Guidance for separate collection of municipal waste

Final deliverable of the study to support the Commission in establishing guidelines for separate collection of waste under Framework Contract N° ENV/B.3/FRA/2017/0005

"Assistance to the Commission on the implementation of the revised waste legislation, assessment of Waste Management Plans and monitoring of compliance with the Waste Framework Directive"

April 2020

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Framework contract: N° ENV/B.3/FRA/2017/005

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The authors thank all stakeholders and representatives of the Member States that have contributed to the study. Moreover, we thank the representatives of the different directorates of the European Commission that have provided inputs and have reviewed the manuscript.

Table of Contents

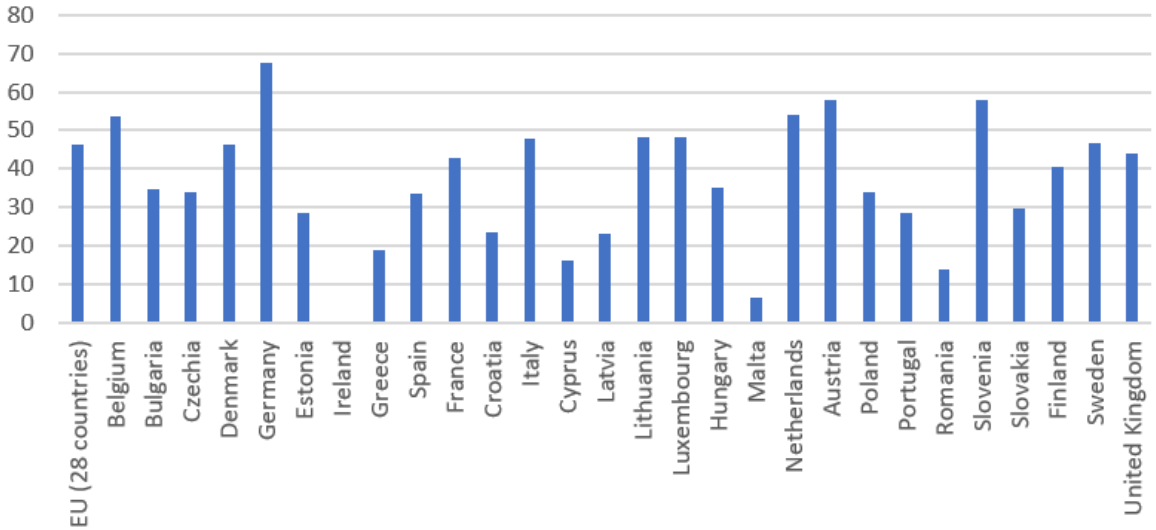
1 Introduction

This guidance document focuses on separate collection of municipal waste. It reviews the EU obligations put forward by the Waste Framework Directive 2008/98/EC as amended by Directive 2018/851 (the revised WFD) and identifies good practices for implementation.

The revised WFD aims to improve the quantity and the quality of the resources fit for reuse and recycling by fostering separate collection of waste. In order to support the Member States (MS) in transposing the EU directive in national or subnational legislation, chapter 2 contains guidance for the interpretation of the legal requirements. More specifically, it focuses on the obligations for separate collection and the derogations that can be invoked.

The targets put forward by the revised WFD are ambitious. For example, the average recycling rate for municipal waste in Europe is 46% (Eurostat, 2017 data, EU-28) while the revised WFD aims for reuse and recycling targets of 55%, 60% and 65% by respectively 2025, 2030 and 2035[1]. Substantial efforts will be needed across Europe to transpose the directive and achieve the targets successfully.

Figure 1: Recycling rate of municipal waste (2017, % of generated, Eurostat)

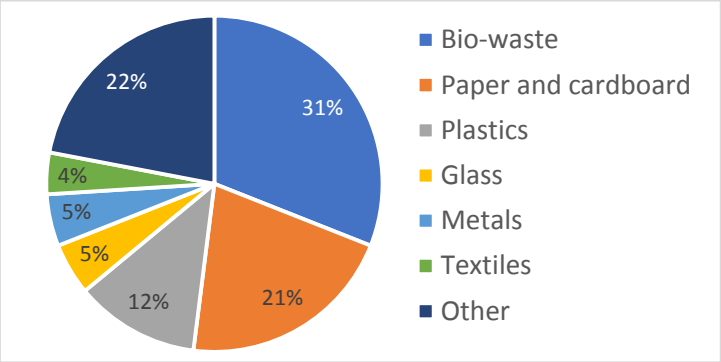


The average recycling rate in Europe has increased substantially in the last two decades: from 17% in 1995 to 46% in 2017[2]. However, the current recycling rates differ significantly between MS as shown by the figure above. This disparity highlights on the one hand, that some countries will need to make structural reforms, and, on the other, that the potential improvements from applying good practices from forerunners consistently across the EU are substantial.

[1] The MS that have to do the biggest efforts to achieve these targets have the option to postpone the deadline for up to 5 years. See revised WFD, article 11(2).
[2] https://ec.europa.eu/eurostat/statistics-explained/index.php/Municipal_waste_statistics#Municipal_waste_treatment

In order to support to the MS in achieving the targets of the revised WFD, this guidance document provides an overview of good practices and recommendations for efficient and effective waste management schemes. Municipal waste is only 10% of total waste generation in the EU but it is highly visible and the potential for improvement is large (Eurostat 2017)[3]. Although the obligations of the revised WFD apply to all waste streams, the overview of best practices given in chapter 3 of this guidance document is limited to municipal waste[4].

Figure 2: Composition of household waste in Europe



Source: based on Worldbank (2018) and Eurostat (2008)[5]

The composition depicted in the figure above highlights that the bulk of municipal waste comes from six waste streams. The separate collection of paper and cardboard, glass and metals is well known and widely implemented. Therefore, the chapters 4 - 6 focus on good practices for the other three waste streams: bio-waste, plastics and textiles.

Moreover, the revised WFD contains obligations for separate sorting of Hazardous Household Waste (HHW). Chapter 7 brings forward good practices for the management of this waste stream.

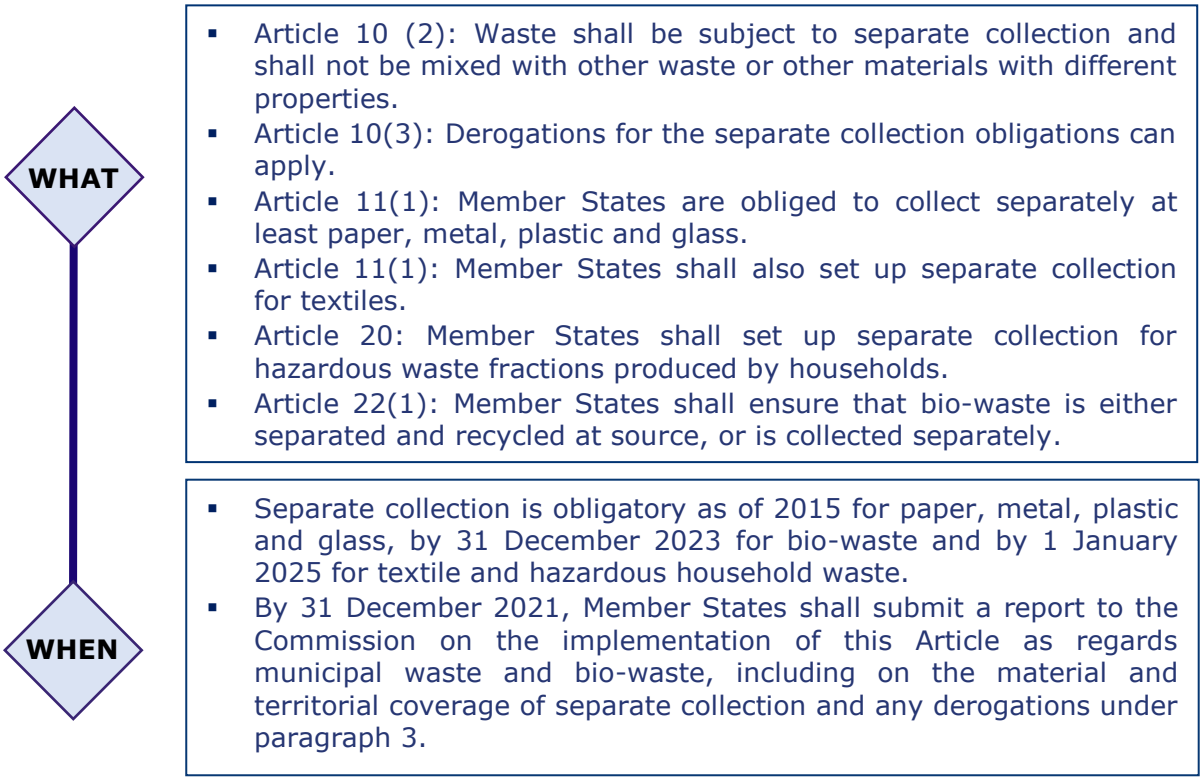
The insights from this report are based on a review of legislation, available data, studies and reports. Moreover, the many discussions with stakeholders have deepened the research[6]. Finally, the report has taken into account good practices reported by the MS via the information request[7].

[3] https://ec.europa.eu/eurostat/statistics-explained/index.php/Municipal_waste_statistics
[4] Municipal waste includes mixed waste and separately collected waste from households and from other sources where such waste is similar in nature and composition to waste from households. See revised WFD article 3, 2b for the full definition.
[5] Within Europe there is quite some disparity. See for example Andreasi et al. (2017) for an overview of the waste composition of different waste streams.
[6] External experts and stakeholders were consulted via interviews and a structured questionnaire. In total, 31 organizations participated coming from different countries and focusing on the different waste streams in scope.
[7] The MS have been consulted via an online survey. In total 15 MS have participated and provided input.

2 Obligations for separate collection

In order to increase the demand and the value of recycled materials, improving the quality of the collected materials is essential. Since sorting waste at source is one of the key levers to achieve better quality, the revised WFD obliges the MS to set up schemes for separate collection as summarized in the diagram below.

Figure 3: Key obligations for separate collection in the revised WFD



Proper implementation of EU legislation is critical in order to harmonize and improve waste management practices. The new obligations of the revised WFD have raised questions from MS and stakeholders. In order to align the interpretation across Europe, this chapter scrutinizes the obligations and provides context to interpret and apply the requirements.

Leveraging the available documents that clarify the wording and intentions of the European decision makers[8], the chapter first focuses on the obligations before turning towards the derogations. Then, the chapter discusses the tools given to the Commission to monitor implementation and the procedure in case MS or local authorities do not comply to the obligations of the revised WFD.

