citizens' homes. The collection can either occur at set time frames or through collection on-demand. On-demand collection is used in Sofia, Bulgaria, for electronic waste[239]. The door-step collection is also offered to citizens in Luxembourg at an interval of four times per year[240]. The system is also used in the Netherlands, Denmark and in Belgium[241].

3.3.3.1 Denmark

In Denmark, hazardous municipal waste includes paint residues, cleaning products, spray cans, mercury thermometers, weed/insect killer, varnish and glue[242]. Medicines are also considered hazardous waste and are delivered to a pharmacy for proper disposal. Although batteries and WEEE are typically also included as hazardous waste, they are also subject to EU-mandated producer responsibility and, as such, subject to their own collection system. In addition to these hazardous waste streams, hazardous C&D waste such as asbestos, impregnated wood, and contaminated soil can also be generated within 'household waste'. However, these are typically collected centrally in Denmark rather than as a collection service. Collection of HHW may not include items that can cause hazards to waste management workers during handling – for example, pressurised canisters and fireworks. These are subject to separate and careful collection and disposal/recycling.

Many Danish municipalities have implemented a "red box" system for the doorstep collection of hazardous waste. In Copenhagen, Denmark, a doorstep collection is offered to house owners. A small red box is supplied for house owners to continuously collect hazardous waste from the household. The box has a volume of 40 litres and locks tightly with a lid to avoid any leakages. The contents of the red box are collected at set dates four times per year. The same "red-box" system exists in Odense, Denmark. In Odense, the citizens can order collection-on-demand, or they can choose to deliver the red box to manned reception points or civic amenity sites[243,244, 245].

3.3.4 Benchmark

A specific collection of hazardous household waste is necessary to avoid discharging hazardous substances from waste facilities or illegal dump sites. The most common system in the EU is specific facilities for hazardous waste at civic amenity sites.

BENCHMARKS[246]	INDICATORS[247]
National standards for monitorisation of municipal solid bulky waste production and management	Common indicators for municipal solid waste management Minimum requirements for separate collection

[239] Interreg Europe (2021c): Waste management pop up recycle stations.

[240] Municipal Office of the City of Luxembourg (2021): SuperDrecksKëscht fir Biirger.

[241] European Commission (2020a): Commission Notice - Separate Collection of Household Hazardous Waste (2020/C 375/01). Official Journal of the European Union C 375/2.

[242] *From the European Waste Catalogue List, EWC codes for hazardous waste recognized in Denmark: 20 01 13 solvents; 20 01 14 acids; 20 01 15 alkalines; 20 01 17 photochemicals; 20 01 19 pesticides; 20 01 21 fluorescent tubes and other mercury-containing waste; 20 01 23 discarded equipment containing chlorofluorocarbons; 20 01 26 (non-edible) oil and fat; 20 01 27 paint, inks, adhesives and resins containing hazardous substances; 20 01 29 detergents containing hazardous substances; 20 01 31 cytotoxic and cytostatic medicines; 20 01 32 medicines other than those mentioned in 20 01 31; 20 01 33 batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries; 20 01 35 discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components; 20 01 37 wood containing hazardous substances.*

[243] Copenhagen Municipality (2021): Sådan sorterer du farligt affald.

[244] Regions for Recycling (2014): Good practice Odense.

[245] Gentofte Municipality (2021): Miljøboks.

[246] European Commission (n.d.a): Civic amenity sites – Green Best Practice Community.

[247] European Commission (n.d.a): Civic amenity sites – Green Best Practice Community.

At civic amenity sites, hazardous waste is collected separately allowing for proper treatment	Share of civic amenity sites with specific hazardous waste collection option
National separate collection system for both urban and rural territories	Separate collection of HHW is available to all citizens, backed by documentation of collection scheme
National governmental support to recycling initiatives for HHW	Support to recycling initiatives of HHW are reflected in the national budget

3.4 Construction and demolition waste

The most common method of collecting construction and demolition waste from European households is delivery to a civic amenity site. Here, the onus is on the household to arrange for waste transportation, and, in best cases, the waste should be pre-sorted.

3.4.1 Extended producer responsibility systems

There are limited examples of applying EPR schemes to the C&D waste stream. The examples that do exist of EPR policy for C&D waste target particular construction materials rather than collective C&D waste[248,249,250]. In academic literature, there are few examples of studies on the adoption of EPR in the construction industry[251]. Due to the large amount of waste produced during construction and demolition, the industry is an exciting case for EPR schemes. Yet because of the long production cycle, life span and heterogeneity of constructions, and the many different companies and temporary organisations involved in the construction services, EPR implementation in the construction industry is difficult[252]. Guggemos and Horvath (2003) have examined EPR strategies for buildings and found that due to the uniqueness of building products, takeback policies are not feasible for entire buildings but possible for many building materials and components[253]. Balba et al. (2013) evaluated EPR potential for different construction materials in metro Vancouver, and they found that EPR can be recommended for several types of materials[254]. There is an increasing trend of *offshore prefabrication,* referring to construction clients sourcing prefabricated components from other regions/countries. Xu et al. (2021) examined potential EPR implantation in offshore prefabrication construction. They have developed a conceptual framework to allocate EPR in offshore prefabrication construction. They identify two dimensions of difficulties: first, the responsibility for reducing, reusing, and recycling arising at the stages of construction and, decades later, during demolition. Secondly, the fragmentation and discontinuity of stakeholders make the EPR challenging to assign. Following the two dimensions, they propose different strategies for analysing and allocating short-term and long-term responsibility in either traditional project delivery or when an integrated project delivery method such as design-build or public-private partnership is adopted. Among other things, Xu, Jinying et al. (2021) conclude that an integrated project delivery consortium as a single entity is better positioned than traditional project delivery to assume EPR. They suggest an ideal approach to implementing EPR in offshore prefabrication construction by introducing a PRO and integrated project delivery methods[255].

[248] Shooshtarian et al. (2021): Extended Producer Responsibility in the Australian Construction Industry.

[249] Guggemos & Horvalth (2003): Strategies of Extended Producer Responsibility for Buildings.

[250] Balba et al. (2013): Assessing the potential for extended producer responsibility in construction, renovation and demolition waste in Metro Vancouver.

[251] Xu et al. (2021): A four-quadrant conceptual framework for analyzing extended producer responsibility in offshore prefabrication construction.

[252] Xu et al. (2021): A four-quadrant conceptual framework for analyzing extended producer responsibility in offshore prefabrication construction.

[253] Guggemos & Horvalth (2003): Strategies of Extended Producer Responsibility for Buildings.

[254] Balba et al. (2013): Assessing the potential for extended producer responsibility in construction, renovation and demolition waste in Metro Vancouver.

[255] Xu, Jinying et al. (2021): A four-quadrant conceptual framework for analyzing extended producer responsibility in offshore prefabrication construction.

3.4.2 Civic amenity sites

Civic amenity sites are one of the primary ways household C&D waste is collected in Europe. To ensure high-quality source separation, citizens must be aware of their responsibility to sort waste and to know which waste fractions to isolate. Communication and unified sorting guides across municipalities support effective source separation. In addition, novel approaches can support more reuse of construction materials and components in and from civic amenity sites.

3.4.2.1 Sweden

In Sweden, municipalities are responsible for handling C&D waste from households. The municipalities have varying resources and waste management practices. Today, most Swedish municipalities do not have reuse practices for C&D materials, but there is a growing interest in reuse practices, and some existing good practices are prominent. Existing forms of reuse practices for C&D waste among municipalities in Sweden can be separated into three categories: sales-based reuse in separate facilities outside recycling centres, sales-based reuse as part of recycling centres or reuse parks and finally, non-sales-based reuse: SWAP places[256].

Some municipalities (e.g. Malmö and Halmstad) have municipality-owned **Second- hand facilities** outside recycling centres. These often cooperate with waste management companies/recycling centres, where they have collection points for C&D materials. This results in high collection volumes. It is typically large premises of up to 16,000 m2 are used. Most of the collected materials come from companies, and only a small part is from households[257].

Some municipalities have an area for sale or reuse as an add-on part of the recycling centre or as a **Reuse Park**. (e.g. Alelyckan in Gothenburg). Usually, less space/premises are designated for delivery, storage and sales compared to the second-hand facilities outside the recycling centre. The collected products and materials are diverse and not limited to construction materials. Customers are primarily private individuals[258].

Some municipalities in Sweden have been testing **SWAP places** as a reuse solution (e.g. in Jönköping[259]). The collection sites dedicated to reusing are small, and the reuse rate is low compared to the sales-based operations. Still, the operating costs are much lower than second-hand facilities and reuse parks[260].

3.4.2.2 Denmark

Sydhavn Genbrugscenter is a new civic amenity site in Copenhagen with a strong focus on reuse. Like other civic amenity sites in Denmark, it accepts many hazardous and non-hazardous waste types from households and small enterprises. At the entrance to the site, however, supervisors greet incoming visitors and briefly inspect what they have brought to the recycling yard. If there is anything that the visitor or the supervisors feel may have value, it is removed and put aside for resale. Doors, shelves, wooden flooring and windows, and timber and wood are commonly captured and put on sale for a nominal price. Other types of building and construction waste are directed to the appropriate container. Beside each container is a space for collecting materials that could be reused if undamaged – toilets and sinks, bricks, roofing tiles, porcelain, paving stones, etc. Construction waste delivered to the civic amenity sites in Denmark must be pre-sorted into the respective waste fractions, and when loose waste should be delivered in transparent plastic bags.

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[256] Miliute-Plepiene & Moalem (2020): Increasing re-use of construction and demolition materials and products – Measures for prevention of waste at Swedish recycling centres.

[257] Miliute-Plepiene & Moalem (2020): Increasing re-use of construction and demolition materials and products – Measures for prevention of waste at Swedish recycling centres.

[258] Miliute-Plepiene & Moalem (2020): Increasing re-use of construction and demolition materials and products – Measures for prevention of waste at Swedish recycling centres.

[259] June Avfall & Miljö (n.d.): Jönköping sortergård.

[260] Miliute-Plepiene & Moalem (2020): Increasing re-use of construction and demolition materials and products – Measures for prevention of waste at Swedish recycling centres.

Waste may not be delivered in non-transparent bags. To support this, retailers of construction products only sell transparent bags[261].

3.4.2.3 *Rome, Italy*

The Municipality in Rome has taken initiatives affecting the collection of C&D waste from households[262]. In Rome, citizens can freely dispose of small quantities of C&D waste in collection areas. The collection areas are spread throughout the municipality's territory. The collection in these areas is primarily for urban waste, but construction and demolition waste from private owners are accepted. Rome Municipality took the initiative to react to the problem of frequent illegal disposal of C&D waste by citizens doing simple renovation works in their houses[263].

3.4.3 Pre-demolition audits

3.4.3.1 *Mandatory waste management plans, Rome*

Small construction companies in Rome have been escaping the control of the mandatory waste tracking systems for larger companies. This has led to the illegal disposal of C&D waste. To solve this issue, management plans for all private construction projects, including small ones producing a maximum of 30 m3 of non-hazardous C&D waste, were made mandatory in 2016. A Waste Production Declaration must be produced when requesting a building permit/authorisation for maintenance before the project begins. The declaration must include a list of the envisaged waste fractions, the relative weight/volume, and the identification of the recycling facilities to which the waste will be delivered. When the construction project ends all certifications demonstrating that waste was transported/recycled/disposed of correctly must be presented to the Municipal Offices. The initiative contributes to increased traceability of construction and demolition waste.

3.4.3.2 *Restore, Canada[264]*

ReStore are non-profit home improvement stores and donation centres that sell new and gently used furniture, appliances, home accessories and building materials. The non-profit housing organisation Habitat for Humanity[265] opened the first Restore in Canada in 1991. The Idea behind Restore was to keep building materials out of the waste stream while helping fund the work of Habitat for Humanity. In 2021 there were more than 1,000 ReStores across six countries, and it has recently opened a store in Poland[266].

3.4.3.3 *The Resource Bank project, Sweden[267,268]*

The Resource Bank project aims to facilitate more efficient matchmaking between the potential users of reusable construction and household demolition waste. The project is performed by the Swedish Environmental Institute IVL and was founded by Vinnova, the Swedish innovation agency, and partners from Sweden's construction and demolition sector. The objective of the project includes:

- Increased knowledge about the circular and bio-based economy;
- Improved resource efficiency along material value chains;

[261] Sydhavn Genbrugscenter (n.d.): Brugte byggematerialer.

[262] Luciano (2021a): Mandatory pre-demolition audits for private works and Site Waste Management Plans in Rome Municipali.

[263] Luciano (2021b): Direct C&D waste collection from citizens by AMA S.p.A.

[264] Habitat for Humanity (n.d.a): Celebrating 30 years of Habitat of ReStore.

[265] Habitat for Humanity (n.d.b): Frequently asked questions.

[266] Habitat for Humanity (n.d.c): Restore.

[267] IVL (n.d.): How do we increase the reuse of construction and demolition waste from households?

[268] Vinnova (2020): Re-Source Banks: Increasing the re-use of construction and demolition materials from households' renovation.

- Contribution to economic growth without negative environmental impacts;
- Waste reduction by strengthening economic, ecological, and socially sustainable production;
- And promoting Sweden's role as a pioneer in the international transition to a circular economy.

A feasibility study was composed to map regulatory, technical, and economic factors that can facilitate the reuse of construction and demolition waste. Further, a Material Atlas and analysis and testing of pathways for large-scale implementation of digital sharing or market platform for the construction and demolition waste. To ensure sufficient waste quantities, the digital platform will provide an overview of the availability of reusable construction and demolition waste material from multiple recycling centres on the national level. As the project's focus was to increase the availability of construction and demolition waste at recycling centres from household renovation work in Sweden, the project further aims to contribute to several goals within the UN 2030 agenda.

3.4.4 Benchmark

Household construction and demolition waste are, as a general rule not collected directly from households by the local municipality or public (contracted) waste management company. Private companies typically offer this service, but an adequate separate collection of the different construction and demolition waste types is often challenging in these systems.

Most member states rely on civic amenity sites to collect construction and demolition waste from households. Information, supervision and control of the use of these sites are essential to ensure proper waste sorting.

Mandatory demolition and waste management plans are essential for ensuring proper fractioning of the waste materials even for minor demolition and/or construction sites.

BENCHMARKS[269]	INDICATORS[270]
National standards for monitorisation of municipal solid bulky waste production and management	Common indicators for municipal solid waste management Minimum requirements for separate collection
At civic amenity sites, C&D waste is collected separately allowing for reuse and recycling	Share of civic amenity sites with C&D containers
At civic amenity sites, product exchange areas aimed at fostering reuse are available	Share of civic amenity sites with product/material exchange areas aimed at fostering reuse
For municipalities with at least 1000 residents, there are at least one civic amenity site in their territory	Easy accessibility of civic amenity sites Number of civic amenity sites per 100 000 residents
Demolition and waste management plans lead to segregation of waste materials, allowing reuse and recycling	Share of municipalities with obligatory requirement of demolition and waste management plans for construction and demolition sites
Systematized and reinforced Green Public Procurement	Green Public Procurement that upholds standards for durability, eco-design, declaration of CO_2e emissions from the production and use-phase

[269] European Commission (n.d.a): Civic amenity sites – Green Best Practice Community.
[270] European Commission (n.d.a): Civic amenity sites – Green Best Practice Community.

4 Drivers and barriers for increased preparation for reuse and recycling

The likelihood of successfully preparing and implementing environmental (and other) strategies depends on a valid and robust understanding of the enablers and barriers to change. The following analysis of barriers and enablers is built on literature research, interviews with relevant actors, and focus group consultations. Barriers are clustered into four types – cultural, regulatory, market-related and technological[271] - an approach the consultant has successfully applied in numerous projects[272]. The main barriers and opportunities for the increase of reuse and recovery of the four waste streams are presented in table 10Table 7.

Table 7. Main barriers to the increased reuse and recycling of textiles, HHW, bulky waste and C&D waste

WASTE STREAMS	TEXTILE WASRE	HOUSEHOLD HAZARDOUS WASRE	BULKY WASTE	CONSTRUCTION AND DEMOLITION WASTE
REGULATORY BARRIERS	Lack of a strategic legal framework for textile waste management	Lack of a clear legal definition for fractions of hazardous waste	Prioritization of costs over sustainability in public procurements	Lack of enforcement of mandatory of incorporation of C&D waste materials in new construction works
TECHNICAL BARRIERS	Lacking system for identification of contamination, quantities, and technological and pragmatic improvement potential	Low recycling potential of some materials and/or lack of recycling solutions	The variety of materials and collection conditions limit the potential for reuse and recycling	Lack of robust quantity estimations, typology of materials and conditions for reuse
CULTURAL BARRIERS	Lack of citizen awareness and willingness to shift consumer patterns, hindering stable markets for reused and recycled textiles	Scarce communication on capacitating citizens to be able to identify the hazardous materials within the generated municipal waste in everyday life.	Lack of awareness of citizens regarding existing collection systems	Significant rates of illegal dumping
ECONOMIC BARRIERS	Lack of demand, high labour costs, and competition with low-cost virgin materials	High collection and treatment costs due to small quantities to collect	Lack of market demand for recycled materials and recovered/repaired products	Low costs of virgin materials, and lack of trust in quality control of reusable and recyclable materials

4.1 Textiles

The following section will review barriers and drivers for increased preparation for reuse and recycling of Portuguese textile waste identified through consultations (interviews and focus groups) with relevant stakeholders from the Portuguese textile industry and waste collection and treatment organisations. Drivers and

[271] Kirchherr et al. (2019): Barriers to the Circular Economy: Evidence From the European Union (EU).

[272] *Examples include: PlanMiljø & Clean (2020): Strengthening the use of secondary raw materials in Portugal; Bauer & Egebæk (2019): Reuse of construction materials in Europe.*

barriers have all been validated through the triangulation method and a workshop with more than 400 relevant stakeholders.

4.1.1 Drivers

From an international perspective, collection and reuse/recycling of post-consumer textile waste has primarily been addressed through collaborative efforts, e.g. through place-based, grassroots collaborations led by social enterprises or consortia of international industry and research enterprises such as the European Clothing Action plan, in the development of technologies to sort and recycle textile waste.

Systematic approaches are required to address post-consumer textile waste to ensure efficient, systematic preparation for reuse and recycling. Assessments of volume, an understanding of consumer behaviour, local municipal solid waste management practices, national policies, technological efforts and supply chain innovation are all crucial aspects in developing a sufficient system[273]. From a local governance view, implementation for circular economy efforts has been explored somewhat fragmented, despite the importance of public policies remaining the most crucial driver towards full implementation of circular economy efforts. Differences in infrastructure approaches to waste collection and technology maturity hinder efficient knowledge exchange between municipalities. Overarching strategy development challenges the awareness among citizens and inclusion of relevant industry and company actors[274].

Waste shipment from Portugal is only allowed if third countries are willing to receive particular waste and manage them sustainably[275]. While this decreases some international trade of reusable and recyclable textile waste, export within, e.g. Europe is still allowed, resulting in Portuguese recyclers competing with recycling facilities in, e.g. Sweden with very advanced technological solutions and strong value chains.

At a local level, some municipalities and SGRUs (e.g. Lipor, Ambisousa and Municipality of Condeixa-a-Nova) are implementing innovative solutions to separately collect different waste streams (HHW, CDs and DVDs, small WEEE and textiles) such as movable collection points travelling from municipality to municipality. This aligns with Decree-Law 102-D/2020 of December 10, establishing that municipalities shall set up a separate collection for textile waste on their territories before January 1, 2025. At the current state of play, several municipalities rely on solutions established by non-profit organisations with a network of textile collection schemes. A significant amount of the non-profit organisations pays a fee to the municipality for the collected clothes, i.e. provide a trade-off to the municipality or parish, in some cases directly benefiting local social initiatives[276].

Private companies, non-profit and charity organisations, and some big brands have paved the way for greater consumer awareness in Portugal on where to dispose of used clothes, enabling more well-functioning collection schemes[277]. However, there is room for improvement in the incentive to buy reusable and recycled textile products, which national or local initiatives could support.

To ensure an overall improvement of the collection and treatment schemes for preparation for the reuse and recycling of textile waste in Portugal, the following additional drivers have been identified:

TEXTILE WASTE	NATIONAL	REGIONAL	LOCAL	INDUSTRY
Plano Estratégico para os Resíduos Urbanos (PERSU) 2030: Legal obligations to implement separate collection of textile waste	X	X	X	

[273] Sinha et al. (2022): Addressing post-consumer textile waste in developing economies.
[274] Dagilienè, et al. (2021): Local governments' perspective on implementing the circular economy: a framework of future solutions.
[275] Obtained though focus group interviews (17th of January 2022)
[276] Obtained though focus group interviews (17th of January 2022)
[277] Obtained though focus group interviews (17th of January 2022)

Legislation proposes the assessment of the implementation of an EPR scheme	X			X
Growing market for sustainable clothing	X	X	X	X
Quality labelling of textiles (e.g. how many washes are guaranteed)	X			X

4.1.2 Barriers

Textile waste collection and economically viable sorting infrastructure are known challenges across the globe. Sorting of textile waste involves intensive time and labour. While textile reuse is the most preferred option from an environmental and economic perspective, the market for reused clothing is not yet stable. EPR schemes are one of the policy tools that can incentivise the sustainable design of textiles and ensure the collection, processing, and treatment of post-consumer textile waste. In France, the EPR scheme has led to an annual increase of 13% in collecting post-consumer textile waste[278]. By making producers responsible for end-of-life handling of the textile waste, economic incentives, as well as incentives for intersectoral collaborations, are created.

A robust understanding of waste amounts is eminent to provide an efficient system for the preparation of reuse and recycling. Regional waste companies referred to several knowledge gaps concerning this waste stream and the difficulties of setting up cost-effective separate collection systems. The cost-effectiveness is of significant concern, and the collectors of used textiles (primarily for reuse) see increasing marginal economics as the primary challenge to their activities. With the current system reliant on non-profit organisations, the economic barriers could result in systemic challenges.

Cascais Ambiente[279] considers optical bags for textile waste a possible solution for the municipality instead of relying on the containers installed on the streets and managed by private companies. Porto Ambiente[280] indicates the need to place containers in strategic locations, such as schools, instead of on the streets. Lipor [281] shared its concern with having open containers freely available on the streets, which allows citizens to place waste other than textiles.

Wippytex has experienced worsening economic conditions in recent years for several reasons. Firstly, the quality of textiles delivered to bring-banks has been reducing, with the share of reusable textiles decreasing. This has a high impact on the economic value of the textiles that they collect. At the same time, collection costs are increasing: more municipalities are asking Whippytex to pay to place their bring-banks on public land and are asking for increased maintenance of the bring-bank sites to ensure that no waste is left around the sites and that they are continuously emptied. Wippytex and Humana foresee a much higher share of non-renewable textiles in separately collected textile streams as more used textiles are collected towards and beyond 2025. This will lead to a much worsened economic situation for collectors. Both view the lack of markets for recycling non-renewable textiles as a critical element in this challenge[282].

The barriers listed in the table below must be prioritised and addressed. The table will serve as a background for the development of a strategy on how to increase the reuse and recycling of post-consumer textiles:

	BARRIERS	LEVEL	CONSEQUENCE
	REGULATORY		

[278] Juanga-Labayen et al. (2022): A review on Textile Recycling Practices and Challenges.

[279] Consultation meeting with Luís Capão and Sandra Rebelo – Cascais Ambiente (August 25, 2021)

[280] Consultation meeting with Luís Assunção, Maria Guedes and Sofia Gomes – Porto Ambiente (September 7, 2021)

[281] Consultation meeting with Fernando Leite, Susana Lopes and Diana Nicolau – Lipor (August 12, 2021)

[282] Obtained though focus group interviews (17th of January 2022)

Lack of a strategic legal framework for textile waste management	National	Difficulties to establish a sustainable management system, technically and economically
Lack of legal framework for second-hand textiles and mandated policies for recycled textiles	National	Limits the encouragement for a more environmentally sustainable market
Lack of a clear legal definition of what is considered waste and resources	National	Textile waste streams are sent to landfill, incineration or downcycling.
Lack of enforcement of existing regulations against illegal waste dumping	Local	Lack of trust in waste management system
Prioritization of costs over sustainability in public procurements	National, regional & local	Discourages operators implementing more sustainable technical solutions focusing on recovering materials separately to reuse or recycling
Lack of regulation or best practices to frame collection partnerships between non-profit organisations and municipalities	National & local	Lack of cost-effective approaches and reduced collection and treatment amounts
TECHNICAL		
Lack of robust quantity estimations on waste production and destination	National, regional & local	Challenges cost-effective treatment and industry interest
Increased risks of contamination with the existing open containers	Local	Increases costs with sorting operation and ultimately diminishes the material potential for reuse and recovery
Challenges in identification of origin of waste	Local	Lack of enforcement of punishment regulation
Civic amenity centres located away from city centres and commercial areas	Local	Decreases the utilisation of civic amenity facilities, increases improper disposal
The visual 'pollution' of more containers for collection and the need to create new collection networks	National & regional	Reluctance from some municipalities, due to an increase of trucks traffic in town, and the idea that it gets confusing for the citizens
Lack of interest for post-consumer textile waste among industry actors	Regional & local	Limits the options for handling the collected materials
Post-consumer textiles collected made of blended complex materials	Regional & local	The variation in composition and quality results in technical and economic challenges with recycling
Immaturity of textile waste processing techniques and recycling technologies	Regional & local	Contributes to a slower circulation of materials in the textile sector
Lack of capacity to meet demand among textile recycling companies	National, regional & local	The national textile industry is not large enough to provide large-scale material recycling solutions
Many of the textile companies in Portugal work for international brands	National	The conception, design and choice of materials is decided by the foreign company
CULTURAL		
Unwillingness to purchase second-hand clothes among Portuguese consumers	National	Lack of market drivers for industry & companies
Illegally use municipal collection system by some textile companies	National, regional & local	Recyclable textile waste ends up in landfill and at incineration plants
Low citizens' awareness on best practice for disposal and the potential impact of incorrect practices	National, regional & local	Weak source-separation and reduced amounts of reused and recycled textiles

Citizen's distrust municipal waste management and are unaware of the real costs	National & local	Weak source-separation and reduced amounts of reused and recycled textiles
Citizens prefer to buy cheaper clothes in spite of lower quality and durability	National	Larger waste generation
Hesitation from local authorities to work with non-profit organisations that collect textiles due of social local institutions and charity projects	Local	A waste production is much higher than what the local institutions can handle
ECONOMIC & MARKET		
Low prices of virgin material results in lower production costs, than with reuse and recycle	National	Discouraging solutions of higher levels of waste management hierarchy
High prices on recycled textile, due to high production costs.	National	Discouraging consumption of reused and recycled textile products
No standards for sorting and distribution of post-consumer textiles	National	A lack of demand for sorted post-consumer textiles
Present fast fashion tendencies make "out of style" clothing hard to sell	National	Limits growth of second-hand market
Labour cost of repairing a garment is often higher than the acquisition of a new garment	National	Challenges in shifting consumer behaviour

4.2 Bulky waste

The following section will review barriers and drivers for increased preparation for reuse and recycling of Portuguese bulky waste identified through consultations (interviews and focus groups) with relevant stakeholders from the Portuguese furniture industry and waste collection and treatment organisations. Drivers and barriers have all been validated through the triangulation method and a workshop with more than 400 relevant stakeholders.

4.2.1 Drivers

Since bulky waste has many sub-fractions, finding a simple collection and treatment pathway is challenging. Not a single solution can be ideal for every type of bulky waste. Therefore, the local and regional context must be considered in developing strategic action to improve preparation for the reuse and recycling of bulky waste. Taking advantage of and combining the available possibilities is crucial to ensure that citizens can operate in various systems according to their priorities and constraints[283].