The guidance in this chapter is intended to assist MS and stakeholders, but it is not binding. The only binding requirements are those stipulated by the directive. In case

[8] For more background on the interpretation of legal texts at EU level see Bredimas (1978) and Lenaerts and Gutiérrez-Fons (2013)

of a legal dispute, it is the Court of Justice of the European Union (CJEU) that has the exclusive authority to interpret the legislation and settle the discussion.

2.1 Definitions

Directive 2018/851 amending directive 2008/98/EC introduces several new definitions including an adapted version of bio-waste and a new definition of food waste. The additions in the revised WFD are underlined in the table below.

WFD version 19/11/2008	Directive 2018/851 (revised WFD)
Article 3 ***Definitions***	*Article 3* ***Definitions***
1. "bio-waste" means biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants.	4. "bio-waste" means biodegradable garden and park waste, food and kitchen waste from households, offices, restaurants, wholesale, canteens, caterers and retail premises and comparable waste from food processing plants. 4a. "food waste" means all food as defined in Article 2 of Regulation (EC) No 178/2002 of the European Parliament and of the Council (*) that has become waste.

The motivation for this change is highlighted by a recital from Directive 2018/851.

Directive 2018/851 (revised WFD)
Recital 9
Definitions of non-hazardous waste, municipal waste, construction and demolition waste, food waste, material recovery, backfilling and extended producer responsibility scheme need to be included in the Directive 2008/98/EC so that the scope of these concepts is clarified.

The revised WFD creates new obligations for bio-waste (e.g. the sorting obligations of Article 22 – see further) and for food waste (e.g. the prevention measures of Article 9). Clarifying the definitions contributes to a full and coherent implementation of those measures.

The definition of 'collection' has not been amended by Directive 2018/851. Consequently, its meaning remains the same and the guidance given on the interpretation (European Commission 2012) as presented in the table below, remains valid.

European Commission (2012) Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste
'Collection' is defined by Article 3(10) WFD as: 'the gathering of waste, including the preliminary sorting and preliminary storage of waste for the purposes of transport to a waste treatment facility.' The moment of collection is the beginning of any waste management processes which are covered by the WFD. A treatment facility is to be understood in terms of the definition of 'treatment' in Article 3(14) WFD, namely as a facility where 'recovery or disposal operations,

including preparation prior to recovery or disposal are carried out'.

The definition of 'separate collection' is also maintained in the revised WFD.

Directive 2018/851 (revised WFD)
Article 3 ***Definitions***
11. 'Separate collection' means the collection where a waste stream is kept separately by type and nature so as to facilitate a specific treatment.

The term *'waste stream'* is not defined by the WFD. However, it is a term that is widely used and that can refer to the waste materials (e.g. plastics, metals) or to the products that originated the waste (e.g. packaging, electronics)[9].

The waste streams can be linked to the '*types of waste'* that have been codified in the List of Waste (LoW), Decision 2000/532/EC[10]. Based on the good practices presented in chapters 3-7, the waste types of the LoW can be clustered in order to determine the minimal waste streams that have to be collected separately in order to '*facilitate a specific treatment'*.

As highlighted by figure 3, the Articles 11, 20 and 22 of the revised WFD impose, at least, the separate collection of waste from metals, paper, plastics, glass, textiles, HHW and bio-waste (see section 2.3 for a detailed discussion of these articles). The table below puts forward the waste streams that have to be separately collected (see section 3.3 for a discussion on the facilities to be foreseen) to be compliant with the revised WFD.

Table 1: minimum municipal waste streams to be separately collected

Focus materials	**Waste streams for separate collection**	**Codes List of Waste**
Paper	Paper & cardboard	150101, 200101
Plastics	Beverage bottles; Other packaging plastics (including beverage cartons); Other plastics	150102, 150105; 200139
Metals	Beverage cans; other packaging metals; other metals	150104, 200140
Glass	Bottles and jars; other glass	150107, 200102
Textiles	Textiles	150109, 200110, 200111
HHW	Many different waste streams including WEEE, batteries,	060404*, 150110*,150111*, 150202*, 160107*, 160113*, 160114*, 160212*, 160215*, 150202*, 170303*, 170601*,

[9] EPRS (2015)
[10] Sepa (2015)
See also https://www.gov.uk/guidance/waste-exemption-t4-preparatory-treatments-baling-sorting-shredding-etc

	asbestos, paints, …	170605*, 200113*- 200123*, 200126*-200137*
Bio-waste	Kitchen waste; green waste	200108, 200201

MS can decide to collect more waste streams separately. Once collected, sorting of the collected waste streams can enhance the separation of different waste types.

For further discussion also three other waste streams are defined using the LoW codes.

Waste stream	List of Waste Codes
Mixed municipal waste or residual waste	200301
Bulky waste	200307
Other household waste	150103, 150105, 150106, 200125, 200138, 200141, 200199, 200202, 200203, 200302-200304, 200399

The following recital highlights that definition of separate collection can be achieved via a range of collection arrangements.

Directive 2018/851

Recital 42

Separate collection could be achieved through door-to-door collection, bring and reception systems or other collection arrangements.

2.2 Rationale for more focus on separate collection

In order to interpret the requirements of the directive, the rationale of the decision makers matters. The motivation to strengthen the obligations around separate collection are illustrated by the following recital:

Directive 2018/851

Recital 41

In order to avoid waste treatment locks in resources at the lower levels of the waste hierarchy, increase preparing for re-use and recycling rates, enable high-quality recycling and boost the uptake of quality secondary raw materials, Member States should ensure enhanced compliance with the obligation to collect waste separately, as laid down in Articles 10(2) and 11(1) of Directive 2008/98/EC, including the obligation to set up separate collection for at least paper, metal, plastic and glass waste that the Member states had to meet by 2015, and should introduce separate collection of bio-waste, hazardous waste produced by households and textile waste. Where appropriate, hazardous bio-waste and packaging waste containing hazardous substances should be subject to specific collection requirements.

Although Directive 2008/98/EC version 19/11/2008 already stressed the importance of separate collection and contained obligations, the European Institutions observed that

the actions taken by the MS were insufficient (need for 'enhanced compliance') to achieve the ambitions ('high quality recycling, boost the uptake requirements, …'). Therefore, the revised WFD extends the obligations for separate collection (to bio-waste, hazardous waste for households and textile waste), defines measurable targets (see chapter on obligations) and sets up systems that better monitor and enforce the progress (see subchapters on monitoring and infringement).

The importance attached by the European Institutes to separate collection as a critical measure to improve waste management, can also be observed in the travaux préparatoires. See for example the explanatory memorandum joined with the initial legislative proposal of 2015.

Explanatory memorandum for the proposal for amending Directive 2008/98/EC European Commission, 2/12/2015
Recital 20 Compliance with the obligation to set up separate collection systems for paper, metal, plastic and glass is essential in order to increase preparing for re-use and recycling rates in Member States. In addition bio-waste should be collected separately to contribute to an increase in preparing for re-use and recycling rates and the prevention of contamination of dry recyclable materials.

Another illustration of the view that the Institutions see a stronger implementation of separate collection across the EU as indispensable, can be found in the Opinion of 27 April 2016 from the European Economic and Social Committee (non-binding, Advisory Committee).

Opinion of the European Economic and Social Committee of 27 April 2016
1.16 Separate collection of waste streams is critical for achieving circularity. 4.3.8 Separate collection of waste streams seems indispensable in order to ensure closing loops with high quality secondary raw materials.

Logically, this focus on separate collection has also been continued by the new Commission. The Communication of December 2019 on 'The European Green Deal'[11] announces that the Commission will propose a model for separate waste collection in order to simplify waste management for citizens and ensure cleaner secondary materials for businesses.

2.3 Obligations

The previous section on the rationale (2.2) provides context for the revision of the WFD. This section discusses the key provisions related to separate collection, using the recitals and travaux préparatoires to provide insights to interpret the text. The text focuses on the obligations of Article 10, 11, 20 and 22 that were already put forward by figure 3 as most relevant for the separate collection requirements.

[11] European Commission (2019)

2.3.1 *Article 10: Recovery*

WFD version 19/11/2008	Directive 2018/851 (revised WFD)
Article 10 **Recovery** 1. Member States shall take the necessary measures to ensure that waste undergoes recovery operations, in accordance with Articles 4 and 13. 2. Where necessary to comply with paragraph 1 and to facilitate or improve recovery, waste shall be collected separately if technically, environmentally and economically practicable and shall not be mixed with other waste or other material with different properties.	*Article 10* **Recovery** 1. Member States shall take the necessary measures to ensure that waste undergoes preparing for re-use, recycling or other recovery operations, in accordance with Articles 4 and 13. 2. Where necessary to comply with paragraph 1 and to facilitate or improve preparing for re-use, recycling and other recovery operations, waste shall be subject to separate collection and shall not be mixed with other waste or other materials with different properties. 3. Member States may allow derogations from paragraph 2 provided that at least one of the following conditions is met: (a) collecting certain types of waste together does not affect their potential to undergo preparing for re-use, recycling or other recovery operations in accordance with Article 4 and results in output from those operations which is of comparable quality to that achieved through separate collection; (b) separate collection does not deliver the best environmental outcome when considering the overall environmental impacts of the management of the relevant waste streams; (c) separate collection is not technically feasible taking into consideration good practices in waste collection; (d) separate collection would entail disproportionate economic costs taking into account the costs of adverse environmental and health impacts of mixed waste collection and treatment, the potential for efficiency improvements in waste collection and treatment, revenues from sales of secondary raw materials as well as the application of the polluter-pays principle and extended producer responsibility. Member States shall regularly review derogations under this paragraph taking into account good practices in separate collection of waste and other developments in waste management. …

The changes made by the European decision makers to the 2008/98/EC directive are underlined and will be discussed below.

Article 4 describes the 'Waste hierarchy' and Article 13 states the ultimate goal and obligation for 'Protection of human health and the environment'.

The changes in Article 10.1 are limited. "Recovery operations" is substituted by "preparing for re-use, recycling or other recovery operations". Since the definition of "Recovery" has not been modified by Directive 2018/851, the guidance on the interpretation of 'recovery' and 'recovery operations' can be maintained.

European Commission (2012) Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste
'Recovery' and the opposite term 'disposal' (negatively defined as operations which are not recovery) together comprise 'waste treatment'. Any waste treatment can only be either a recovery operation or a disposal operation. Recovery is divided into three sub-categories: preparing for re-use, recycling and other recovery.

Taking into account, the interpretation of recovery, it becomes clear that the main change of article 10 is related to the introduction of the derogations that substitute the technically, environmentally and economically practicable (TEEP) principle. As highlighted by the Opinion of the European Economic and Social Committee of 2016 on the proposal for amendments by the Commission, TEEP was considered too generic and 'soft'.