At the regional level in Portugal, some parish councils have their solution with which they collect and store furniture in good condition in a warehouse to be used by families in need living in the same parish councils. This is, however, a short and time-limited solution. CM Nazaré and its parishes have two call lines for citizens who want to donate furniture. These entities arrange for the collection at households and, depending on the furniture condition, it is sent for recycling and donation, accordingly[284].

At a local level, some municipalities and SGRUs currently manage to separate metal from wood and furniture, which is sent to recycling while the rest goes to landfill. Mattresses mostly go to landfill. However, several municipalities and SGRU dismantle them to recover metal from the springs and structure, which is

[283] ARC+ (2020): URBANREC – How can bulky waste management be improved?
[284] Obtained though focus group interviews (20th of January 2022)

sent to recycling facilities. To collect the mattresses, some municipalities and SGRUs have specific containers in civic amenity centres, ensuring separate disposal by citizens[285].

Among industry actors, only a few initiatives exist in Portugal. Some existing projects developed by furniture retailers, such as IKEA, promote the second-hand market by buying IKEA used products from consumers and reselling them at stores[286].

To ensure an overall improvement of the collection and treatment schemes for bulky waste in Portugal, the following primary drivers have been identified:

BULKY WASTE	NATIONAL	REGIONAL	LOCAL	INDUSTRY
New legal obligation of implementing municipal separate collection systems	X		X	
National targets on preparing for re-use, recycling and recovery set a minimum contribution for furniture recovering	X	X	X	
Nudging for a widespread interest in vintage objects	X	X	X	X

4.2.2 Barriers

From a European perspective, it is common that reuse activities of bulky waste are organised by charity and socioeconomic organisations[287]. This is also the case in Portugal, where many associations and institutions linked to the Church promote these initiatives[288]. The institutions and associations facilitate the bulky waste collection, which is then delivered to families in need. However, materials in the bulky waste are not being quantified as a waste stream for preparation for reuse and recycling targets. This creates challenges for the non-regulated products that may be discarded in MSW management systems after being used for families in need, often in a relatively chaotic way.

A proper collection system is a crucial element for reusing bulky waste streams. In Portugal, consulted stakeholders perceive the required licensing of facilities and operators for reuse preparation as a barrier. This problem is tightly bound up in the definitions of waste, the categorisation of an item as waste, and the potential solutions for the end of waste. All these components must be clarified nationally to facilitate a well-function collection and treatment of bulky waste. The lack of an effective collection of furniture waste means that the furniture industry, which is driven to incorporate recycled materials in new products, can only buy reusable wood from Spain instead of locally[289].

Consulted stakeholders experience the communication of the correct disposal routes to be relatively good. However, lack of knowledge and awareness on disposal, collection and treatment of bulky waste is still a common barrier. It is questioned whether the communication can be considered uniformly good since a cultural fear of being seen while disposing of bulky waste when using the municipal system has been identified. Instead, some citizens drive to remote areas to dispose of their bulky waste incorrectly[290].

[285] Obtained though focus group interviews (20th of January 2022)
[286] Obtained though focus group interviews (20th of January 2022)
[287] ARC+ (2020): UrbanRec: How can bulky waste management be improved?
[288] *According to APA, there is no national intervention on bulky waste (e.g., furniture) and the waste category it is not considered for preparation for reuse operation. There are therefore no legal requirements for civic amenity centres and the bulky waste can be given to the citizen freely. Obtained though focus group interviews (20th of January 2022)*
[289] Obtained though focus group interviews (20th of January 2022)
[290] Obtained though focus group interviews (20th of January 2022)

The barriers listed in the table below must be addressed and prioritised. The barrier analysis will serve as a background for the development of a strategy to increase reuse and recycling of bulky waste:

BARRIERS	LEVEL	CONSEQUENCE
REGULATORY		
Lack of enforcement of existing regulations against illegal dumping	Local	Lack of trust in waste management system
Prioritization of costs over sustainability in public procurements	National, regional & local	Discourages operators implementing more sustainable technical solutions focusing on recovering materials separately to reuse or recycling
Challenges of obtaining a license for reuse and recycling centers for bulky waste	National & regional	Discourages waste management operators to set up reuse and recycling solutions
TECHNICAL		
Lack of dedicated collection schemes for bulky waste, particularly furniture	National, regional & local	Greatly decreases the potential for reuse and recycle
Challenges in identification of the origin of bulky waste	National & local	Reduced enforcement of punishment regulation for illegal dumping
Low reuse of bulky waste, due to low human resources capacity and lack of space for sorting and storage at civic amenity centres and/or treatment facilities	Regional & local	Discourages proper disposal, decreases trust in waste management system, decreases collection and treatment of reusable and recyclable materials
Lack of robust quantity estimations on waste produced	National, regional & local	Challenges cost-effective treatment and industry interest
Civic amenity centres located away from city centres and commercial areas	Local	Decreases the utilisation of civic amenity facilities, increases improper disposal
The variety of materials and collection conditions limit the potential for reuse and recycling	National, regional & local	Increases risks of improper disposal and contamination of waste streams
CULTURAL		
Underground containers are often utilised incorrectly due to dimensions	Regional & local	Reusable and recyclable bulky waste ends up in landfill or at energy recovery facilities
Lack of citizens' awareness regarding existing collection systems and correct disposal behaviour	National & local	Improper source separation
Citizen’s distrust municipal waste management and are unaware of the real costs	National & local	Weak source-separation and reduced amounts of reused and recycled textiles
ECONOMIC & MARKET		
Reluctance among citizen to purchase second-hand bulky products such as furniture and mattresses	National, regional & local	Discourage higher investments and actions towards improvement of second-hand markets
Lack of demand on repaired and refurbished bulky products	National, regional & local	Lack of good market conditions the evolving of large-scale repair and refurbishment service providers, underutilised reusable and recyclable materials

4.3 Household hazardous waste

The following section will review barriers and drivers for increased preparation for reuse and recycling of Portuguese hazardous waste identified through consultations (interviews and focus groups) with relevant stakeholders from the Portuguese chemical industry and waste collection and treatment organisations. Drivers and barriers have all been validated through the triangulation method and a workshop with more than 400 relevant stakeholders.

4.3.1 Drivers

Hazardous waste can be considered the most important waste fraction when it comes to ensuring proper separate disposal to benefit the environment. The HHW waste fraction includes substances that seriously threaten public health and the environment, and contamination of other waste types is hard to avoid if HHW is collected and disposed of properly. Proper management of HHW is expensive, and therefore illegal dumping is common in many places in the world. Control of dumping is, therefore, a key issue to be considered when designing and implementing legislation on hazardous waste management[291].

In Portugal, municipalities collect HHW at the civic amenity sites and deliver it to SGRU facilities for sorting. Any reusable or recyclable WEEE materials are sold to Producer Responsibility Organisations (e.g., Electrão). Some partnerships are being established between municipalities and PROs to collect specific sub-fractions for hazardous waste streams[292]. While the municipalities are experts in waste collection, the PROs are experts in their products. Knowledge exchange, economic incentives and collaboration facilitation are important tools for the municipalities to ensure effective cooperation with the PROs.

Collaborations are already present in the Portuguese sociotechnical landscape. This is exemplified in Electrão's current pilot project in partnership with the Municipality of Lisbon, which aims to collect the big WEEE straight at households. This enables better recycling and reuse options for WEEE waste while reducing contamination risks of other waste streams.

In addition, some municipalities and SGRUs (e.g. Lipor, Ambisousa and Municipality of Condeixa-a-Nova) are implementing innovative solutions to separately collect different waste streams, including HHW, with mobile collection points travelling from municipality to municipality[293]. This can provide a solution for the sometimes very small amounts of e.g. medical waste. However, the sustainability of mobile collection points is discussable, depending on the means of transport of the hazardous waste.

To ensure an overall improvement of the collection and treatment schemes for HHW in Portugal, the following main drivers have been identified:

HOUSEHOLD HAZARDOUS WASTE	NATIONAL	REGIONAL	LOCAL	INDUSTRY
New legal obligation of implementing municipal separate collection systems	X	X	X	
New range of innovative collection schemes are being implemented such as mobile collection points		X	X	X

[291] World Bank Group (1998): Management of Hazardous Wastes.
[292] Obtained though focus group interviews (21st of January 2022)
[293] Obtained though focus group interviews (21st of January 2022)

4.3.2 Barriers

The household sector is an important source of hazardous waste, generating, on average, a fifth of all European hazardous waste in 2012 and with volumes rising. To a certain extent, the upward trends in identified HHW amounts can be explained with better separation practices, allowing better identification of hazardous waste and, therefore, improved reporting of it. WEEE is one of the major drivers of increased amounts of hazardous waste[294], and the Electrão's pilot project in partnership with the Municipality of Lisbon could significantly affect WEEE waste collection in Portugal.

Other important types of HHW are chemical and medical waste (although most chemical waste comes from the manufacturing sector, and most medical waste comes from the service sector).

Healthcare waste from in-home patients (catheters, dressings, and diapers, for example) is currently causing a problem in collection and treatment by contaminating other waste fractions (including residual waste) and posing a risk of creating hazardous working conditions for waste workers. In the focus group consultations, it has been suggested that this type of waste could be subject to a specific collection system[295], as seen in other European countries. Medicinal waste is also perceived as a problem for the producer responsibility scheme Valormed, and a concern in their management system since hospitals and other healthcare centres do not often accept healthcare waste. Sometimes patients are advised to put this waste stream in the collection system for medicines and packaging waste managed by Valormed[296].

The barriers listed in the table below must be prioritised and addressed. The table will serve as a background for the development of a strategy:

BARRIERS	LEVEL	CONSEQUENCE
REGULATORY		
Lack of a clear legal definition and strategic plan for household hazardous	National & local	Challenges the establishment of a sustainable management system, technically and economically
Prioritization of costs over sustainability in public procurements	National, regional & local	Discourages operators implementing more sustainable technical solutions focusing on recovering materials separately to reuse or recycling ends
Lack of enforcement of existing regulations	National & local	Illegal dumping of hazardous waste, environmental and health risks
PROs are not allowed to collect municipal waste straight from households, except with the explicit agreement of municipalities	National & local	Limits the opportunity for innovative approaches and higher recovery rates of the materials
TECHNICAL		
Lack of robust quantity estimations on waste produced	National, regional & local	Challenges cost-effective collection, treatment, and industry interest
Variety of materials and nature of hazardous content	National	Challenges implementation of a simple collection system based on a single container
Small quantities of some types of household hazardous waste	Regional & local	Challenges the set-up of an efficient collection and treatment scheme
Civic amenity centres located away from city centres and commercial areas	Local	Decreases the utilisation of civic amenity facilities, increases improper disposal

[294] EEA (2016): Prevention of hazardous waste in Europe – the status in 2015.
[295] Obtained though focus group interviews (21st of January 2022)
[296] Obtained though focus group interviews (21st of January 2022)

Differences between municipalities regarding available capacity of means (RH and collection equipment)	National, regional & local	Differentiating efficiencies on collecting and managing this waste stream, challenging benchmark standards
Challenges in identification of the origin of hazardous waste	National & local	Reduced enforcement of punishment regulation for illegal dumping
Low recycling potential of some materials and/or lack of recycling	National, regional & local	Limits the treatment solutions of the higher levels of the waste management hierarchy
CULTURAL		
Lack of citizens' awareness on best practice for disposal and the potential risks of incorrect practices	National	Disposal of household hazardous waste mixed with other waste factions of in recycling drop-off containers
Scarce communication on capacitating citizens to be able to identify the hazardous materials	National & local	Weak source separation and reduced amounts of reused and recycled household hazardous waste
Non-licenced operators pick WEEE from the municipal/official collection circuits to recover the materials with economic value	National & local	Illegal practices pose environmental risks due to hazardous content, and effects system sustainability. This makes it near to impossible to track the amount of diverted materials and its final destination
Citizen's distrust municipal waste management and are unaware of the real costs	National & local	Weak source-separation and reduced amounts of reused and recycled bulky waste
ECONOMIC & MARKET		
High collection costs of some household hazardous waste types due to small quantities	Local	Weak source separation and reduced amounts of reused and recycled bulky waste
High treatment costs associated to the hazardous nature of the waste materials	Regional & local	Greater temptation for illegal dumping, improper treatment, and distrust in the waste management system

4.4 Construction and Demolition waste

The following section will review barriers and drivers for increased preparation for reuse and recycling of Portuguese C&D waste identified through consultations (interviews and focus groups) with relevant stakeholders from the Portuguese construction industry and waste collection and treatment organisations. Drivers and barriers have all been validated through the triangulation method and a workshop with more than 400 relevant stakeholders.

4.4.1 Drivers

Based on volumes, C&D waste is the largest waste stream in the EU, presenting about one-third of all waste produced. There are common challenges with reusing and recycling C&D waste, among others, due to the lack of (confidence in the) quality of the waste materials and potential health risks of waste workers and industry workers utilising the waste materials. These challenges reduce the willingness to utilise C&D waste materials as secondary raw materials, inhibiting the development of C&D waste management and recycling infrastructures all over EU[297,298].

[297] Ecorys (2016): EU Construction and Demolition Waste Management Protocol.
[298] Eionet (2020): Construction and Demolition Waste: challenges and opportunities in a circular economy.

To effectively increase the reuse and recycling of C&D waste, it is eminent to pursue a willingness to utilise the waste materials. The literature study indicates that the following are of the greatest importance in providing trading grounds for the reuse and recycling of C&D waste:

- Awareness of the economic benefits of reuse and recycling;
- Promoting eco-design;
- Aligning stakeholder's perspectives on C&D waste management;
- Raising multilevel awareness of the benefits of managing waste Through trading practices;
- Making quality waste data and reporting mandatory;
- Making user-friendly trading platforms available;
- Develop specific guidelines, specifications, and a clear definition of process standards for reusable and recycled materials[299].

In Portugal, Smart Waste Portugal is currently developing an online platform to enable waste exchange or trade. Smart Waste Portugal is now in the testing phase for members of SWP, which can provide the needed trading to implement successful preparation of reuse and recycling. Smart Waste Portugal is developing a tool to estimate the waste generated during demolition. This can be the first stepping stone towards quality waste data and reporting.

On the communication side, BUILTColab is developing SIMPLEX, a tool to guide SMEs in navigating the Portuguese waste system. This provides the grounds for developing broader communication on adequately disposing of C&D waste. BUILTColab is further developing a roadmap for C&D waste, at the request of APA, including a communication plan aiming to disseminate different activities and guidelines for better management of this waste stream[300]. This communication plan affects the amount of poorly sorted C&D waste and the contamination reduction.

To ensure an overall improvement of the collection and treatment schemes for C&D waste in Portugal, the following main drivers have further been identified:

CONSTRUCTION & DEMOLITION WASTE	NATIONAL	REGIONAL	LOCAL	INDUSTRY
Waste declassification can also be provided by collaborative laboratories, and not just APA. But it is still not clear for the industry, and it is still a very expensive and complex process.	X	X	X	X
Legal obligation of implementing municipal separate collection systems for C&D waste produced in private small repairs and do-it-yourself works at households	X		X	X
Assessment and implementation of an EPR scheme	X			X

[299] Ratnasabapathy et al. (2021): Drivers for implementing effective waste trading practices in the construction industry.
[300] Obtained though focus group interviews (19th of January 2022)

4.4.2 Barriers

There are significant similarities in the barriers to the preparation for reuse and recycling of C&D waste across the EU. While reclamation rates for high-value materials, such as metals and hardwood timbers, have increased over the years, there is still a lack of market for these materials. In order to create a stable demand, proof of satisfactory quality is needed[301].

Public collection of C&D is typically done through civic amenity sites or collections services in the EU, meaning that large storage facilities are needed and waste storage often comes with high costs. Here, the similarities between bulky waste and C&D waste are clear. A joint solution might be relevant if contamination can be avoided. Improper handling during storage and the potential risks of hazardous substances entering the material streams are major risks and barriers with storage solutions[302]. Therefore clear guidelines are essential to ensure the actual effects of this approach.

Lack of interest among potential buyers and economic aspects are often the dominant barrier to C&D waste reuse and recycling. Commercial interests are increased by larger amounts of C&D waste, which drives the costs of reusable materials down[303]. While the main source of large amounts of C&D waste would be the C&D sector, the C&D waste from civil society could provide additional materials to the potential market of reusable and recycled materials through proper alignment of the two types of waste streams. In this regard, proper communication is essential. This should be facilitated through national communication plans and at collection points and civic amenity centres to ensure a clear understanding of proper disposal.

In Portugal, the new legislation on municipal waste management, which requires municipalities to take responsibility for C&D waste from small repairs and DIY works in households, is by some stakeholders not perceived as sufficiently clear on the limits of municipal responsibility. Stakeholders report that citizens are unsure of their responsibilities regarding C&D waste from domestic projects and that there is a lack of understanding on where to dispose of C&D waste. There is a need to reassess how to ensure knowledge and awareness among citizens.

Another major barrier related to civil society in Portugal is the inconvenience and expense of disposal at civic amenity centres. The current solution, where waste quantity is measured to a threshold limit, allegedly leads to illegal dumping; this should be seen in relation to the challenges of enforcing the existing legislation for proper disposal due to the costly and inefficient process of identifying and fining citizens dumping C&D waste illegally[304]. Stakeholders in focus group interviews stated that lack of enforcement of legislation could be linked to local election cycles since no politician wants bad publicity[305]. This underlines the importance of national public entities acting as a guard dog for common legislation, ensuring that municipalities comply with their obligations, also during elections.

The barriers listed in the table below must be addressed and prioritised. The table will serve as a background for the development of a strategy for increased reuse and recycling of C&D waste:

BARRIERS	LEVEL	CONSEQUENCE
REGULATORY		
Lack of quality and technical criteria of materials for reuse and recycling	National	Discourages operators from using recovered materials in new construction, increases risks of illegal dumping

[301] Ecorys (2016): EU Construction and Demolition Waste Management Protocol.
[302] Miliute-Plepiene & Moalem (2020): Increasing re-use of construction and demolition materials and products.
[303] Miliute-Plepiene & Moalem (2020): Increasing re-use of construction and demolition materials and products.
[304] Obtained though focus group interviews (19th of January 2022)
[305] Obtained though focus group interviews (19th of January 2022)

Lack of monitoring and enforcement of mandatory incorporation of C&D waste materials in new construction projects	National & regional	Discourages operators implementing more sustainable technical solutions, hinders large-scale sales
Prioritization of costs over sustainability in public procurements	National, regional & local	Discourages operators implementing more sustainable technical solutions focusing on recovering materials separately to reuse or recycling ends
Lack of inspection of construction sites	Local	Reduces compliance with the regulation on C&D waste management, increases risks of illegal dumping
Lack of enforcement of existing regulations	National, regional & local	Increases risks of illegal dumping, lack of trust in waste management system
Lack of consolidated proceedings to control C&D waste management produced in small construction site, that does not require a license nor prior notification	Local	Enable malpractices in waste disposal, increases risks of illegal dumping, lack of trust in waste management system
TECHNICAL		
Lack of robust quantity estimations on waste produced	National, regional & local	Challenges cost-effective collection, treatment, reduces industry interest in reusable and recyclable materials
Lack of appropriate space and facilities for stocking	Regional & local	Challenge determination of when and how much of a certain material will be needed, reduces ability to implement large-scale reuse and recycle
Lack of knowledge and/or resources from small contractors to comply with waste management regulations and sustainable concepts	National, regional & local	Enable malpractices in waste disposal, increases risks of illegal dumping, reduces trust in waste management system
In some municipalities, the available human resources are insufficient to meet the new national regulations and strategies of waste management	National & local	Increases risks of illegal dumping, reduces trust in waste management system, lack of enforcement of regulation
Civic amenity centres located away from city centres and commercial areas	Local	Decreases the utilisation of civic amenity facilities, increases improper disposal
Challenges in identification of the origin of C&D waste	National & local	Reduced enforcement of punishment regulation for illegal dumping, reduces trust of waste management system
Challenges of disseminating good practices	National & local	Limits replication and improvement, especially when it comes to small contractors which constitute almost 99% of constructions sites, reduces utilisation of reusable and recyclable materials
Heterogenous waste composition and hazardous nature	National	Limits the potential for efficient sorting and disposal, reduces reuse and recycling, increases risk of contamination
In some regions, there is a long distance from construction sites and recycling facilities	Regional & local	Reduces appeal of proper disposal, reduces utilisation of reusable and recyclable materials, increases risks of illegal dumping
CULTURAL		
Significant rates of illegal dumping (in woods, roadside, etc.), due to lack of awareness and correct disposal behaviour and an unwillingness of small operators to pay treatment fees	National, regional & local	Limits the development of more sustainable technical solutions focused on recovering materials separately to reuse or recycling

Lack of innovation in national construction sector	National	Discourages operators from using recovered materials in new construction projects
Lack of trust on secondary raw materials due to poor quality control	National	Reduces trust in waste management system, reduces cost-effectiveness of recovery process, hinders large scale markets
Developers and citizens are unaware of responsibilities	National & local	Construction companies are not chosen on a basis of their compliance with regulation, reduces utilisation of reusable and recyclable materials
ECONOMIC & MARKET		
Lack of market demand for recycled materials from C&D waste recovery	National, regional & local	Perceived lack of quality assurance and of higher costs, limits the growth of the recycling sector
It is cheaper to send C&D waste to quarries than to recycling processes	National	Discourage operators to invest more in utilisation of reused and recycled materials
Lack of C&D waste input	National, regional & local	Emerging reuse and recycling companies goes out of stock and thereby business fast
Distance between supplier and projects is too far	Regional & local	Underutilisation of reusable and recyclable materials, lack of trust in the waste management system
Extraction of natural raw materials is cheaper than reusable and recycled materials	National	Underutilisation of reusable and recyclable materials, hinders large scale market

5 Strategic considerations - increased reuse and recycling

5.1 Textile waste

Identified barriers indicate an extensive need to clarify when used textiles are waste, to reduce the legal uncertainty among the citizens, collectors, and treatment facilities. The regulatory framework can facilitate an improvement in monitoring the circular economy for textiles via data collection and reporting on volumes placed on the market, volumes of separately collected textiles and the treatment of the textiles. In addition, it is essential to promote consumer awareness to foster environmentally sustainable consumption patterns of textiles.

The existing collection infrastructure currently aims to capture textiles for reuse, while the collection of textiles for recycling only comes from textiles unsuitable for reuse. In the future, the collection infrastructure must capture textiles for reuse and recycling – textiles that can be reused and textile waste. The reuse infrastructure is already well developed, although coverage is better in urban areas than rural areas. Making used clothes more attractive and building local Portuguese second-hand markets could facilitate that the collected textile waste maintains a higher value. Measures to ensure monitoring and reporting on the textile waste streams going to reuse are needed to justify national reporting of the preparation for reuse and recycling.

The collection of used textiles and textile waste must be improved throughout Portugal across regional and municipal borders. This requires expanding the existing collection infrastructure to make it more amenable to citizens throughout the country and facilitate the collection of waste textiles for both reuse and recycling.

Textile recycling is currently very limited in Portugal, despite the significant textile sector. This presents an opportunity to exploit future collected waste textiles in the local production of new products. Local

production of new products from upcycled textile waste should be perceived as a supporting action towards greater preparation for reusing and recycling textile waste. In this context, national and regional support should be considered. This could be regarding economic support in the early stages, reduced taxes etc. To ensure local production can flourish, significant improvements in local recycling infrastructure and the development of new recycling techniques and technologies for recycling must be supported by all levels of public entities, ensuring challenges with improper disposal, collection, sorting, and treatment of waste textiles are overcome.

The EU's Strategy for sustainable and circular textiles indicates that the European Commission will, in the 2023 revision of the Waste Framework Directive, propose common rules for textile EPR systems. Developing an EPR system for textiles in Portugal should follow this process closely. EPR schemes also appear to be how Portugal will implement the EU requirement for separate collection of textiles waste by 1 January 2025[306]. Decree-Law 102-D/2020, of December 10[307], establishes the following targets:

- By December 31, 2022 – the government will prepare a study which analyses: i) environmental benefits and performance improvement opportunities, ii) a verification and authentication system for textiles durability, specifically for clothes, iii) a regulation system to promote textiles durability and iv) EPR scheme implementation.
- By December 31, 2024, the government will approve specific textile waste EPR scheme regulations.
- An EPR scheme for textiles should start two years later.

Cascais Ambiente argues against an EPR scheme for textiles[308], claiming a better solution could be a centralised collection assumed by municipalities in collaboration with private companies to optimise textile waste management. Other collectors, however, were in relatively close agreement in their desire to establish a mandatory Extended Producer Responsibility (EPR) system for textiles, with current collectors as an integral part of the system.

A higher density of textile containers could incentivise citizens to separate their waste. The additional containers could be funded through the earnings of implementing an EPR scheme or by the municipalities. Among the consulted actors, investments in automated sorting and recycling non-reusable textile waste in Iberia are highlighted[309]. This could be funded through the EPR scheme or national or European funding channels such as the EU Recovery Funds[310].

It was highlighted in a cultural and economic context that developing skills for upcycling or redesigning textiles into new clothing is currently lacking. Educational programmes could facilitate new market opportunities in this area. The stakeholder consultations identified a lack of measures to increase the demand for recycled clothing content. This hinders good market conditions for reusable or recycled clothing[311].

The following table demonstrates options and approaches to tackle identified barriers, at what level the options should be handled, what area the option is related to, and the possible effects of the solutions for improved reuse and recycled of textile waste in a Portuguese context:

	OPTIONS	LEVEL	AREA	ANTICIPATED EFFECT
	REGULATORY			

[306] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0851&from=EN

[307] Law 52/2021, of August 10.

[308] Consultation meeting with Luís Capão and Sandra Rebelo – Cascais Ambiente (August 25, 2021).

[309] Obtained though focus group interviews (17th of January 2022)

[310] Obtained though focus group interviews (17th of January 2022)

[311] Obtained though focus group interviews (17th of January 2022)

Develop gamification strategies to engage and promote source-separation, reuse, and recycling	National	Collection, reuse & recycling	Reduce the distrust of the waste management system among citizens and enhance consumer awareness of reused and recycled textiles
If omitted in the legal and regulatory frameworks on waste management, include the obligation for all producers (domestic and non-domestic) to separate waste at source. Failure to do so constitutes an environmental crime punishable by law	National & local	Collection	Enforcement of illegal dumping, enable robust quantity estimation, reduce contamination risks, and enhancement of trust in waste management system
Create an EPR scheme (e.g. SIGR - Integrated Waste Management Systems for a specific waste stream) to manage textile waste sector	National	Collection, reuse & recycle	Enable robust quantity estimations, systemic handling of blended materials, enabling large-scale material recycling, reduction of textile waste sent to landfill and incineration, and creating an incentive to reduced virgin material input in production
Develop and publish guidelines to municipalities on good practices for separate collection	National & local	Collection	Reduce difficulties to establish a sustainable management system, reduce textile waste streams are sent to landfill and incineration, enhancement of trust in waste management system, and enabling more cost-effective approaches to textile waste treatment
Develop standards for content of reused and recycled textiles in public procurement	National	Reuse & recycling	Encourage operators to implementing more sustainable technical solutions to recover materials, enabling a shift in consumer behaviour, and enhancing demand on reused or recycled textiles and growth of a second-hand market
Reducing VAT or tax breaks on second-hand goods and repair of textiles.	National	Reuse	Reduction of textile waste sent to landfill and incineration, creates an economic incentive, and creating an incentive to reduced virgin material input in production
TECHNICAL			
Develop guidelines on which types of waste can enter licensed waste treatment facilities for reuse and recycling	National, regional & local	Reuse & recycling	Enables robust quantity estimations, enhance trust in the waste management system, reduce contamination, create an incentive to reduce virgin material, reduce labour costs
Increase collection capacity and source separation by additional disposal solutions to civic amenity centres	Regional & local	Collection	Increased utilisation of civic amenity centres, improvement of citizens awareness, enables robust quantity estimations, enhancement of trust in waste management system, and enabling large-scale materials recycling solutions
Increase collection capacity and source separation by additional mobile collections points in rural areas	Regional & local	Collection	Enables robust quantity estimations, enhance trust in the waste management system, reduce contamination, and improvement of citizens awareness
Expand existing municipal task to residential textile collection, by adding two additional containers for textiles for reuse and textiles for recycling (monthly collection)	National & local	Collection	Enables robust quantity estimations, enhance trust in the waste management system, reduce contamination, and improvement of citizens awareness
Add an additional container for reusable textile waste and a bag for recyclable textile waste (quarterly collection)	National & local	Collection	Enables robust quantity estimations, enhance trust in the waste management system, reduce contamination, and improvement of citizens awareness
CULTURAL			
Improve communication to citizens on good disposal practices, treatment, and positive impact on the management system efficiency	National & Local	Collection	Improvement of citizens awareness, enhancement of trust in waste management system, and enabling a shift in consumer behaviour