Opinion of the European Economic and Social Committee of 27 April 2016
4.3.8 … Instead of these strict separate collection requirements the new proposal entails a 'soft' – in practice less effective – provision requiring separate collection 'where technically, environmentally and economically feasible and appropriate'. The EESC calls for this to be strengthened. …

Also the European Parliament wanted a more stringent formulation to support separate collection across the EU. The Parliament proposed the amendment that took out the TEEP principle and formed the basis of the new derogations in the revised WFD.

European Parliament (2017) Report on the proposal for a directive amending Directive 2008/98/EC, 09/02/2017
Proposed amendment 156 Article 10(2) is replaced by: "In order to comply with paragraph 1 and to facilitate or improve recovery, waste shall be collected separately and shall not be mixed with other waste or other material with different properties. By way of derogation from the first subparagraph, Member States may exclude sparsely populated areas where it is demonstrated that separate collection does not deliver the best overall environmental outcome taking into account life-cycle thinking. Member States shall notify the Commission of their intention to make use of this derogation. The Commission shall review the notification and assess whether the derogation is justified, taking into account the objectives of this Directive. Where the Commission has raised no objections within nine months of the notification, the derogation shall be considered to be granted. Where the Commission objects, it shall adopt a decision and inform the Member State accordingly."

Interestingly, the last paragraph has not been withheld at all. This paragraph turned around the evaluation cycle and shifted the initiative to the Commission. It proposed

that the Commission should first evaluate and approve before a MS could allow/put into place a derogation from the separate collection obligation. Since this paragraph is not withheld, it highlights that the decision makers did not follow the Commission in its proposal on this point. Instead, the normal procedure applies, i.e. the MS assess the benefits of different waste management systems and transpose the Revised WFD in the national or subnational legislation. If the Commission suspects that the transposition is late or non-compliant, it can start an infringement procedure[12].

The briefing to the European Parliament also highlights that the policy makers consider the new derogations to be stricter than the previous conditions, in the sense that the aim is to have more separate collection in the future.

European Parliamentary Research Service, Briefing EU Legislation in progress, March 2018[13]
On 18 December 2017, Parliament and Council reached provisional agreements on the proposals in trilogue negotiations (…). The main features include:… • Strengthening requirements related to separate waste collection, in particular by specifying exemptions in further detail; …

The interpretation of the derogations will be discussed in depth in subchapter 2.4.

By isolating the introduction of the derogations in Article 10 (3), the existing guidance (Commission 2012) can be easily reformulated (*changes in italics*) in order to apply to the Revised WFD.

European Commission (2012) Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste
General obligation to encourage separate collection so as to facilitate recovery. Article 10 (2) *Revised* WFD encourages Member States to make use of separate collection of waste to facilitate or improve *preparing for re-use, recycling and other recovery*. This provision applies to all waste streams *including waste from commercial and industrial sources*. *Article 10(3) specifies the potential derogations.* Further, by referring to compliance with Member State's obligations under Article 10(1) *Revised* WFD, Article 10(2) WFD makes it clear that the separate collection has to be a necessary measure to ensure that the waste undergoes *preparing for reuse, recycling or other recovery operations* in accordance with the principles set out in Articles 4 (Waste hierarchy) and 13 (Protection of human health and the environment).

Article 10 (3) also stipulates that MS shall regularly review derogations taking into account good practices (from other countries) and technological evolutions. The waste management sector has proven to be an innovative sector that can realize

[12] See for more info: https://ec.europa.eu/info/law/law-making-process/applying-eu-law/infringement-procedure_en

[13] Documents of the EPRS are not part of the travaux préparatoires. The content does not represent an official position of the European Parliament. The document, however, highlights the overall interpretation of the specifications in the run-up to the approval of the revised WFD.

technological breakthroughs. Consequently, technological progress may make accepted derogations for separate collection unjustified owing to new collection techniques. Conversely, new sorting or recycling techniques may generate an interest in new derogations. The Directive does not specify the regularity of the review but taking into account that the Directive has specified targets to be achieved by 2025, 2030 and 2035 (see further) and that status reports have to be provided to the Commission upfront (see section 2.5 on Monitoring), a review of the justification of the derogations every 5 years seems appropriate. Moreover, there are factors that would trigger the need for a full revision of the waste collection system in place, for example, structural changes in the EPR set-up, obligations for separate on new waste streams or the introduction of a deposit-refund system that has cross-stream impacts.

Directive 2018/851 (revised WFD)

Article 10 **Recovery**

…

4. Member States shall take measures to ensure that waste that has been separately collected for preparing for re-use and recycling pursuant to Article 11(1) and Article 22 is not incinerated, with the exception of waste resulting from subsequent treatment operations of the separately collected waste for which incineration delivers the best environmental outcome in accordance with Article 4.

5. Where necessary to comply with paragraph 1 of this Article and to facilitate or improve recovery, Member States shall take the necessary measures, before or during recovery, to remove hazardous substances, mixtures and components from hazardous waste with a view to their treatment in accordance with Articles 4 and 13.

Article 22 refers to the obligation for separate collection of bio-waste (see further for discussion). Article 10(4) ensures that separately collected waste streams that are collected for preparing for re-use and recycling cannot be incinerated. This applies to all waste streams.

Article 10 (5) focuses on the potential disruptive effects of hazardous waste for recovery processes or valorization of hazardous substances. Recital 38 provides more background on the aim of the Article.

Directive 2018/851 (revised WFD)

Recital 38

When products, materials and substances become waste, the presence of hazardous substances may render that waste unsuitable for recycling or the production of secondary raw materials of high quality. Therefore, in line with the 7th Environment Action Programme, which calls for the development of non-toxic material cycles, it is necessary to promote measures to reduce the content of hazardous substances in materials and products, including recycled materials, and to ensure that sufficient information about the presence of hazardous substances and especially substances of very high concern is communicated throughout the whole life cycle of products and materials. …

Article 10 (6) demands the Member States to submit a report to the Commission on the implementation of Article 10 relating to municipal waste and bio-waste. This Article will be discussed in section 2.5 on Monitoring.

2.3.2 *Article 11: Preparing for re-use and recycling*

Directive 2008/98/EC	**Directive 2018/851 (revised WFD)**
Article 11 **Re-use and recycling** 1. Member States shall take measures, as appropriate, to promote the re-use of products and preparing for re-use activities, notably by encouraging the establishment and support of re-use and repair networks, the use of economic instruments, procurement criteria, quantitative objectives or other measures. Member States shall take measures to promote high quality recycling and, to this end, shall set up separate collections of waste where technically, environmentally and economically practicable and appropriate to meet the necessary quality standards for the relevant recycling sectors. Subject to Article 10(2), by 2015 separate collection shall be set up for at least the following: **paper, metal, plastic and glass**.	*Article 11* **Preparing for re-use and recycling** 1. Member States shall take measures to promote preparing for re-use activities, notably by encouraging the establishment of and support for preparing for re-use and repair networks, by facilitating, where compatible with proper waste management, their access to waste held by collection schemes or facilities that can be prepared for re-use but is not destined for preparing for re-use by those schemes or facilities, and by promoting the use of economic instruments, procurement criteria, quantitative objectives or other measures. Member States shall take measures to promote high-quality recycling and, to this end, subject to Article 10(2) and (3), shall set up separate collection of waste. Subject to Article 10(2) and (3), Member States shall set up separate collection at least for **paper, metal, plastic and glass**, and, by 1 January 2025, for **textiles**. …

The change of the title of the article resolves a conceptual unclarity between the content of the Article (recovery) and the title (prevention). The explanatory statement sheds some light on the difference between 'reuse' and 'preparation for reuse'. Further details and the exact wording can be found in Article 3(13) and 3(16) that contain the respective definitions.

European Parliament (2017) Report on the proposal for a directive amending Directive 2008/98/EC, 09/02/2017
Explanatory statement Reuse, unlike preparing for reuse, is a process entailing the treatment of products to prevent waste generation; it should therefore be regarded as a specific waste prevention measure and incentivized by the Member States.

The additions in 11(1) with respect to the access to collected materials or components are in line with the target to increase reuse and foster the circular economy. Waste management collectors have to make waste products or end-of-life spare parts available for reuse actors even when other types of waste management would be more convenient. The text can be interpreted together with, among others, Article 9(1)d that encourages new actions to promote reuse.

Revised WFD
Article 9: Prevention of waste 1.d Encourage as appropriate and without prejudice to intellectual property rights, the availability of spare parts, instruction manuals, technical information, or other instruments, equipment or software enabling the repair and reuse of products without compromising their quality and safety.

In a similar way as for article 10, the TEEP principle has been removed in Article 11 and has been substituted by the more specific derogations of 10(3). For discussion, see article 10.

Directive 2018/851 has also removed the rather vague reference to 'the necessary quality standards for the relevant recycling sectors'. As a consequence, the definition of 'high quality recycling' is not determined. The Directive also does not offer any help on how to calculate this concept. Nonetheless, high-quality recycling is used amply to express the objectives of the Directive. Recital 41, discussed above, and article 11.1 already contain the concept, but the table below illustrates that it is a recurring theme.

Directive 2018/851
Recital 42 … While the obligation to separately collect waste requires that waste be kept separate by type and nature, it should be possible to collect certain types of waste together provided that this does not impede **high-quality recycling** or other recovery of waste, in line with the waste Hierarchy. Recital 56 In order to avoid waste treatment which locks in resource at the lower levels of the Waste hierarchy, to enable **high-quality recycling** and to boost the uptake of quality secondary raw materials, Member States should ensure that bio-waste is separately collected and undergoes recycling in a way that fulfils a high level of environmental protection and the output of which meets relevant high quality standards

High-quality recycling can be understood as a subconcept of recycling. Actually, scholars quite commonly distinguish recycling subconcepts such as open-loop vs

closed-loop[14] or upcycling vs downcycling[15]. It highlights that resources due to technical deficiencies, mixed collection or contamination, often lose quality[16] with every recycling cycle they go through[17]. For example, metals that are recycled in low-value alloys, plastics from packaging that are recycled as street furniture or flower pots, textiles that are recycled as rags. In this perspective, the high-quality recycling from Directive 2018/851 can be understood as recycling that does not cause the recycled resources to lose value over time. More formally:

> *High quality recycling is the reprocessing of waste into materials which have a similar or higher economic value in comparison to the products or applications from which the waste originates.*

Article 11 of Directive 2018/851 also introduces the requirement to set up separate collection systems for textiles. As highlighted in Figure 2, textiles contribute in a significant way to the volumes of municipal waste. Moreover, the waste stream holds substantial potential for more preparing for reuse and high-quality recycling (see chapter 6 for an overview of good practices for textile waste collection). In 10 (6) the Commission is also asked to propose targets on textiles and other waste streams.