Enhance the framing and appeal of civic amenity centres as a fundamental infrastructure for efficient separately collection	National & local	Collection	Increased utilisation of civic amenity centres, improvement of citizens awareness on reused and recycled textiles, enhancement of trust in waste management system, and enabling a shift in consumer behaviour
Facilitation of intermunicipal collaboration and implementation of additional joint disposal and collection sites and mobile collection	Regional & local	Collection	Enables robust quantity estimations, enhance trust in the waste management system, reduce textile waste sent to landfill and incineration or downcycling, reduces risks of illegal dumping
Facilitation of industry collaboration, industrial symbiosis, and collaboration between municipalities and industry	Local	Collection, reuse & recycle	Enables robust quantity estimations, enhance trust in the waste management system, reduce textile waste sent to landfill and incineration or downcycling
Implement visual and informative signage on collection points	National & local	Collection	Reduces risk of contamination, improvement of citizens awareness on reused and recycled textiles, enhancement of trust in waste management system, and enabling a shift in consumer behaviour
Facilitation of P2P & educational repair and recycling workshops, cafés etc.	Regional & local	Reuse & recycling	Improvement of citizens awareness on reused and recycled textiles, enhancement of trust in waste management system, and enabling a shift in consumer behaviour
ECONOMIC & MARKET			
Develop communication plans aimed at every entity involved in the value chain of materials/waste	National	Collection, reuse & recycling	Improvement of citizens awareness, enhancement of trust in waste management system, enabling a shift in consumer behaviour, reduce textile waste sent to landfill and incineration or downcycling, and enable more cost-effective approaches to reuse and recycle
Create incentives structures for companies and non-profit organisations (eg Ultriplo and Humana) prioritizing the donation of non-contamination clothes for reuse, clarifying that landfill is considered last resort	National	Reuse	Reduce recyclable textile waste sent to landfill and at incineration plants, and enable large-scale material recycling solutions
Reinforce inspection and tracking the origin of dumped waste	Local	Collection	Enhancement of trust in waste management system, enabling large-scale materials recycling solutions, create an economic incentive, and reduction of illegal dumping
Economic support of SMEs offering leasing and renting options for textile products	National	Reuse	Improvement of citizens awareness on reused textiles, create an economic incentive and enabling a shift in consumer behaviour
Facilitation on expansions of network of second-hand shops and platforms	National	Reuse	Improvement of citizens awareness on reused textiles and enabling a shift in consumer behaviour
Develop guidance for applications for EU and national funding options to innovative recycling solutions, acquisition and development of sorting and recycling technologies	National	Recycling	Improvement of citizens awareness on reused textiles and enabling a shift in consumer behaviour, reduce textile waste sent to landfill and incineration or downcycling, create economic incentive

PITFALLS THAT SHOULD BE CONSIDERED

- Most textiles have organic substances in the material blend to some extent. Therefore the collection of textile waste for preparation of reuse and recycling must be protected from the following:

  - Sun exposure to reduce discolouration since this can reduce the reusability.
  - Pest and insects to reduce degradation since this will reduce the reusability.
  - Humidity to reduce rotting of the textiles since this will reduce recyclability.
- Regional and local collectors must be guided or educated on the sub-fractions of textile waste and contamination identification.
- Communication efforts should address all citizen groups across age, gender etc.
- Intermunicipal sorting facilities enable the use of more expensive technologies. However, there is a need for clear agreements on how the outcome is shared between the municipalities and how reporting of quantity estimations is split between the municipalities.

5.2 Bulky waste

Mapping the waste streams is an essential part of monitoring, allowing the identification of relevant parameters to improve the performance of the bulky waste disposal, collection, and treatment systems. Missing information and data prevent a good overview of the current situation, which can lead to improvement of the management strategy for the preparation of reuse and recycling of bulky waste. Therefore this is one of the critical elements. A solution to identified barriers should address through regulatory measures[312]. Solutions to technical barriers rely on supporting regulation since implementing technical systems and solutions is costly and require new management solutions.

EPR schemes could be policy tools that provide economic incentives for greener design, prolonging the product's lifespan, collection, and treatment of bulky waste streams, but most important for this specific waste stream: a design for disassembly. Since there are various material types in bulky waste, some with high recycling potentials, design for disassembly could be utilised as a key market driver. Bulky waste, designed for disassembly, enables an easier, cheaper, and less technologically reliant process for the preparation for reuse and recycling of bulky waste.

Intermunicipal collaboration could be another solution to facilitate some sub-factions of bulky waste, as illustrated in Denmark. Here, inter-municipal collaboration has resulted in up to 80% recycling of mattresses compared with the 22% achieved without the collaboration[313]. Intermunicipal collaboration enables large-scale treatment due to more significant waste flow amounts. Therefore, more efficient technology can be implemented, making the process significantly more cost-effective.

While communication with civil society is crucial in ensuring useable bulky waste amounts, some cultural barriers must be overcome. The ‘easy’ challenges to overcome are currently rooted in the Portuguese population. Many are unaware of the penalties, proper disposal routes, and the damage wrongfully disposed of bulky waste can cause to collection equipment and treatment lines. It is pointed out that generational knowledge is lost, and different norms and values are at play depending on the population group[314]. This cultural approach to bulky waste challenges a flourishing economic market of reusable or recycled bulky products. These types of barriers should be addressed as closely connected.

The following table demonstrates options and approaches to tackle identified barriers, at what level the options should be handled, what area the option is related to, and the possible effects of the solutions for improved reuse and recycling of the bulky waste in a Portuguese context:

	OPTIONS	LEVEL	AREA	ANTICIPATED EFFECT

[312] ARC+ (2020): UrbanRec: How can bulky waste management be improved? Available at: http://www.acrplus.org/images/project/URBANREC/Deliverables/URBANREC_D6.1_Guidelines.pdf
[313] https://circularcph.cphsolutionslab.dk/cc/news/results-mattresses
[314] Obtained though focus group interviews (20th of January 2022)

REGULATORY			
Development of guidelines aimed at every entity involved in the value chain of materials/waste enhancing the circularity potential of the furniture sector	National, regional & local	Collection, reuse & recycling	Improvement of properly disposed, collected, and treated bulky waste material, increases awareness, enable robust quantity estimations and better conditions for second-hand and refurbishment markets
If omitted in the legal and regulatory frameworks on waste management, include the obligation for all producers (domestic and non-domestic) to separate their waste at source. Failure to do so constitutes an environmental crime punishable by law	National & local	Collection	Enforcement of illegal dumping, enable robust quantity estimation, reduce contamination risks, and enhancement of trust in waste management system
Create an EPR scheme (e.g. SIGR - Integrated Waste Management Systems for a specific waste stream) to manage furniture and mattresses waste, or schemes to return of product to providers	National	Collection, reuse & recycle	Enable robust quantity estimations, systemic handling of blended materials, enabling large-scale material recycling, reduction of bulky waste sent to landfill and incineration, and creating an incentive to reduced virgin material input in production
Foster intermunicipal collaboration for waste collection	Regional & local	Collection	Promotes the achievement of economies of scale, increasing the efficiency of collection, improves conditions for repair and refurbishment service providers, enable improved disposal options for rural areas
TECHNICAL			
Enhance the framing and appeal of civic amenity centres as a fundamental infrastructure for efficient separately collection	National & local	Collection	Increased utilisation of civic amenity centres, improvement of citizens awareness on reused and recycled bulky waste, enhancement of trust in waste management system, and enabling a shift in consumer behaviour
Enhance the collection services of bulky waste, preferably through door-to-door collection schemes	Local	Collection	Increases amounts of collected bulky waste, decreases distrust in waste management systems, and enhances citizens awareness
CULTURAL			
Communication campaigns directed at adults to ensure citizens' engagement in available waste services, such as collecting schemes, recycling, and reusing solutions	National, regional & local	Collection, reuse & recycling	Improvement of citizens awareness, enhancement of trust in waste management system, and enabling a shift in consumer behaviour
Develop guidelines for citizens regarding good practice on bulky waste disposal and to separate it according to what can be reused, what needs small fixing and unrecyclable waste	National	Collection, reuse & recycling	Ensure higher rates on recovery and preparing for reuse and recycle processes, improvement of citizens awareness, enhancement of trust in waste management system, and enabling a shift in consumer behaviour
Create the bridge between waste/furniture and families with economic difficulties	National, regional & local	Reuse & recycling	Enable robust quantity estimations and reuse of bulky waste, improvement of citizens awareness, enhancement of trust in waste management system, and enabling a shift in consumer behaviour
ECONOMIC & MARKET			

Facilitate industrial symbiosis centres to ensure local reuse and recycle of materials from bulky waste	National, regional & local	Reuse & recycling	Enable robust quantity estimations, higher rates of reuse and recycled materials, enable robust quantity estimations, enhancement of trust in waste management system, creating an incentive to reduced virgin material input in production, and enabling large-scale materials recycling solutions
Reinforce inspection and tracking the origin of dumped waste	National & local	Collection, reuse & recycling	Improvement of citizens awareness, enable robust quantity estimations, enhancement of trust in waste management system, enabling large-scale materials recycling solutions, and reduction of illegal dumping
Separation of sub-factions (e.g. wood and metals) for recycling based on economic value	National & local	Collection & recycling	Enables economies of scale, enable robust quantity estimations, enhancement of trust in waste management system, enabling large-scale materials recycling solutions, creating an incentive to reduced virgin material input in production, and enable economic incentives for recycling
Mainstream intermunicipal communities' engagement	National	Collection, reuse & recycling	Enables economies of scale and improve education and awareness efforts, collaboration between companies and associations, and decreases distrust in waste management systems

PITFALLS THAT SHOULD BE CONSIDERED

- Most bulky waste has organic substances in the material blend to some extent. Therefore the collection of bulky waste for preparation of reuse and recycling must be protected from the following:
    - Sun exposure to reduce discolouration since this can reduce the reusability.
    - Pest and insects to reduce degradation since this will reduce the reusability and recyclability.
    - Humidity to reduce rotting and rusting of textiles, wood, and metal since this will reduce recyclability.
- Regional and local collectors must be guided or educated on the sub-fractions of the bulky waste and contamination identification.
- Communication efforts should address all citizen groups across age, gender etc.
- Separation of sub-factions of bulky waste, based on economic value, could create major incentives for recycling high-quality materials

5.3 Household hazardous waste

Measures to prevent hazardous waste, and contamination from hazardous waste, are included in several waste prevention programmes around EU member states and include activities such as product passports, eco-dynamic company labels, partnerships for substitutions, and guidelines drawn up by authorities[315]. In Portugal, there is a significant demand for guidance from APA on the types of household hazardous waste that should be collected and a framework and best practice for collecting these wastes. The guidance in

[315] https://www.eea.europa.eu/publications/waste-prevention-in-europe/file

demand focuses on advisory and equipping municipalities with the knowledge to effectively implement household hazardous waste collection[316].

Through evaluation of the different approaches for the collection and treatment of hazardous waste, the EEA has assessed that the most effective prevention tools for hazardous waste are:

- Product requirements (e.g. by prohibited toxic substance, packaging or volume requirements etc.)
- Financial incentives
- Awareness and education
- Green public procurement (e.g. green organisations and public spendings agencies)
- Voluntary agreements (Environmental targets set in consultation with industry stakeholders)
- Ecodesign
- Technological standards

Financial incentives, awareness and education and voluntary agreements are also assessed as the most effective prevention tools for household waste. Therefore a special focus should be on these tools[317]. The stakeholders in the focus group highlighted that any solutions implemented must ensure safety conditions for waste management system workers and citizens using the collection scheme[318]. Therefore conditions for environmental protection must be ensured as well. Clear guidance, including definitions for different types of household hazardous waste and how they best can be collected and treated, is needed as a first step.

A solution to collect household hazardous waste is through a reverse logistics system, where the point of sale serves as a collection point. This would require space to be set aside within stores for this purpose. There are also potential legal barriers to this solution – to what extent would the shops have to register as waste handlers (including training etc.), which would have to be overcome. Similarly, shopkeepers could be communication and information agents for citizens regarding the products they sell and could inform buyers about the correct management of those products at the end of their life[319].

The Mobile collection points for household hazardous waste have been trialled in Portugal and seem to provide good coverage and collection safety/security. However, they still require clearer guidelines on what to collect and how to collect. This solution could be beneficial to ensure greater collection and, thereby, possibilities for preparation for reuse and recycling in rural areas and can, e.g., be placed at markets. Financial incentives are important for hazardous waste, ensuring funding options for cross-actives and partnerships between entities. EPR schemes could further function as a financial incentive to reduce harmful chemicals in products by placing financial responsibility on the companies, producing, e.g. self-care products[320].