Directive 2018/851
Article 10(6) By 31 December 2024, the Commission shall consider the setting of preparing for reuse and recycling targets for construction and demolition waste and its material-specific fractions, textile waste, commercial waste and recycling targets for municipal bio-waste. To that end, the Commission shall submit a report to the European Parliament and to the Council, accompanied, if appropriate, by a legislative proposal

Taking into account the changes discussed above, the guidance on the old version of the WFD (Commission 2012) can be modified with regard to new aspects (*changes highlighted in italics in the table below*).

European Commission (2012) Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste
General obligation to introduce separate collection to facilitate recycling. In accordance with Article 11(1), paragraph 2 *revised* WFD, Member States are required to set up separate collection schemes as measures to promote high-quality recycling. Bearing in mind that recycling is a specific case of recovery, Article 11 is 'lex specialis' in comparison with Article 10, meaning that in cases where separate collection is needed to facilitate waste recycling, Article 11 shall apply. Article 11(1) paragraph 2 applies to all waste streams in a similar manner to Article 10 (2)

[14] Huysman et al. (2015)
[15] E.g. Koffler and Florin (2013)
[16] McDonough and Braungart (2002)
[17] For a discussion see: De Romph (2018)

revised WFD. *Article 11(1) paragraph 3 confirms the obligation to collect paper, metal, plastic and glass separately and inserts the obligation to collect textile waste separately by 1 January 2025. Article 10(3) specifies the potential derogations.*

The remainder of Article 11, revised WFD, focuses on the preparing for reuse and recycling targets to be achieved in 2025, 2030 and 2035. Moreover, the Article also refers to co-processing of municipal waste with minerals and contains prescriptions encouraging selective demolition of buildings to enable safe handling of hazardous substances and facilitate reuse and high-quality recycling.

2.3.3 *Article 20: Hazardous waste produced by households*

WFD version 19/11/2008	**Directive 2018/851 (revised WFD)**
Article 20 **Hazardous waste produced by households** Articles 17, 18, 19 and 35 shall not apply to mixed waste produced by households. Articles 19 and 35 shall not apply to separate fractions of hazardous waste produced by households until they are accepted for collection, disposal or recovery by an establishment or an undertaking which has obtained a permit or has been registered in accordance with Articles 23 or 26.	*Article 20* **Hazardous waste produced by households** 1. By 1 January 2025, Member States shall set up separate collection for hazardous waste fractions produced by households to ensure that they are treated in accordance with Articles 4 and 13 and do not contaminate other municipal waste streams. 2. Articles 17, 18, 19 and 35 shall not apply to mixed waste produced by households. 3. Articles 19 and 35 shall not apply to separate fractions of hazardous waste produced by households until they are accepted for collection, disposal or recovery by an establishment or an undertaking which has obtained a permit or has been registered in accordance with Article 23 or 26. 4. By 5 January 2020, the Commission shall draw up guidelines to assist and facilitate Member States in the separate collection of hazardous waste fractions produced by households.

Directive 2018/851 introduced the requirement in Article 20(1), revised WFD, to collect hazardous waste from households separately by 2025. As a reminder, Article 4 describes the 'Waste hierarchy' and Article 13 stresses the 'Protection of human health and the environment'. The motivation and the type of waste streams to be collected separately are discussed more elaborately in the Recitals.

Directive 2018/851
Recital 54 Hazardous waste that is produced by households, such as hazardous waste from paints, varnishes, solvents or cleaning products, should also be collected separately in order to avoid contamination of municipal waste with hazardous waste fractions that could lower recycling

quality and to ensure the environmentally sound management of that hazardous waste.

Article 20 serves as lex specialis for hazardous waste from households and does NOT refer to Article 10(3) that describes the potential derogations. This means that MS cannot invoke derogations for the separate collection of hazardous waste. The European Institutions have made safety and prevention of contamination a priority that does not allow exceptions.

Article 20 also demands the commission to draw up guidelines for separate collection of hazardous household waste to support the MS in the implementation of the revised Directive. Chapter 7 (see further) presents good practices to organize separate collection of hazardous waste from households.

2.3.4 *Article 22 Bio-waste*

WFD version 19/11/2008	**Directive 2018/851 (revised WFD)**
Article 22 **Bio-waste** Member States shall take measures, as appropriate, and in accordance with Articles 4 and 13, to encourage: (a) the separate collection of bio-waste with a view to the composting and digestion of bio-waste; (b) the treatment of bio-waste in a way that fulfils a high level of environmental protection; (c) the use of environmentally safe materials produced from bio-waste. The Commission shall carry out an assessment on the management of bio-waste with a view to submitting a proposal if appropriate. The assessment shall examine the opportunity of setting minimum requirements for bio-waste management and quality criteria for compost and digestate from bio-waste, in order to guarantee a high level of protection for human health and the environment.	*Article 22* **Bio-waste** 1. Member States shall ensure that, by 31 December 2023 and subject to Article 10(2) and (3), bio-waste is either separated and recycled at source, or is collected separately and is not mixed with other types of waste. Member States may allow waste with similar biodegradability and compostability properties which complies with relevant European standards or any equivalent national standards for packaging recoverable through composting and biodegradation, to be collected together with bio-waste. 2. Member States shall take measures in accordance with Articles 4 and 13, to: (a) encourage the recycling, including composting and digestion, of bio-waste in a way that fulfils a high level of environment protection and results in output which meets relevant high-quality standards; (b) encourage home composting; and (c) promote the use of materials produced from bio-waste. 3. By 31 December 2018, the Commission shall request the European standardisation organisations to develop European standards for bio-waste entering organic recycling processes, for compost and for digestate, based on best available practices.

Strengthening the quality and quantity of recycled bioresources is a key ambition of the revised WFD that links well with, among others, the bio-economy in Europe[18]. Consequently, the old provisions of article 22 have been fully rewritten. The new Article 22(1) first paragraph, makes home composting and separate collection of waste obligatory. MS can invoke the derogations of Article 10(3).

Article 11a(4), revised WFD (calculation of the targets), further highlights that the European decision makers consider that separate collection of bio-waste is an essential instrument to improve the quality of the recovered resources.

Revised WFD
Article 11a(4) second paragraph
As from 1 January 2024, Member States may count municipal bio-waste entering aerobic or anaerobic treatment as recycled only if, in accordance with Article 22, it has been separately collected or separated at source.

Within the perspective of circular (packaging) strategies, many companies are considering to start using compostable plastics and other biodegradable products. Article 22(1) second paragraph, states that the MS can allow such products in the bio-waste collection as long as they do not disturb the quality and value of the bio-waste streams.

Article 22(3) refers to the development of European standards for bio-waste to standardize the outputs from composting and digesting process in order to support the further development of the market for recovered bio-based resources.

2.4 Derogations

Although the derogations put forward by directive 2008/851, are more specified than before (see discussion on Article 10(3) before), the WFD acknowledges that waste management is diverse in Europe[19] and that there may be local circumstances that require customized solutions. The discussion of articles 10(2) and 10(3) above highlights that separate collection is the rule, the derogations have to be justified and they must be interpreted strictly. Earlier legal cases[20] have highlighted that MS and local authorities can only deviate from the rule (in this case separate collection) after careful analysis which means that each of the derogations shall be properly assessed[21] on a merits, concrete basis.

[18] European Commission (2018)
[19] European Commission (2011)
[20] High Court (Wales) in Campaign for Real Recycling, March 6, 2013, EWHC 245 (Admin).
[21] Court of Justice of the EU, Verdi Ambiente e Societa (VAS) – Aps Onlus, Movimento Legge Rifiuti Zero per l'Econnomia Circoalare Aps / Presidenza del Consiglio dei Ministri, Ministero dell' Ambiente e della Tutela e del Mare, Regione Lazio, C-305/18 , 8 May 2019

The draft decree for implementation of the revised WFD in the Netherlands[22], highlights that MS can decide to allow local authorities to invoke derogations for some waste streams (such as commingled collection of packaging plastics and metals) while forbidding to invoke derogations for other waste streams (such as paper & cardboard, textiles and hazardous waste). In order to be compliant with the revised WFD, the local authorities that invoke a derogation still need to justify the derogation based on local circumstances and analysis of the alternatives.

The revised article 10 of the WFD requires that MS shall regularly (e.g. 5 years, see section 2.3 for discussion on Article 10) review the derogations taking into account good practices in separate collection of waste and other developments in waste management.

Chapters 4–7 contain examples of good practices for respectively bio-waste, plastics, textiles and HHW that highlight that in most situations separate collection can be organized efficiently such that the derogations are redundant. Moreover, chapter 3 provides an integrated approach to set up performant systems for separate sorting of municipal waste. In addition to economic incentives, legal enforcement and engaging communication, the proposed approach for separate collection of waste includes four coherent scenarios to implement the obligations of the revised WFD.

Taking into account the periodic nature of the review, MS would best put into place effective and transparent procedures to assess and revalidate derogations invoked. In each of the derogations below, indicators will be suggested that can be used to assess whether the derogations are in line with the aspirations and prescriptions of the revised WFD.

In what follows, each of the derogations will be discussed in more detail.

2.4.1 *Commingling*

Revised WFD
Article 10(3), condition a) Collecting certain types of waste together does not affect their potential to undergo preparing for re-use, recycling or other recovery operations in accordance with Article 4 and results in output from those operations which is of comparable quality to that achieved through separate collection;

The motivation for the derogation is further explained by the recitals for Directive 2018/851 that amends the old version of the WFD.

Directive 2018/851

[22] Besluit van […] houdende implementatie van enkele bepalingen van Richtlijn (EU) 2018/851 van het Europees Parlement en de Raad van 30 mei 2018 tot wijziging van Richtlijn 2008/98/EG betreffende afvalstoffen (PbEU L 150/109) (Besluit gescheiden inzameling huishoudelijke afvalstoffen)

Recital 42

'…While the obligation to separately collect waste requires that waste be kept separate by type and nature, it should be possible to collect certain types of waste together provided that this does not impede high-quality recycling or other recovery of waste, in line with the waste hierarchy…'

This derogation refers to commingled waste collection, i.e. collecting different types of waste or waste streams (see section 2.1 on Definitions and section 3.3 on best practice collection scenarios per waste stream), together in one bin, bag, truck or container with the aim to use sorting techniques that induce high quality recycling in a later step. Commingled waste collection can refer to door-to-door, bring and reception systems. A typical example where this derogation for commingling could apply, is the joint collection of plastics and metals. In many countries and municipalities[23], these waste streams are collected together followed by a sorting process that reaches a quality similar to the quality when collected separately[24]. Another example refers to the collection of beverage cartons jointly with either plastics or paper & cardboard. Beverage cartons are a composite material made of paper with a plastic layer and sometimes some aluminum. They are almost never collected separately but rather commingled with plastics or paper & cardboard[25].