The following table demonstrates approaches to tackle identified barriers, at what level the solutions should be handled and the possible effects of the solutions for improved reuse and recycling of household hazardous waste:

	OPTIONS	LEVEL	AREA	ANTICIPATED EFFECT
	REGULATORY			

[316] Obtained though focus group interviews (21st of January 2022)
[317] https://www.eea.europa.eu/publications/waste-prevention-in-europe/file
[318] Obtained though focus group interviews (21st of January 2022)
[319] Obtained though focus group interviews (21st of January 2022)
[320] Obtained though focus group interviews (21st of January 2022)

Develop gamification strategies to engage and promote source-separation and recycling	National	Collection, reuse & recycling	Reduce the distrust of the waste management system among citizens and enhance consumer awareness of reused and recycled household hazardous waste
If omitted in the legal and regulatory frameworks on waste management, include the obligation for all producers (domestic and non-domestic) to separate their waste at source. Failure to do so constitutes an environmental crime punishable by law	National & local	Collection	Enforcement of illegal dumping, enable robust quantity estimation, reduce contamination risks, and enhancement of trust in waste management system
Set a clear definition on qualifications for household hazardous waste so it is simpler to set the rules for collection and treatment activities to which municipalities and other waste management operators should comply	National	Collection & recycling	Improves the understanding of regulations and enforcement of legislation, simplifies systemic collection and treatment activities for municipalities and other waste management operators, and improves ability to comply with regulations and legislations
Develop and publish guidelines on good practices for separate collection	National, regional & local	Collection	Improves efficiency of collection and treatment schemes, enables waste amounts for large scale recycling, enable robust quantity estimations, and enable large-scale material recycling
TECHNICAL			
Develop guidelines on which types of waste can enter licensed waste treatment facilities for recycling	National, regional & local	Recycling	Enables robust quantity estimations, enhance trust in the waste management system, reduce contamination, create an incentive to reduce virgin material, reduce labour costs
Enhance the framing and appeal of civic amenity centres as a fundamental infrastructure for efficient separately collection	National & local	Collection	Increased utilisation of civic amenity centres, improvement of citizens awareness on recycled household hazardous waste, enhancement of trust in waste management system, and enabling a shift in consumer behaviour
Implementation of door-to-door collection schemes or mobile collection points	National & local	Collection	Enables robust quantity estimations, enhance trust in the waste management system, reduce contamination, improved amount of household hazardous waste that undergoes preparation for recycle
CULTURAL			
Better communication with citizens on identification of household hazardous waste, its destinations and why it is important to collect it	National & local	Collection & recycling	Positive impact on management efficiency, enhance trust in the waste management system, reduce contamination, enable robust quantity estimations, and improved amount of household hazardous waste that undergoes preparation for recycle
ECONOMIC & MARKET			
Assess the feasibility of implementing a deposit or incentive scheme for specific hazardous waste streams	National	Collection & recycling	Enhancement of trust in waste management system, enabling large-scale materials recycling solutions, collaboration

			between companies and associations, and reduction of illegal dumping
Reinforce inspection and tracking the origin of dumped waste	National & local	Collection & recycling	Improvement of citizens awareness, enable robust quantity estimations, enhancement of trust in waste management system, enabling large-scale materials recycling solutions, and reduction of illegal dumping

PITFALLS THAT SHOULD BE CONSIDERED

- Very few to no sub-fractions of household hazardous waste has reuse potential, and the development of recycling systems of household waste should be done in consolidation with experts in the area to ensure work and citizen health.
- Sub-factions of interest are plastics and metals due to their high recycling potential and options for decontamination.
- Evaluation of treatment approaches for different sub-fractions of household hazardous waste, specialised for common Portuguese waste streams, is recommended.

5.4 C&D waste from households

Through the literature study, insights into different approaches for the preparation of C&D waste have been identified. One solution for the preparation of reuse is reoccurring: promotion of preparation for reuse. The actin involves little to no processing but is vital to ensure greater reuse. Economic incentives are among the essential measures to utilise for the processes related to recycling preparation. Economic incentives both serve as a driver for the separation and proper disposal of industry C&D waste. There are indicators that the effect could be the same if similar measures are implemented for C&D waste produced by civil society[321].

The Portuguese stakeholders have verified similar solutions as good options. It has been identified that economic incentives implemented in the licensing process, e.g. differentiated taxes, could increase the demand for recycled materials. This could be facilitated through municipal material banks to increase demand and support the creation of a market for used materials. Concerning collection, it was suggested that the tariff applied by municipalities could be lowered to increase collection. This, however, cannot exonerate waste producers at the risk of compromising the prevention policies.

Consolidated stakeholders had a consensus regarding communication of proper disposal and the collection & treatment practices. Communication is a vital tool to ensure that the waste generators know how and where to dispose of C&D waste. A clear and easy-to-understand communication plan should be developed and target Portuguese households and small contractors working on small domestic projects. This communication should also be undertaken at a national level coordinated by APA or the National Association of Municipalities to ensure compliance monitoring and alignment of the practices in municipalities. The stakeholder highlighted the underutilisation of SEPNA, which should be further assessed.

The following table demonstrates approaches to tackle identified barriers, at what level the solutions should be handled, and the possible effects of the solutions for improved reuse and recycled on C&D waste:

	OPTIONS	LEVEL	AREA	ANTICIPATED EFFECT
	REGULATORY			

[321] EC (2016): EU Construction & Demolition Waste Management Protocol. ECORYS.

If omitted in the legal and regulatory frameworks on waste management, include the obligation for all producers (domestic and non-domestic) to separate their waste at source. Failure to do so constitutes an environmental crime punishable by law	National & local	Collection	Enforcement of illegal dumping, enable robust quantity estimation, reduce contamination risks, and enhancement of trust in waste management system
Development of action plans on material efficiency, recovery solutions, life cycle of products, and guidelines for sustainable dismantling and deconstruction processes.	National	Collection, reuse & recycling	Enable robust quantity estimations, higher rates of reuse and recycled materials, enhancement of trust in waste management system, and enabling large-scale materials recycling solutions
Create an EPR scheme (e.g. SIGR - Integrated Waste Management Systems for a specific waste stream) to manage furniture and mattresses waste, or schemes to return of product to providers	National	Collection, reuse & recycling	Enable robust quantity estimations, systemic handling of blended materials, enabling large-scale material recycling, reduction of C&D waste sent to landfill and incineration, and creating an incentive to reduced virgin material input in production
Develop guidelines on which types of waste can enter licensed waste treatment facilities for reuse and recycling	National, regional & local	Reuse & recycling	Enables robust quantity estimations, enhance trust in the waste management system, reduce contamination, create an incentive to reduce virgin material, reduce labour costs
TECHNICAL			
Place specific disposal points between parishes or using mobile collection points for C&D waste, with clear instruction on separation of different fragments	Regional & local	Collection	Reduced amounts of illegally dumped C&D waste, greater visibility of collection sites for the civil society, improvement of awareness enable robust quantity estimations, and higher rates of reuse and recycled materials
Promote better use of e-GARs	National	Collection, reuse & recycling	Enables cross information between estimated waste production and its destination in project specifications ('caderno de encargos'), enable robust quantity estimations, higher rates of reuse and recycled materials, enhancement of trust in waste management system, and enabling large-scale materials recycling solutions
Enhance the framing and appeal of civic amenity centres as a fundamental infrastructure for efficient separately collection	National & local	Collection,	Increased utilisation of civic amenity centres, improvement of citizens awareness on recycled C&D waste, enhancement of trust in waste management system, and enabling a shift in consumer behaviour
CULTURAL			
Capacitate small contractors with guidelines to good practices on sustainable construction and demolition and waste management. This can be achieved through training sessions promoted by national or regional sectorial associations	National & regional	Collection, reuse & recycling	Enable robust quantity estimations, higher rates of reuse and recycled materials, enhancement of trust in waste management system, enabling large-scale materials recycling solutions, and improvement of awareness of proper disposal

Guidance at civic amenity centres on sorting according to the waste hierarchy, e.g. in three categories: - Suitable for reuse: no-few damages of the product - Suitable for recycle damage of the product, general separation of factions needed - Suitable for energy recovery - Hazardous C&D waste	National & local	Collection, reuse & recycling	Enable robust quantity estimations, higher rates of reuse and recycled materials, enhancement of trust in waste management system, enabling large-scale materials recycling solutions, reduction of risk of contamination, and improvement of awareness of proper disposal
ECONOMIC & MARKET			
Develop better communication plans to aimed at every entity involved in the value chain of materials/waste	National	Collection, reuse & recycling	Improvement of citizens awareness, enhancement of trust in waste management system, enabling a shift in consumer behaviour, reduce difficulties to establish a sustainable management system, reduce C&D waste sent to landfill and incineration or downcycling, and enable more cost-effective approaches to reuse and recycle
Establish or strengthen a marketplace for sustainable materials for construction companies	National & regional	Reuse & recycling	Higher rates of reuse and recycled materials, enhancement of trust in waste management system, enabling large-scale materials reuse and recycling solutions
Sorting according to economic value at civic amenity centers	Local	Collection, reuse & Recycling	Cheaper municipal post-sorting, higher rates of reuse and recycled materials, enhancement of trust in waste management system, enabling large-scale materials reuse and recycling solutions
Reporting of on-site construction recycling (economic incentive recommended)	National, regional & local	Recycling	Enable robust quantity estimations, higher rates of recycled materials, and reduction C&D waste sent to landfill and incineration or downcycling, and creating an incentive to reduced virgin material input in production
Removal of threshold limits for recyclable materials	National	Recycling	Enable robust quantity estimations, higher rates of recycled materials, reduction C&D waste sent to landfill and incineration, improvement of citizens awareness, enhancement of trust in waste management system, enabling a shift in consumer behaviour, and creating an incentive to reduced virgin material input in production
Mainstream intermunicipal communities' engagement	National	Collection, reuse & recycling	Enables economies of scale and improve education and awareness efforts, collaboration between companies and associations, and decreases distrust in waste management systems

OPTIONS FOR HAZARDOUS C&D WASTE

- PCBs and PAHs can be decontaminated by decolouration or sent to incineration with special fumes treatment;
- Phenol-contaminated C&D waste (often wood and insulation panels) can be treated by the removal of the contaminated surface. With proper surface decontamination, the wood is suitable for recycling;

- Lead-based paints are only suitable for lined landfills;
- C&D waste contaminated by mercury can be treated with selective demolition methods and will often need to be sent to specialist recyclers[322]

TECHNICAL OPTIONS FOR REUSE AND RECYCLING

- Recycling by crushing for processing concrete and rubble, usable as a sub-base;
- Recycling by shredding for processing wood, boards, and uncontaminated panels;
- Reuse through screening for the grading of soils and stones;
- Recycling and reuse by segregation of easily accessible waste components materials, such as metal, plastic, glass, and plasterboard;

PITFALLS THAT SHOULD BE CONSIDERED

- Some C&D waste has organic substances. Therefore, the collection of C&D waste for preparation of reuse and recycling must be protected from the following:
    - Pest and insects to reduce degradation since this will reduce the reusability and recyclability;
    - Humidity to reduce rotting and rusting of wood and metal since this will reduce recyclability;
- Clear guidelines should be visible at every collection site (mobile, stationary, civic amenity centres etc.) informing citizens of proper disposal approaches for high-value C&D waste, handling of blended materials, and handling of hazardous C&D waste to reduce improper disposal and contamination.

[322] JRC (2011): Supporting Environmentally Sound Decisions for Construction and Demolition (C&D) Waste Management – A practical guide to Life Cycle Thinking (LCT) and Life Cycle Assessment (LCA).

6 Strategy development

Based on the analysis of the state of play for the recycling and preparation for reuse of textile-, hazardous-, bulky- and construction and demolition waste, and the inputs of relevant Portuguese Governmental entities, EPR schemes has been prioritised as a the most important regulatory instrument. The following section will provide a context for the development of EPR schemes, based on the overarching objective:

Overarching objective: Implementation of EPR schemes for relevant waste streams

	SUPPORTING ACTIVITIES
1.1	Assessment of options to introduce EPR schemes for the four waste streams (textile-, hazardous-, bulky- and construction and demolition)
1.2	Development of individual EPR or separate collection schemes for the four waste streams
1.3	Development of inclusion activities with industry stakeholders validating that EPR schemes are applicable
1.4	Preparation guidelines for PROs

6.1 Assessing options for EPR schemes

To identify the relevance of the development and implementation of EPR schemes for the different waste streams a working group should be put down to identify the best options for development of the schemes. The group should consist of:

- Relevant governmental entities (APA, Ministério da Economia, etc.), with backing from the Central Government;
- Large industry stakeholders;
- Actors from knowledge institutions (Universities, consultancy providers, etc.);
- NGOs facilitating citizen involvement;
- PROs of already existing Portuguese EPR schemes (providing lessons learned and best practices);

The assessment should account for the economic viability (of the different economic setups of EPR schemes), applicability (assessing whether EPR schemes would facilitate and increase in recycling and preparation of reuse), the industry acceptance (and how to increase this if relevant), and concrete objectives for recycling and preparation for reuse facilitated through the EPR schemes.

6.2 Development of an EPR scheme

There is a wide range of tasks and activities involved in operating an effective and efficient waste management system. While there are many different approaches to collecting, treating, and managing waste

systems within the EU, some general tendencies, approaches, and measures can be highlighted regarding costs that can benefit from being covered by producers through EPR schemes[323]. EPR schemes have resulted in a range of environmental, social, and economic benefits, including:

- Increased reuse and recycling;
- Increased green product design or eco-design;
- Financing of waste collection and processing systems;
- Reduced cost of utilising recycled materials;
- Job creation; and
- Reduced potential health risks from landfills[324].

Typically, EPR schemes have fundamental environmental goals, to incentivise producers to design more resource-efficient products with reduced environmental impacts[325], in line with the Eco-design Directive[326]; and to ensure effective end-of-life collection and environmentally efficient treatment of the waste collected, to increase recycling and preparation for reuse rates[327].

In the EU, EPR schemes were implemented in the 1990s and have since been increasingly used as a policy measure to improve waste collection and treatment. In 2020, more than 400 EPR schemes were in use[328]. Different types of EPR instruments have been developed since the 1990s, hereunder:

- Product take-back requirements;
- Economic and market-based instruments
- Regulations and performance standards
- Information-based instruments[329]

Product take-back requirements are the most common, with almost three-quarters of all EPR schemes based on this instrument globally. The product take-back requirements often entail that producers and distributors must take back products from consumers when the products reach their end-of-life. Management of end-of-life collection and treatment often involve mandatory or voluntary recycling and collection targets for specific product groups, sectors, or materials[330].

There is a wide range of aspects to consider when it comes to the design and development of an EPR scheme. The following aspects should, at least, be included in the design and development process[331]:

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[323] Hogg et al. (2020): Study to Support Preparation of the Commission's Guidance for Extended Producer Responsibility Schemes.
[324] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.
[325] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.
[326] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0125
[327] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.
[328] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.
[329] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.
[330] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.
[331] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.

6.3 Product and producer definition

Sometimes, EPR schemes are unnecessary to fiancé the collection, recovery, and recycling systems. Market dynamics are sufficient to reach recycling targets because revenues from reselling materials enable a self-financing system[332]. Throughout the assessment of the current state of play for textile and bulky waste production, it can be determined that there is a cross-regional lack of overview of the waste production quantities. Therefore it cannot be determined conclusively that recycling targets are met. An EPR scheme could provide the needed data on waste production, recovery, recycling, and preparation for reuse rates; financing for collection and treatment; and data monitoring and evaluation requirements. It has been concluded that stakeholders from the Portuguese textile sector have identified the development of EPR as desirable, which is further supported legislatively by Decree-Law 102-D/2020 of December 10[333], setting targets for the development of EPR schemes for textiles. For bulky waste, the development of EPR schemes is not as explicitly supported. However, by condensing the meaning of the barriers identified, an EPR scheme could facilitate reducing a wide range of barriers identified by stakeholders. In developing EPR schemes, all the products covered by an EPR scheme must be clearly defined to ensure the best options for compliance[334]. Product definitions should include the following:

- types of products;
- categories and sub-categories where appropriate;
- materials;
- and consumer type (household and/or commercial)[335].

To ensure that EPR schemes reflect the reality of Portugal, an understanding of responsibilities among producers, and thereby compliance with EPR requirements, it is essential to organise a dialogue with involved and co-responsible stakeholders[336]. During this dialogue, it should be discussed how all affected producers can be registered in a streamlined and equal manner. The following should be taken into consideration:

- Producers and other actors affected by the EPR scheme must face the same obligations.
- It can be reasonable to provide some support to SMEs and micro-enterprises to ensure a continuous market development flow[337].

6.4 Individual or collective schemes

EPR involves a shift in responsibility (administrative, financial, and/or psychical) from governments or municipalities to producers or PROs, compared to the traditional solid waste management approach. From a polluters-pays perspective, the definition and role of the polluters (i.e. consumers) shift from an individual directly causing pollution, to an economic agent (producers) in EPR schemes, playing a decisive role in the reduction of pollution[338]. The shift in responsibilities is commonly facilitated through either individual compliance schemes (ICS) or collective compliance schemes (CCS)[339,340]. ICSs are a rare approach in the EU and

[332] Monier et al. (2014): Development of Guidance on Extended Producer Responsibility (EPR).

[333] Law 52/2021, of August 10.

[334] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.

[335] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.

[336] Monier et al. (2014): Development of Guidance on Extended Producer Responsibility (EPR).

[337] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.

[338] Monier et al. (2014): Development of Guidance on Extended Producer Responsibility (EPR).

[339] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.

[340] Monier et al. (2014): Development of Guidance on Extended Producer Responsibility (EPR).

are limited to instances where one producer sells its products to a limited number of users. CCSs are much more common than individual schemes and are organised by a specific organisation (PROs) in the setup and implementation of EPR principles.

PROs' responsibility perimeter differs based on the type of waste producers in question. Often, there is a relevance in districting between household waste and commercial and industrial waste[341].

- Implementation of IPR entails that producers are responsible for collecting and treating their own products, thereby creating a direct link between producers and waste management. This can incentivise durable product design, reuse, and inclusion of recycled materials in production.
- Implementation of CPR entails that producers join a collective producer responsibility organisation (PROs) that takes responsibility for waste collection and treatment on behalf of their members. CPRs tend to be more efficient regarding waste collection and treatment and cost-effective due to pooled resources, economies of scale, etc.[342]

6.4.1 Type of producer obligations

Obligations placed on producers should be clearly defined to ensure the best options for compliance. The clarification of obligations can be made, utilising a variety of approaches:

- Producers can be obliged to finance the current waste management system based on an average cost, KPIs, and production output. Cost determination can be based on national, regional, or local waste management costs.
- Producers can be obliged to set up waste management contracts with the regional or municipal waste manager. Contract templates can be developed to ensure easy compliance and implementation.
- The partial organisational approach, whereunder regional or municipal organisations still are responsible for waste collection, but with financial support from the producers. In some cases, this approach further obliges producers to participate in or facilitate waste activities such as the sorting and selling of secondary raw materials.
- The full organisational approach obliges producers to take responsibility for waste collection and treatment. This is typically done with direct contracts with waste operators, and the producers keep ownership of the waste and, thereby, any recyclable secondary raw materials[343].

6.5 Setting targets and responsibilities

Measurable targets or KPIs should be set for waste management, collection, and treatment. These targets should be reviewed periodically to ensure a continuation of an increase in recycling and preparation for reuse. As a matter of course, Target should take legislative and supranational mandatory waste collection and treatment targets into account. Furthermore, measurable targets or KPIs should consider technical and economic feasibility, existing/needed infrastructure (which will be addressed in WP2.2), and geographic and demographic characteristics.

- Targets for EPR schemes are often based on product weight due to the relative ease of measuring the weight producers place on the market.

[341] Monier et al. (2014): Development of Guidance on Extended Producer Responsibility (EPR).
[342] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.
[343] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.

- Often under-prioritised, but an important aspect is that EPR targets should align with the waste hierarchy, prioritising or rewarding reuse and recycling over energy recovery.
- To provide an increased incentive for improvements in product durability, recyclability and streamlined preparation for reuse, targets for eco-design in an EPR scheme can be beneficial. Including eco-design targets can further reduce the utilisation of harmful or high-emission materials and promote waste prevention through increased reuse and recycling[344].

6.6 Setting fees and cost coverage

The costs of waste management, collection, and treatment of the products covered by an EPR scheme should be covered. In the case of IPR, it is recommended that standard contracts and fee calculation guidelines are set out to ensure fair and equal treatment of the producers. In the case of CPR, PROs should ideally set fees to cover the entire net waste management costs for the products included in the EPR scheme. Any revenue from sales of secondary raw materials or reusable products, both in the case of IPR and CPR, should be subtracted from the costs paid by the producers.

- Fees may include a fixed element, e.g., a producer membership fee, typically paid annually.
- Product-related fees should be established per product, category, subcategories, and/or material if appropriate. With this approach, a fee can be paid annually based on the number of products a producer places on the market.
- Fees can also be modulated, as seen with the French EPR scheme for textiles (cf. section 5.1.1). Fees can be modulated based on specific product features, such as recyclability, hazardousness, utilisation of renewable resources, etc. EPR schemes that target product characteristics directly provide the most directive incentives for eco-design increments[345].

6.7 Information provisions

Systems for EPR schemes cannot function properly if consumers are unaware of their role in increasing preparation for reuse and recycling. Therefore it is crucial that governments provide adequate information and, if relevant, PROs to consumers and stakeholders. Dialogues between PROs, producers, governmental entities, local municipalities, waste companies, consumers, and NGOs should be encouraged to facilitate innovative uptake of recyclable materials and reusable products.

- Governments and/or PROs can facilitate networking platforms or events for relevant stakeholders.
- Information provided to consumers should be clear and easy to understand. Informational channels include product labelling, as seen in Denmark (cf. section 5.1.3), and EPR publicity, e.g. through posters, leaflets, and media spots.
- Information to stakeholders' perimeter field of the EPR scheme should include clear guidance documents on roles and responsibility distribution, efficient participation, and interactions with other stakeholders and consumers [346].

[344] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.
[345] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.
[346] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.

6.8 Transparency, monitoring, and enforcement

Transparency of an EPR scheme is crucial in ensuring that EPR targets are met and monitoring EPR schemes' contribution to national and supranational waste management targets. Transparency of the achievements of EPR schemes further provides grounds for increased citizen trust in the waste management system. To provide transparency in EPR processes, an adequate monitoring system should be in place, and public authorities must enforce legislative obligations[347].

Publicly available information, e.g., annual PRO reports, can contribute to adequate transparency of the EPR scheme. Such reports should include information on collection methods and amounts, recycling and reuse rates achieved through the EPR scheme, fees charged to producers, costs incurred, revenue from the resale of secondary raw material, and recommendations to consumers and stakeholders on how to increase proper collection and treatment of waste[348].

An adequate monitoring system for EPR schemes is not only beneficial when it comes to determining the net costs of collection and treatment. A monitoring system can further function as an input to the assessment of national waste management targets, contribute to a transparent EPR scheme, and, if relevant, identify any iterations needed for the EPR scheme. A monitoring system should, at least, entail the following:

- Detection of free riders, in the form of producers, benefitting but not contributing to the EPR scheme;
- Detection of unfair commercial practices by producers, PROs, and waste management companies;
- Detection of compliance or nonconformity with EPR targets[349];

Enforcement of regulative and legislative requirements is crucial, not only in the context of identifying free riders or stakeholders with unfair commercial practices but also to ensure that citizens trust the waste management system. Interviews with Portuguese stakeholders identified a distrust in the waste management system regarding textile-, bulky- and hazardous household waste (cf. section 6.1.2-6.3.2). Further, there are significant challenges with illegal dumping regarding construction and demolition waste (cf. section 6.4.2), indicating an expectation that the consequences of these actions are minimal or insignificant. Enforcement practices related to EPR schemes should entail the following:

- Penalties for free riders;
- Punishment of unfair commercial practices;
- Ensure fair and sound financial management of EPR schemes;
- Ensure compliance with legislation by all stakeholders involved.

It is recommended that the Portuguese Government initiate a review of the existing EPR schemes on packaging, batteries, ELV, oil products, & WEEE[350] to identify what aspects have been a success and lessons learned. Following strategy development further suggest initiating a feasibility study and testing new EPR schemes through pilot projects.

6.9 Inclusion activities

Upon the development of EPR schemes, inclusion activities should be held with a wide range of industry stakeholders, validating the approaches, applicability and industry acceptance. The inclusion activities

[347] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.
[348] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.
[349] Watkins & Gionfra (2020): How to implement extended producer responsibility (EPR) – A briefing for Governments and businesses.
[350] Monier et al. (2014): Development of Guidance on Extended Producer Responsibility (EPR).

should provide context to the improvement potential of the developed EPR schemes, ensuring industry acceptance. If the inclusion activities determine that EPR schemes are not viable, different approaches for increased recycling and preparation for reuse must be investigated. Inclusion activities can be in the shape of:

- Workshops for industry stakeholders adding each of the four waste streams;
- Interactive webinars;
- Pilot projects;
- Surveys;
- Advisory activities, etc.

One or more of the activities mentioned above should be developed to ensure that industry stakeholders know the consequences of non-compliance and that perspectives for improving EPR setups are included in the final implementation of the EPR schemes.

6.10 Development of guidelines

When stakeholder inclusion activities have been finalised, EPR schemes should be revised to reflect the knowledge gained. The inputs and feedback from relevant stakeholders on the suggested EPR schemes provide essential information for developing guidelines for PROs, industry stakeholders, municipalities and citizens. Guidelines for the developed EPR schemes should provide a clear description and understanding of the following:

- The purpose of the EPR scheme;
- The different aspects of the EPR scheme;
- The responsible PROs and public entities;
- Where it is possible to submit complaints and grievances;
- Consequences of non-compliance;
- Fee modulation;
- Monitoring and enforcement efforts;
- Expected outcome, etc.

6.11 When EPR is not an option

EPR schemes can be developed to cover the collection and treatment costs of the waste management system. However, this does not mean that EPR schemes are the best option always. For waste streams such as hazardous waste, EPR schemes will likely not facilitate an increase in recycling and preparation for reuse. If the working group determine the EPR schemes is not the best option for one or more specific waste stream following options and regulatory instruments should be considered:

- Door-to-door collection;
- Increased availability to amenity sites (particularly in rural areas);
- Economic support for the implementation of the Best Available Technology (BAT) for both industries and municipalities;
- Development and support for local reuse and recycling centres;
- Evaluation of waste classification system;

- Separate curb collection, etc.

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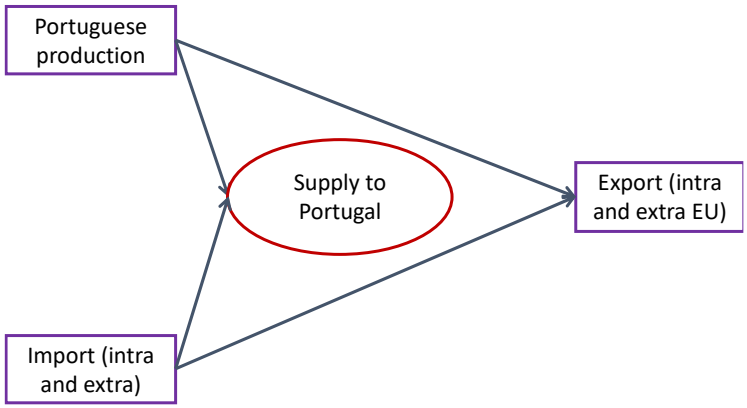
Annex A - New textiles placed on the market

The consumption of clothing and home textiles is usually assumed to be equivalent to supply, e.g. the volume of textiles placed on the market. This is also sometimes referred to as apparent consumption. Supply/apparent consumption is guided by the simple equation (see Figure A.1): Supply = Domestic production + Import – Export.