Waste streams that are separated at source and are collected in one truck but kept separate per material in different bags '*so as to facilitate a specific treatment*', it is considered separate collection, not commingling (see section 2.1 on definitions).

MS and municipalities worldwide have extensively experimented with collection systems in order to optimize waste management costs and performance. Commingling is sometimes also used to collect dry recyclables such as paper and cardboard, plastics, glass, metals and textiles jointly. However, such extensive commingling of streams with different properties risks to hamper the high quality pursued by the revised WFD[26]:

- Paper and cardboard are typically considered as one waste stream and are jointly collected. To avoid a degradation of the quality of recycled paper & cardboard (e.g. by commingling it with other recyclables such as plastics/metal/glass which may be contaminated with food), paper & cardboard should be collected as a separate stream[27];

[23] Besluit van […] houdende implementatie van enkele bepalingen van Richtlijn (EU) 2018/851 van het Europees Parlement en de Raad van 30 mei 2018 tot wijziging van Richtlijn 2008/98/EG betreffende afvalstoffen (PbEU L 150/109) (Besluit gescheiden inzameling huishoudelijke afvalstoffen)

[24] http://com.fostplus.be/jaarverslag2018nl/welkom/

[25] http://www.ace.be/beverage-cartons/recycling/collection
https://www.fostplus.be/en/sorting-recycling/all-about-recycling/recycling-drinks-cartons
Expra (2018)

[26] See also European Commission (2012)

[27] See also Miranda, R. (2013) and CEPI (2018)

- Reuse of high quality clothes is driving the economic feasibility of textiles collection and the reusability of clothing is highly affected by the way in which it is collected. Therefore, dedicated collection facilities that only collect waste textiles will generate a better outcome (see extensive discussion in chapter 6 on Textiles);
- The end-of-waste criteria for glass cullet, as defined in Regulation 1179/2012, specify strict levels for the impurities in the glass and exclude collection of glass with mixed municipal waste in order to be accepted as end-of-waste. Moreover, glass can break during collection which complicates sorting of commingled streams and causes pollution that downgrades the quality of the other recyclables[28]. Therefore, glass should be kept separate to allow recycling in high-quality (i.e. closed-loop) applications.

Bio-waste is wet and difficult to remove from other recyclables. Mixing biowaste with dry waste types would contaminate other waste types. Furthermore, separate collection of bio-waste is needed to achieve a high-quality compost/digestate. Indeed, impurities such as plastics, glass and metals will be difficult to extract during treatment and reduce the value of the compost or digestate. Therefore, a derogation for the collection of bio-waste with other waste streams is hard to motivate taking into account the intentions and the prescriptions of the revised WFD.

As a reminder, derogations regarding the separate collection of hazardous waste are not allowed (see section 2.3.3 on Obligations, discussing Article 20, revised WFD).

Recycling technology evolves and innovation in sorting techniques is strong[29]. Sorting waste has improved thanks to a suite of techniques such as magnets, wind shifters, sieves, NIR sensors, optical detectors, density separation, ballistic machines[30] and other technologies such as artificial intelligence. Derogation 10(3)a allows MS to deviate from the separate collection if they organize commingled collection followed by an adequate suite of separation techniques that would guarantee high-quality recycling. However, the following (non-exhaustive) list of criteria has to be checked to assess the compliance of the proposed alternative to the revised WFD. If one of the criteria cannot be achieved by commingled collection, then separate collection is required:

- The commingling cannot have a negative effect on the quality, price and availability of products, components or spare parts that can be prepared for reuse.
- The quality and price of the secondary materials separated and treated after commingled collection should be equal or higher than for recovered resources from separate collection schemes.
- There should be guarantees, contracts or concrete requests for the procurement and use of the recovered resources in high-value applications.

[28] For illustration see a discussion of the US context relating to glass recycling via single stream (i.e. commingling: Jacoby (2019)

[29] See Worrel and Reuter (2014) for a discussion of sorting and recovery techniques for a wide range of waste streams

[30] See for example: https://www.avr.nl/nl/nieuws/nieuwe-installatie-haalt-plastic-uit-restafval-rotterdammers

- The process losses and contamination levels of the commingled process and of the applied sorting practices, including technology and infrastructure, should be equal or lower than the rates of resulting from separate collection schemes.
- The performance of the commingled collection system in terms of collection rate, recycling rate and cost efficiency should be similar or better with respect to preparing for reuse or recycling than a benchmark of municipalities with similar characteristics.

2.4.2 *Environmental outcome*

Revised WFD
Article 10(3), condition b) Separate collection does not deliver the best environmental outcome when considering the overall environmental impacts of the management of the relevant waste streams;

The motivation for the derogation is further explained by the recitals for Directive 2018/851 that amends the old version of the WFD.

Directive 2018/851
Recital 42 '…Member States should also be allowed to deviate from the general obligation to separately collect waste in other duly justified cases, for instance where the separate collection of specific waste streams in remote and scarcely populated areas causes **negative environmental impacts that outweigh its overall environmental benefits** or entails disproportionate economic costs...'

This derogation refers to a situation where the ecological benefits are not sufficient to compensate for the negative environmental effects of separate collection. For example, in scarcely populated areas, remote communities, small islands and mountainous regions, the additional emissions from transport could exceed the environmental benefits of more recycling via separate collection. Especially for door-to-door waste collection, the balance can be precarious.

For this reason, MS such as Bulgaria, Estonia, Sweden, Slovenia and Ireland already accept that municipalities in low-density areas with inhabitants below thresholds that range from 500 to 5000, can deviate from separate collection obligations. Consequently, the derogation could be easily invoked for sparsely populated areas[31], i.e. NUTS 3 regions with fewer than 12,5 inhabitants[32] per km^2 or NUTS 2 regions with

[31] See maps of sparsely populated regions at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Sparsely_populated_regions.png and of mountains, islands and sparsely populated regions at https://ec.europa.eu/regional_policy/sources/policy/themes/sparsely-populated-areas/map_mountains_islands_spas.pdf

[32] For the definition of sparsely populated areas see the guidelines on national regional aid for the 2014-2020 period (2013/C 209/01).

fewer than 8 inhabitants per km^2. In sparsely populated areas, there is ample space and opportunity for home composting. In addition, storing biowaste for a longer time is challenging and can create bad odors. Consequently, the derogation could be used to set up intensive campaigns that promote home composting to deliver a better outcome than separate collection of biowaste.

The derogation for separate collection should be duly assessed for each material stream and local situation. Moreover, all externalities have to be taken into account. It is not because a region is remote, scarcely populated, mountainous or an island that separate collection does not deliver the best environmental outcome. There are plenty of examples where such regions have successfully set up separate collection schemes.[33]

As discussed in section 2.2 on obligations, the Directive stipulates that separate collection can be organized by 'door-to-door collection, bring and reception systems or other collection arrangements'. Therefore, customizing the system for separate collection to the local circumstances will often be a better solution than omitting it. Especially for dry recyclables, solutions exist to collect waste separately even in challenging areas. Dry recyclables such as paper and cardboard, plastics, metals, textiles and glass can be easily stored and even compacted such that households can return them when it is convenient. For such materials, bring systems with street containers at central locations such as town halls, supermarkets or gasoline stations can offer suitable alternatives to door-to-door collection for sparsely populated regions.

In case MS want to allow the local authorities to use this derogation for other circumstances than described above, an in-depth assessment of the local environmental impact is needed. Life Cycle Analysis (LCA), as described in the norm ISO 14040, would be a suitable methodology to assess whether separate collection achieves the best environmental outcome for a specific situation[34]. Importantly, assumptions will be needed to analyse the local context.[35] Moreover, the choice for the

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For more discussion see: EPRS (2016) sparsely populated and underpopulated areas

[33] See for example:

- Sardinia as a zero waste champion: https://zerowasteeurope.eu/downloads/case-study-10-the-story-of-sardinia/
- Capannori (Italy) as a zero waste champion in a rural region https://zerowasteeurope.eu/2013/09/the-story-of-capannori-a-zero-waste-champion/
- Samothraki (Greece) for initiatives to improve waste sorting and collection at a small island: https://www.researchgate.net/publication/312575792_Waste_management_on_small_islands_A_case_study_from_Samothraki_Greece
- Târgu Lapus (Romania) for separate collection and composting in a mountainous region: https://ec.europa.eu/regional_policy/en/projects/major/romania/improved-waste-management-leads-to-better-quality-of-life http://www.academia.edu/35130829/The_implementation_of_a_plan_of_the_integrated_municipal_solid_waste_management_at_T%C3%A2rgu_L%C4%83pu%C8%99_Maramure%C8%99_County

[34] See for more discussion: European Commission (2012) and Hoogmartens and al. (2014)

[35] See for discussion LCA and other assessment techniques for European legislation Dalhammar (2015) and Lazarevic et al. (2012)

assessed scenarios in the LCA with the different waste management options may affect the conclusions of the assessment[36]. Therefore, a well-motivated and transparent selection of the input data is needed as well as an external quality review that assures the quality of the assessment.

If the environmental benefits are questioned due to long distance trips and low collected volumes, the system may also cause disproportionate economic costs which would relate to Article 11(3)d that is discussed in a separate section below (see 2.4.4).

In order to assess whether derogation 11(3)b can be applied, the following (non-exhaustive) criteria can be taken into account. If one of the criteria is not fulfilled, then separate collection is required to be compliant to the revised WFD:

- If there there are municipalities or regions with similar characteristics that have successfully implemented separate collection, then a derogation cannot be allowed.
- The analysis should prove that suitable bring or reception systems do not offer a more environmentally friendly solution to organize separate collection.
- The derogation can only apply to the area where the local circumstances are problematic, not for the whole administrative region (municipality/district).
- A LCA or other structured environmental assessment that does an in-depth and quantified analysis is needed to motivate the use of the derogation. The scenarios taken into account for comparison should be appropriate and contain potential policy measures that give incentives for behavioral change (e.g. Pay-as-You-Throw). Moreover, the difference in results of the scenarios calculated by the LCA or alternative assessment should be significant to confirm that deviating from separate collection leads to a better environmental outcome.

2.4.3 *Technical feasibility*

Revised WFD
Article 10(3), condition c) Separate collection is not technically feasible taking into consideration good practices in waste collection;

'Technically feasible' is not defined in the revised WFD. However, earlier guidance documents described **'Technically practicable:**

Commission (2012) Guidance on the interpretation of key provisions of the Directive 2008/98/EC
'Technically practicable' means that the separate collection may be implemented through a system which has been technically developed and proven to function in practice.

[36] See for guidance on LCA for policy assessment JRC (2011) and Mandredi et al. (2011);

This derogation cannot be used for situations where other local authorities in Europe that operate in similar conditions, have found a technical solution to set up separate collection.

The following chapters present examples and best practices for separate collection. The many successful schemes for separate collection in Europe, highlight that most practical, technical and operational constraints can be overcome by good management and focus on the target groups. [37] For example:

- Modern waste collection trucks may face problems to maneuver through narrow streets in dense historical city centres. A functional solution is the installation of underground street containers at central locations.
- Existing apartment blocks may not have space available for different containers. Under- or overground street containers nearby have been shown to be a functional alternative as well as visits by experts that propose location-specific solutions and give support to building managers and the syndicus.
- Section 2.4.2 already referred to examples and good practices applied on islands, scarcely populated areas, remote communities, small islands and mountainous regions.[38]

Moreover, the revised WFD allows to set up a variety of collection schemes including door-to-door, bring and reception systems. Situations where separate collection of the waste streams determined earlier (see section 2.1 Definitions and 3.3 for collection scenarios) is not technically feasible will be rare and be related to specific local conditions.

In order to assess whether derogation 11(3)c can be applied, the following (non-exhaustive) criteria can be taken into account. If one of the criteria is not fulfilled, then separate collection is required to be compliant to the revised WFD:

[37] See for example BiPRO/CRI (2015)

[38] See for example:

- Sardinia as a zero waste champion: https://zerowasteeurope.eu/downloads/case-study-10-the-story-of-sardinia/
- Capannori (Italy) as a zero waste champion in a rural region https://zerowasteeurope.eu/2013/09/the-story-of-capannori-a-zero-waste-champion/
- Samothraki (Greece) for initiatives to improve waste sorting and collection at a small island: https://www.researchgate.net/publication/312575792_Waste_management_on_small_islands_A_case_study_from_Samothraki_Greece
- Târgu Lapus (Romania) for separate collection and composting in a mountainous region: https://ec.europa.eu/regional_policy/en/projects/major/romania/improved-waste-management-leads-to-better-quality-of-life
- http://www.academia.edu/35130829/The_implementation_of_a_plan_of_the_integrated_municipal_solid_waste_management_at_T%C3%A2rgu_L%C4%83pu%C8%99_Maramure%C8%99_County

- If there are locations with similar characteristics that have successfully implemented separate collection using different collection methods, technologies or recycling outlets, then the derogation cannot be invoked.
- A study should investigate and show that alternative bring systems or reception systems do not offer a feasible solution. This analysis should incorporate the potential use of innovative technologies.
- The derogation should be limited to the specific location where the issue arises, rather than for the whole administrative region concerned (municipality/region).

2.4.4 *Disproportionate economic costs*

Revised WFD
Article 10(3), condition d) Separate collection would entail disproportionate economic costs taking into account the costs of adverse environmental and health impacts of mixed waste collection and treatment, the potential for efficiency improvements in waste collection and treatment, revenues from sales of secondary raw materials as well as the application of the polluter-pays principle and extended producer responsibility.

The motivation for the derogation is further explained by the recitals for Directive 2018/851 that amends the previous version of the WFD.

Directive 2018/851
Recital 42 ▪ (similar as for the derogation on Environmental outcome): …Member States should also be allowed to deviate from the general obligation to separately collect waste in other duly justified cases, for instance where the separate collection of specific waste streams in remote and scarcely populated areas causes negative environmental impacts that outweigh its overall environmental benefits or entails disproportionate economic costs… ▪ …When assessing any cases in which economic costs might be disproportionate, Member States should take into account the overall economic benefits of separate collection, including in terms of avoided direct costs and costs of adverse environmental and health impacts associated with the collection and treatment of mixed waste, revenues from sales of secondary raw materials and the possibility to develop markets for such materials, as well as contributions by waste producers and producers of products, which could further improve the cost- efficiency of waste management systems**...**

This derogation applies in a similar way as the derogation b) 'Environmental Outcome' that was discussed earlier.

In scarcely populated areas, remote communities, small islands and mountainous regions, the costs from transport, especially for door-to-door collection, could be excessive compared to the collected volumes. Moreover, in such regions there is ample place for home composting. Therefore, the derogation can be used by

municipalities in sparsely populated areas[39], i.e. NUTS 3 regions with fewer than 12,5 inhabitants[40] per km^2 or NUTS 2 regions with fewer than 8 inhabitants per km^2,that want to substitute separate bio-waste collection by high levels of home composting.

Especially for dry recyclables, solutions exist to collect waste separately even in challenging areas. Dry recyclables such as paper and cardboard, plastics, metals, textiles and glass can be easily stored and even compacted such that households can return them when it is convenient. For such materials, bring systems with street containers at central locations such as town halls, supermarkets or gasoline stations can offer cost efficient alternatives to door-to-door collection for sparsely populated regions. As will be discussed further (see section 3.1 Economic incentives), EPR can play an important role to facilitate separate collection.

Section 2.4.2 already refers to examples where islands and remote areas have successfully set up separate collection schemes. Indeed, as discussed in section 2.2 on obligations, the Directive stipulates that separate collection can be organized by 'door-to-door collection, bring and reception systems or other collection arrangements'. Therefore, customizing the system for separate collection to the local circumstances will often be a better solution than omitting it.

If MS want to allow municipalities to invoke this derogation for other circumstances than the management of bio-waste in sparsely populated regions, then Cost Benefit Analysis (CBA) would be a suitable methodology to assess the economic impact[41]. A CBA inventorises all internal and external costs and analyses them from a societal viewpoint[42]. For example, the following (non-exhaustive) list presents examples of impacts that could be taken into account:

- Operational costs: transport, labor, write-offs, running costs, …
- Revenues from recovered resources
- Health impacts
- Environmental effects
- Employment outcomes
- Avoided risks for calamities
- Administrative and time gains/losses
- Research and development spillovers
- Social and redistribution effects

[39] See maps of sparsely populated regions at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Sparsely_populated_regions.png and of mountains, islands and sparsely populated regions at https://ec.europa.eu/regional_policy/sources/policy/themes/sparsely-populated-areas/map_mountains_islands_spas.pdf

[40] For the definition of sparsely populated areas see the guidelines on national regional aid for the 2014-2020 period (2013/C 209/01).
For more discussion see: EPRS (2016) sparsely populated and underpopulated areas

[41] Brent (2011), Hoogmartens et al. (2014)

[42] European Commission (2014)

Short-term constraints such as availability of treatment facilities should not determine the medium or long term policy scenario. For the CBA, also the effects of the application of the polluter-pays principle via Pay-As-You-Throw (PAYT), or deposit-refund schemes and extended producer responsibility (EPR) must be taken into account. Moreover, if a country has no or low landfill or incineration taxes, claiming that separate collection is expensive cannot justify a derogation. Similarly, it is not sufficient that household payments (via PAYT or fixed fees) are unpopular to invoke the derogation[43].

A CBA requires strong assumptions and a choice of scenarios for comparison. A well-motivated and transparent approach is needed as well as an external review to give assurance on the results.

Elements that could be taken into account to do a case-specific assessment of the applicability of derogation 10(3)d. If one of the criteria is not fulfilled, then separate collection is required to be compliant to the revised WFD:

- If there municipalities or regions with similar characteristics that have implemented separate collection in a cost efficient way, then this derogation cannot apply.
- A CBA or other structured economic analysis should be available.
- All internal and external costs/benefits should be taken into account and the economic flows should be correctly allocated and relevant for the analysis of the case.
- Concluding that separate collection induces excessive costs for a specific case, can only occur if the good practices (see chapters 4-7) or success factors (see chapter 3) are properly implemented at regional or national scale. This includes considering to apply measures such as PAYT, EPR and disposal taxes.
- The cost difference should be significant to justify an exception to the rule.
- More cost efficient solutions via bring or reception systems should be investigated.
- The derogation can only apply for the problematic area, rather than for whole administrative region (municipality/region).

2.5 Monitoring

Proper implementation, application and enforcement across are essential to achieve the targets and underlying ambitions of the revised WFD. The MS hold the initiative to transpose the legislation in national or subnational legislation, but as highlighted by the following recital, the European decision makers want a monitoring system that assesses and enforces coherent implementation across the Union.

Directive 2018/851
Recital 51 In order to ensure better, more timely and more uniform implementation of this Directive and anticipate any implementation weaknesses, a system of early warning reports should be

[43] See also European Commission (2015)

established to detect shortcomings and allow taking action ahead of the deadlines for meeting the targets.

The revised WFD foresees several tools for the Commission to monitor the implementation of the obligations:

Revised WFD
Article 10(6) By 31 December 2021, Member States shall submit a report to the Commission on the implementation of this Article as regards municipal waste and bio-waste, including on the material and territorial coverage of separate collection and any derogations und paragraph 3.

This one-off round of reports from the MS allows the Commission to evaluate whether MS have transposed the obligations of the revised WFD and have put into place waste management systems that can achieve the targets on reuse and recycling put forward in Article 11(2).

Revised WFD
Article 11b Early warning report 1. The Commission shall, in cooperation with the European Environment Agency, draw up reports on the progress towards the attainment of the targets laid down in points (c), (d) and (e) of Article 11(2) and in Article 11(3) at the latest three years before each deadline laid down therein. 2. The reports referred to in paragraph 1 shall include the following: (a) an estimation of the attainment of the targets by each Member State; (b) a list of Member States at risk of not attaining the targets within the respective deadlines accompanied by appropriate recommendations for the Member States concerned; (c) examples of best practices that are used throughout the Union which could provide guidance for progressing towards attaining the targets.

The Early warning report provides a periodic checkpoint. Taking into account that the Article 11.2 (c) (d) (e), contains deadlines for targets by 2025, 2030 and 2035, the Early warning reports will have to be submitted by 2022, 2027 and 2032.

Article 11.3 provides leeway with respect to the reuse and recycling targets (to be achieved by 2025, 2030 and 2035) for the MS that have to make the most structural reforms. The memorandum of understanding (European Commission 2015) referred to

Estonia, Greece, Croatia, Malta, Romania and Slovakia but the names have been substituted in Directive 2018/851 with two objective conditions. Article 11(3) allows an extension of the deadlines with up to 5 years subject to the following conditions that include additional reporting obligations and an implementation plan.