Figure A.1: Textiles supply (apparent consumption) to Portugal (all final users)



SOURCE: OWN MAKING

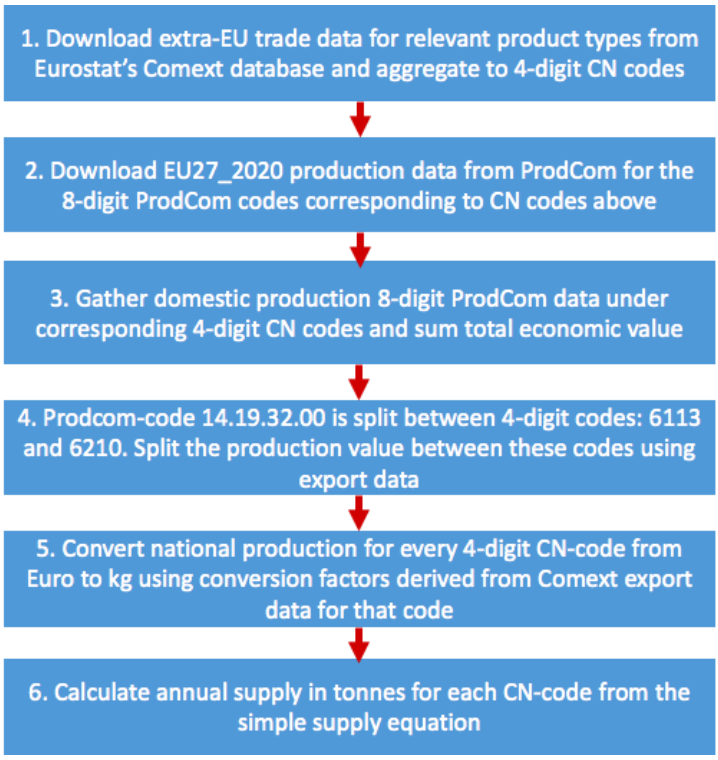
The weight of apparent consumption can be calculated for any product for which there is compatible import, export and production data and for which the physical unit is a weight.

EU Comext data includes imports and exports from all EU Member States to all trade partners both within (Intra-EU) and external (Extra-EU) to the EU, both by value (Euro) and by weight (100 kg). Domestic production data for finished garments and home textiles are available from ProdCom in Euro. Still, the physical unit for most products is not a weight but typically provided in 'pieces' or m^2. Moreover, ProdCom codes and the CN8 codes given in the Comext database are not immediately compatible.

Fortunately, there is a *many-to-one* relationship between ProdCom 8-digit and CN4 4-digit codes in Comext. This allowed estimating production weights for each 4-digit CN code by using a Euro/kg conversion factor derived from the Comext trade data. It should be noted that using a Euro/kg conversion factor derived from exports to apply to the value of production for a given product group is associated with some error since the value of exports is evaluated at the time the goods cross the border and may differ from the price of goods as they leave the factory[351]. The calculation process is presented in Figure A.2. This error is not significant for countries that don't have a large domestic production of textiles. However, the error can be significant for countries like Portugal, with an important textile sector.

[351] Europroms (2008) Europroms User Guide on ProdCom data https://ec.europa.eu/eurostat/documents/120432/4433294/europroms-user-guide.pdf

Figure 2: Method used for calculating the total supply of new clothing and home textiles to Portugal



SOURCE: OWN GRAPHIC

It should also be noted that the apparent consumption calculation method does not take into account the following material flows:

- **Purchases while abroad** on vacation or other travel – however, since we are considering consumption for the EU as a whole and since the majority of holidays taken by EU citizens are in other EU Member States – the underestimate caused by this should be minimal
- **Online purchases** from businesses in other countries are seen as a small underestimate because of the EU scope. It is assumed that due to shipping costs, most internet sales will be internal within the EU.
- **Hidden production** – production data in ProdCom is not always accessible for commercial confidentiality reasons. This is the case, for example, if a single company dominates the production of a particular product type.
- **Illicit imports/exports/sales** – purchases on grey markets/black markets can represent a significant part of total consumption in some EU regions. A study[352] in six EU countries (Estonia, Czech Republic, Latvia, Lithuania and Sweden) estimated that between 10% and 14% of clothing, consumption is via illicit sources.

Portuguese apparent consumption (including the gaps and errors above) was estimated for each year between 2005 and 2020.

Results

There are several means for piecing together a picture of flows of used textiles from different types of information and evidence. These can include:

- **New textiles placed on the market** are part of a mass balance approach. In the status of the steady-state system, even though householders may keep and use their textiles for several years, what

[352] Oxford Economics (2018). Combatting Illicit Trade: Consumer Motivations and Stakeholder Perspectives

goes into the system in terms of new clothing purchases will eventually become used textiles or textile waste that will be discarded or donated by the household. Households are not necessarily steady state, e.g. 1) consumption of new textiles may be increasing from year to year, which will lead to increases in textile waste after a time lag of one or more years, and 2) people may store more and more textiles in their houses. Nevertheless, the consumption of new textiles provides a good ballpark figure for eventual volumes of waste. *We have calculated consumption from trade and production statistics.*

- **Information from collectors of used textiles –** as noted earlier, Portugal, like most other European countries, has a tradition of collecting used rewearable textiles for resale on second-hand markets. These collectors often have valuable data on the annual quantities they collect, how these are processed and the share that is reused, recycled or undergoing other waste treatment. *We interviewed the two most prominent used textile collectors in Portugal concerning these issues.*
- **Information from municipal waste collectors on separate collection –** in some countries, the companies responsible for municipal waste collection have begun to set up separate collections of textile waste. Municipal waste companies have, until recently, left used textile collections to professional and charitable collectors. However, there is an increased focus on non-renewable textiles waste and beginning to separate collect these for recycling markets. Since such recycling markets remain relatively small and uninteresting from an economic point of view, such separate collection has been relatively limited. However, this is under change. All Member States must set up separate collection systems for separate collection of textiles waste by the beginning of 2025. *We consulted three regional waste collectors on textiles waste, amongst other issues*
- **A sampling of mixed waste streams** In addition to data on separate collection of textile waste, regional waste companies may also have estimates of the quantities of textiles waste disposed of in mixed waste for incineration or landfill. These estimates are usually made by taking regular samples of mixed waste, sorting and weighing the various fractions and then scaling this up to the national level using total quantities of mixed waste generation. *This process is formalised in Portugal via Portaria no. 851/2009, of August 7*[353] *and reported on by APA in national waste inventories*[354]*.*

We have used these sources as far as possible to create a picture of the flows and treatment of new and used clothing and home textiles through the Portuguese economy.

Depending on the expected lifetime of a product, quantifying new products placed on the market can give a reasonable indication of quantities that will eventually emerge as waste. Such calculations are possible for clothing and home textiles purchased by households but are more difficult for other products that eventually become waste.

Figure 1 shows trends in imports, exports and domestic production of textiles in Portugal since 2005. Imports and exports increased significantly between 2007 and 2010/11 but have reduced somewhat since then. All three factors have remained relatively stable from 2013 to 2019 but saw a significant drop in 2020. This drop is most likely indicative of the impact of the COVID-19 pandemic on the global textile industry as demand for new clothing reduced significantly, coincidental with disruptions to supply caused by working restrictions etc.

[353] https://dre.pt/pesquisa/-/search/494002/details/maximized

[354] APA (2020) Relatório Anual Resíduos Urbanos 2019. Retrieved from https://apambiente.pt/sites/default/files/_Residuos/Producao_Gest%C3%A3o_Residuos/Dados%20RU/RARU%202019.pdf

Figure 1: Domestic production, imports and exports of clothing and home textiles to and from Portugal, 2005 to 2020

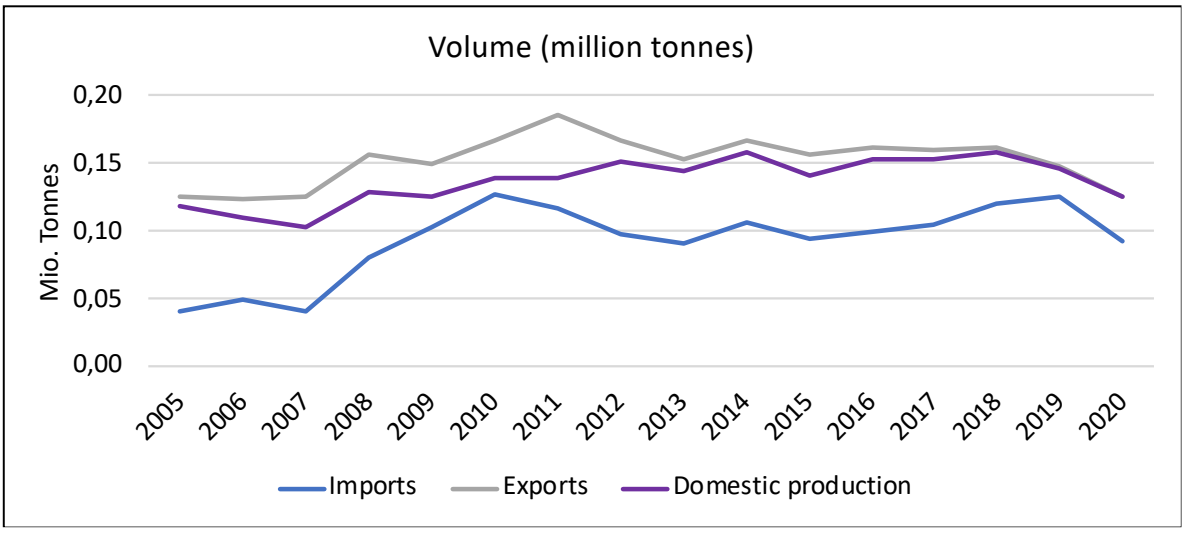
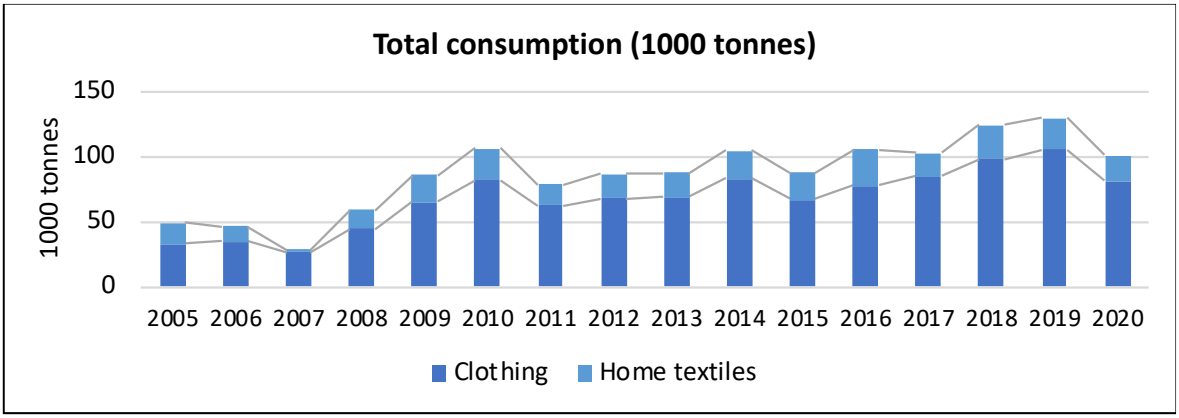


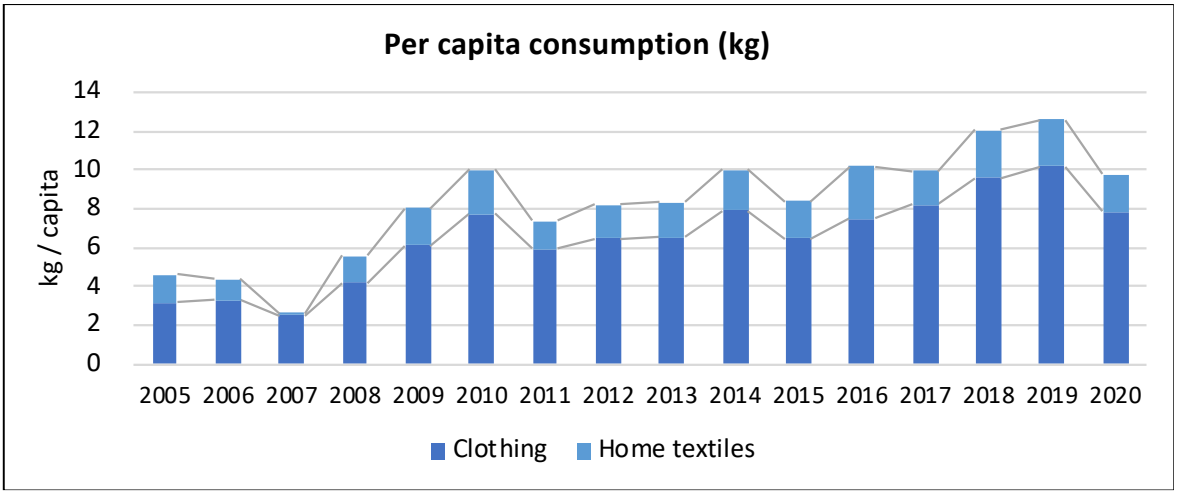
Figure 2 presents the estimated supply (apparent consumption) of textiles to Portugal for final use in the same years, differentiated between product types. Apparent consumption more than doubled from 4.6 kg/capita to 10 kg/capita between 2005 and 2010, fell off and then gradually rose to a maximum of 12.6 kg/capita in 2019. As such, consumption in Portugal has risen from being at the lower end of consumption in EU Member States in 2005 to just exceeding the EU average by 2019 (see JRC, 2021[355]). In 2019, clothing represented 81% of consumption, with home textiles at 19%.

Consumption reduced by 22% between 2019 and 2020, probably due to the response to the COVID-19 pandemic and subsequent impacts on household economies and consumer confidence.

Figure 2: Apparent consumption of clothing and home textiles in Portugal, 2005 to 2020, both in absolute weight and per capita



[355] https://publications.jrc.ec.europa.eu/repository/handle/JRC125110



It should be noted that there is a good deal of uncertainty in these calculations of apparent consumption because domestic production of textiles is relatively important in Portugal, which means that uncertainties in using export-based conversions from the value in Euro to weight can be significant.

Nevertheless, the volume of pre-COVID consumption at over 120 000 tonnes per year gives a reasonable ballpark figure for the volume of clothing and home textiles that will eventually be donated and/or discarded in Portugal and will need to be treated circularly.