Revised WFD
Article 11(3) A MS may postpone the deadlines for attaining the targets referred to in points (c) (d) and € of paragraph 2 by up to five years provided that that MS: (a) Prepared for re-use and recycled less than 20% or landfilled more than 60% of its municipal waste generated in 2013 as reported under the Joint Questionnaire of the OECD and Eurostat; and (b) At the latest 24 months before the respective deadline laid down in point (c), (d) or € of paragraph 2, notifies the Commission of its intention to postpone the respective deadline and submits an implementation plan in accordance with Annex IVb.

Article 11(4) provides another tool for the Commission to monitor progress and assure the compliance to the revised WFD.

Revised WFD
Article 11(4) Within three months of receipt of the implementation plan submitted pursuant to point (b) of paragraph 3, the Commission may request a Member State to revise that plan if the Commission considers that the plan does not comply with the requirements set out in Annex IVb. The Member State shall submit a revised plan within three months of receipt of the Commission's request.

Article 37, revised WFD (Reporting) contains more specifications on the content and process of the reporting system.

Based on the information gathered via these monitoring tools and other data, the Commission can evaluate whether MS are doing sufficient effort and have made the required reforms to fulfill the reuse and recycling targets.

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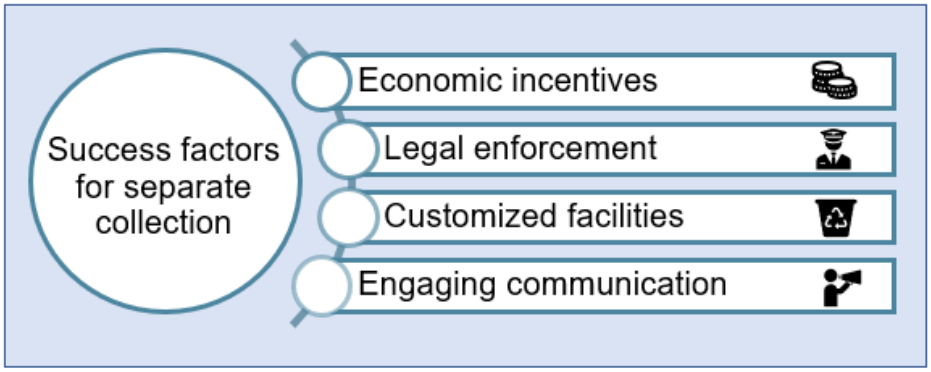
3 Success factors and risks

Separate collection is key to manage waste in a sustainable way and to evolve towards a circular economy. By setting the right incentives and facilities for separate collection, households will sort at source which results in homogeneous streams for reuse and recycling that can be valorized in closed-loop or other high-value applications.

The recipes to organize separate collection successfully have been analysed in many studies[44]. As highlighted in the figure below, success requires four elements: economic incentives, legal enforcement, customized facilities and engaging communication.

Figure 5: Performant separate collection schemes need an integrated approach



This chapter reviews the success factors that apply across waste streams and highlights the potential pitfalls for separate collection.

3.1 Economic incentives

The table below depicts five key instruments to increase sorting in Europe. The three first instruments (EPR, PAYT and taxes[45] on landfilling and incineration) should desirably become part of every waste management system in Europe.

[44] See, among others, OECD (2012), WRAP (2014), UNEP (2016) and EEA (2019)
[45] See for an extensive discussion of green taxation at https://ex-tax.com/

Table 2: policy instruments that give economic incentives for separate sorting

	Target actor	Waste stream	Primary objective	Secondary objective	Priority
Extended Producer Responsibility (EPR)	Producer/ consumer	Recyclables/ reusables	Cost internalization Sorting/recycling	Eco-design Waste prevention	High
Pay-As-Your-Throw (PAYT)	Consumer	Mixed waste	Sorting/recycling	Cost internalization	High
Landfill and incineration taxes	Municipalities and companies	Mixed waste	Sorting/recycling	Cost internalization	High
Deposit-refund	Consumer	Beverage packaging or other	Anti-Litter Sorting		Medium

Extended Producer Responsibility (EPR) shifts the financial and operational responsibility of waste management from municipalities to the producers of goods. By providing the adequate infrastructure and necessary communication, EPR contributes to better sorting and recycling. EPR has shown its merits for the recycling of many waste streams such as packaging, electronics, batteries and vehicles. Moreover, scholars as well as policy makers are convinced that EPR can be further deepened and extended to have more impact[46]. For example, by applying EPR to textiles the recycling rates can be increased (see chapter on textiles), the recycling targets for plastics packaging will increase significantly (see chapter on plastics) and the eco-design incentives could be strengthened by introducing modulation of the fees that producers have to pay (a separate guidance document will be issued on this topic).

Good practice example

Flanders[47] is a frontrunner in source separation thanks to its PAYT system. The variable part of the municipal waste tax paid by households, has to stay between 0,1 and 0,3 €/kg for residual waste or between 0,75 € and 2,25 € for a bag of 60 litres.

PAYT typically works via registered bags or bar-coded bins. For apartment buildings and very dense areas, (underground) public containers that automatically open

[46] See for example Dubois (2012), EY (2016), OECD (2016), European Commission (2019)
[47] Vlarema bijlage 5.1.4

Pay-As-Your-Throw (PAYT) asks households to pay when they dispose of (mixed) waste. This typically goes via labelled waste bags that have to be procured upfront, street containers that will only unlock after identification of the citizen by a personalized card or individualized bins that have a sticker or chip. It is critical that mixed waste is expensive while recyclable streams can be (almost) for free to give a clear incentive to sort. Thanks to the strength of financial incentives, PAYT is an extremely powerful tool to enhance separate collection. To overcome initial resistance, introduction of PAYT should occur at low levels and progressively increase up to levels of 1 or more € per bag/bin of 60 litres.

after payment or identification via badge can be used.

Good practice example

In 1996 the UK introduced a landfill tax and gradually increased it to 91 £/ton in 2019 for the standard rate[48]. The economic incentive has transformed waste management and has made the UK a front runner for landfill diversion and recycling.

Good practice example

Thanks to its national deposit system for bottles, Estonia has been able to reduce littering and achieve high collection rates of more than 90%.[50]

Landfill and incineration taxes do not affect citizens directly but incentivize municipalities to improve the effectiveness of waste sorting, collection and recycling in their region. These taxes help to internalize the external costs from disposal (carbon and methane emissions, air and groundwater pollution) and the external benefits from recycling (energy savings, reduction of environmental and health impacts of virgin resource extraction). In order to become effective, the disposal taxes of the MS should increase to 20 € per ton or more[49].

In a **deposit-refund** system, the consumer pays a deposit when buying a drink in a bottle and receives a refund when he returns the empty bottle[51]. Typical deposits would range around 0,2 € per bottle, depending on the size, material and national priorities. The system applies typically for beverage packaging but also exists for returnable products such as propane tanks for a BBQ. Owing to the financial incentive, deposit-refund induces an almost immediate increase of recycling rates to levels above 90%. Simultaneously, litter occurs less and some people even collect littered bottles to recover the refund. The benefits are partially cancelled owing to the cost of implementation and the narrow focus on beverage bottles. Consequently, deposit-refund is a recommended instrument, but MS that achieve equivalent results with alternative solutions can opt not to set up deposit-refund schemes.

[48] https://www.gov.uk/government/publications/rates-and-allowances-landfill-tax/landfill-tax-rates-from-1-april-2013 - accessed 15 November 2019 - https://www.360environmental.co.uk/legislation/waste_legislation/landfill_tax/ - accessed 15 November 2019

[49] See for a discussion on taxes for disposal of waste Dijkgraaf and Vollebergh (2004), Bio Intelligence (2012) and Dubois (2013)

[50] https://eestipandipakend.ee/en/how-does-the-deposit-system-work/

[51] See ACR+(2019) for an overview of existing deposit-refund systems in Europe

Table 3: risks and pitfalls

- **EPR** is a strong policy instrument but requires substantial and maintained policy focus to monitor[52]. Also once implemented, the recycling targets tend to be static i.e. changing (increasing) them seems to raise substantial controversy[53]. Therefore, EPR will only fulfil its full potential if policy makers impose implementation with strict deadlines (e.g. 2 years of preparation time) and keep updating the recycling rates regularly (e.g. every 3 years) to keep on improving the recycling performance.
- Many householders dislike **PAYT** at start because it feels as if a 'free service' is taken away. This often results in ample fly-tipping in the first months after introducing a new PAYT scheme. Moreover, if not controlled, PAYT may lead to improper sorting which degrades the quality of the collected recyclables. Nonetheless, in regions such as Flanders (Belgium) where PAYT already applies for several years, the instrument has gradually become part of normal practices and finds ample public support. The existing enforcement and communication programs succeed in minimizing the pollution of the collected recyclables. Moreover, if PAYT is introduced simultaneously with a decrease of the general collection tax, the acceptability can be substantially increased. Indeed, the balanced budget stresses the incentives for sorting, rather than the income revenues for the municipality. Consequently, PAYT can be successfully implemented if it is driven by strong political leadership that can overcome initial resistance and that it is accompanied by a reduction of the general waste collection tax, legal enforcement (see following section) and engaging communication (see below).
- Opinions differ on **deposit-refund** systems. Proponents herald the unmet advantages (high recycling rates and litter avoidance) while opponents highlight the costs, the burden for all actors and the narrow scope. Owing to the controversial nature some local authorities and regional governments want to introduce it while others hesitate. Although not impossible, partial implementation of deposit-refund across one national market creates substantial risks for fraud and financial imbalances. Ergo, implementation of deposit-refund would best be agreed at the national level.
- **Product taxes** are also a possible policy instrument. They make the targeted products more expensive and give a clear message to incentivize consumers to procure other or less products. Product taxes have been successfully applied to specific products generating waste streams deserving special attention such as plastic bags. The product tax gives clear incentives for prevention, but apart from a potential communicative aspect, does not incentivize citizens to sort their waste.
- Many municipalities also work with **fixed yearly fees** to finance the waste

[52] See OECD (2001), European Commission (2014) and OECD (2016) for an extensive discussion on the functioning, cost coverage, transparence and role of actors under EPR.
[53] See for example the long delay to change the initial low WEEE EU recycling targets from 2004. The recycling target was 4 kg/inhabitant while WEEE put on the market is about 20 kg per/inhabant (Dubois 2012)

management costs. Households pay a fee each year regardless of the amount of waste generated. Consequently, fixed fees do not give any economic incentives to sort waste. Although this measure can be used to balance the municipal budget, it should not be seen as a measure that enhances recycling rates.

3.2 Legal enforcement

Improper sorting degrades the quality of collected recyclables. Although communication incentivizes households to sort their waste correctly, a control system is needed. In practice municipalities can take the following actions when collecting the waste:

- Visual inspection of transparent recycling bags: if the waste worker sees incorrect materials, he can attach a sticker or other marker that highlights the non-compliance and leave the bag at the pick-up point.
- Weight-based check: packaging recyclables such as aluminum and plastics are light. If the waste worker notices that the bag is heavy, it probably means that biowaste or other residual waste has been wrongly added to the recycling bag.
- In addition to refusing to pick up bags or bins with impurities, municipal fines contribute to selective sorting. Municipal fines also help to avoid that refused bags remain in the public space and become litter.

Fly-tipping is the uncontrolled and illegal abandoning of waste. This undesirable practice circumvents the incentives for PAYT and creates substantial nuisance. An investigation and penalization program for fly-tipping is a cornerstone for successful waste management. Local authorities can take the following measures:

- Investigate the content of fly-tipped waste bags in order to try to identify the offender.
- Monitor the frequency and locations of fly-tipping in order to measure the success of ongoing actions and narrow the focus (hotspot location and moments) for further action
- Foresee sample visits by policemen or foresee cameras at hotspots to discourage fly-tipping behavior and try to identify offenders
- Develop performant digital tools (apps, websites…) that facilitate the reporting of fly-tipping and potential causes by citizens
- Foresee clear and strong penalties for identified offenders. Pursue the offenders legally in order to create precedents and set examples.

Good practice example

IVAGO, the public waste operator for the city of Ghent, has fully digitalized the follow-up of its cleaning operations for fly-tipped waste. Consumers can report via a user-friendly application and the operational management is displayed in automatically calculated indicators and maps. The improved management control helps to focus and optimize the action plan against fly-tipping.[54]

[54] https://www.ivago.be/meldpunt-sluikstort.htm-0

Good practice example

The city of Charleroi (Belgium) has made the fight against fly-tipping a priority in order to make the city cleaner and more attractive. The efforts to identify offenders include opening bags to search for letters with addresses or payment receipts and installing cameras. Penalties include fines up to 250 € and convictions for community service to help clean up littered waste.[55]

National or regional governments can further enhance the performance by **benchmarking** the municipalities and promoting the sharing of good practices around enforcement. Evidently, the benchmarking needs to be executed vis-à-vis municipalities or regions with similar characteristics. For example, Flanders has clustered its municipalities in 16 groups that have different targets for separate collection.[56] Characteristics for the clustering include, among others, age of population, migration, tourism and level of urbanization. The targets for mixed waste collection range between maximum 113 kg per inhabitant for residential municipalities with an older population to maximum 193 kg per inhabitant for larger cities. Moreover, for coastal regions that have few 'residents' but many tourists, the maximum amount of mixed waste collected is 258 kg per inhabitant. More refined methodologies to benchmark the performance of municipal waste management systems can be found in literature[57].

EPR typically works with **recycling targets** that have to be achieved by producers and recycling organizations. Although legislation often foresees penalties, few penalties are given. National and regional authorities can link penalties to measurable indicators and apply the penalties consistently to ensure compliance with the targets.

Not all producers comply with EPR obligations[58]. These '**freeriders**' hamper the revenue stream of recycling organizations and disrupt the level playing field because they do not pay the product fees in contrast to the competitors that do comply with legislation. National or regional regulators should collaborate with producer organizations to identify and prosecute freeriders. More specifically, regulators should foresee penalties for freeriders, a clear legal procedure to enforce the penalties and a single point of contact where producer organizations can report freeriders.

[55] https://www.rtbf.be/info/regions/hainaut/detail_gare-a-vos-poubelles-la-ville-de-charleroi-inspecte-les-depots-et-les-sacs-illegaux?id=9844256
https://www.rtbf.be/info/regions/detail_charleroi-des-travaux-d-interet-communal-contre-les-depots-sauvages?id=10354557
https://www.walloniepluspropre.be/wp-content/uploads/2019/03/Exemple-fiche-mise-en-page-Charleroi-Ouest.pdf
[56] Ovam (2019)
[57] See for example Lavigne et al. (2019)
[58] OECD (2018)

Good practice example[59]
The Luxembourg waste management law of 21 March 2012 obliges apartment buildings to have separate waste collection facilities. SuperDrecksKëscht®, the integrated waste collection system, provides free advisory services for the building manager to support local implementation: on-site visit for analysis of the existing situation, recommendations for sorting infrastructure and support for communication to inhabitants. The legal obligation supported by an integral approach has contributed to high collection rates. [60]

Table 4: risks and pitfalls

- Obligations and penalties are never popular. Implementing the investigation and penalization measures must be accompanied with communication to explain the motivation and to build a **support base** (see section on communication).
- Householders are rapidly irritated if their waste bags are not picked up. To avoid mistakes and to be able to respond to questions correctly, municipalities should foresee a **training program** for the waste workers. Moreover, municipalities that foresee incentive schemes for waste workers (individual or collective – financial or non-financial) related to the quality of the collected recyclables get higher quality material streams.
- EPR organizations have a good view on volumes and operational aspects. National and regional policy makers sometimes feel insufficiently informed to overrule such organizations. Although listening to well-informed stakeholders is an important element of efficient and effective legislation, regulators should have direct access to relevant **information**. Therefore, National and regional policy makers should impose clear reporting processes and indicators on producers and EPR schemes.

3.3 Customized facilities

There is no single waste collection system that fits for all waste streams and even within a single waste stream different collection schemes may be optimal owing to density of inhabitants, kind of housing, climate, limited space for storage, collection in historic cities etc. Despite the wide variety in collection schemes in Europe, good practice systems have many common elements that provide guidance on how to set

[59] http://ec.europa.eu/environment/waste/studies/pdf/20180227_Haz_Waste_Final_RepV5_clear.pdf
[60] LU Environment Agency 2015

up performant systems for separate collection. The table below makes recommendations for efficient waste collection systems.

More details on best practices for separate collection are available for bio-waste (chapter 4), plastic waste (chapter 5), textile waste (chapter 6) and hazardous waste from households (chapter 7). Based on these insights and on a screening for other waste streams, the table below presents good practices for separate collection that apply for all municipal waste streams.

Table 5: Four coherent scenarios for separate collection of waste

		Home compos-ting	Door-to-door* ≤2weeks	Periodic pick-up** >2weeks	Street container	In-shop take-back	Civic Amenity sites
Paper & cardboard			S^{12}		S^{34}		S^{1234}
Plastics and metals packaging	Cans and bottles		S^{2}		S^{4}	S^{13}	S^{1234}
	Other		S^{12}		S^{34}		S^{1234}
Glass packaging	Jars and bottles		S^{2}		S^{4****}	S^{13}	S^{1234}
	Other						S^{1234}
Textiles				S^{12}	S^{34}		S^{1234}
HHW				S^{12}		S^{1234}	S^{1234}
Bio-waste	Kitchen	$S^{1234***}$	S^{12}		S^{34}		
	Green	S^{1234}		S^{1234}			S^{1234}
Bulky waste				S^{1234}			S^{1234}
Residual waste			S^{12}		S^{34}		
Other waste							S^{1234}

* *periodicity of door-to-door collection is typically ranges from twice every week to once every 2 weeks*

** *periodicity of periodic pick-ups could for example be once month or several times per year. Sometimes variable depending on the needs and the season, e.g. for the collection of green waste, or on demand, e.g. for bulky waste*

*** *Home composting should exclude products such as meat and fish that may attract vermin and induce nuisance from odor*

**** *Collection of glass should at least keep clear and colored glass separate. Collecting glass via street containers is also often done in scenario 2 to minimize costs.*

The table above indicates that the collection facilities should be customized for each waste stream. The table also clusters the good practices in four coherent collection scenarios that can achieve good recycling results:

- **S^{1} : Scenario 1** combines extensive **door-to-door** collection services with a **deposit-refund** system for beverage packaging. The door-to-door collection is

foreseen for kitchen waste, paper & cardboard, packaging materials and textiles. The door-to-door collection provides maximum service to citizens while the deposit-refund enhances recycling of beverage packaging (plastics and metals) and minimizes littering. Compared to the other scenarios, Scenario 1 will be more costly but also achieve the best results.

- **S^2 : Scenario 2** provides extensive **door-to-door** collection services (similar to Scenario 1) but does not have a deposit-refund system. The scenario provides a high level of service to consumers which encourages consumers to sort waste in a non-financial way.
- **S^3 : in Scenario 3** widely available **street containers** (overground or underground) are an important receptacle for household waste. A typical size would be 1,5 – 5 m3. The logistical optimization (compared to door-to-door collection) induces cost efficiency and can provide solutions for local mobility issues in historic city centers. Street containers are foreseen for kitchen waste, paper & cardboard, beverage packaging and residual waste. To increase the reuse/recycling rates and quality of beverage packaging (plastics and metals), a **deposit-refund system** is introduced.
- **S^4: Scenario 4** foresees **street containers** (similar to Scenario 3) to collect waste streams separately. Compared to the other scenarios this system will have the lowest cost, but also the largest challenges with impurities.
- **S^{1234} – all scenarios**: these are essential facilities to organize the separate collection of waste and should be available in any policy scenario. These facilities include home composting incentives, periodic pick-ups (e.g. mobile collection), In-shop take-back via EPR systems and CAS.

Door-to-door collection (scenarios 1 and 2) would be especially suited for urban regions with a high population density where transport distances are small. Scenario 3 and 4 work both in an urban as well as a rural context. Consequently, although harmonization within a MS is recommended to avoid confusion from citizens, differences between municipalities are possible.

Each of the four scenarios focus can fulfil the obligations of the revised WFD and achieve the targets for preparing for reuse and recycling. MS can select and tune the preferred scenario in line with their priorities. However, it is essential that the infrastructure described in Table 1 is combined with economic incentives (e.g. PAYT – see section above), legal enforcement (e.g. against impurities or littering – see section above) and engaging communication (to clarify the instructions and build a support base – see section below).

The annex provides an overview of the current collection facilities and volumes for separate collection in the European capitals.

Owing to the diversity of conditions and systems in Europe, benchmarking costs is challenging and comprehensive overviews are rare. To give an order of magnitude of the related the costs, the table below gives some indicative costs for the collection and treatment of the different waste streams.

Reference costs for municipal waste management in Flanders[61]

Fixed costs:

- 14 € per year per inhabitant for the door-to-door collection
- 250.000 € per year per CAS (one per 20.000 inhabitants)

Variable costs:

- Kitchen waste via door-to-door collection: 0,08 €/kg
- Green waste via periodic pick-up and CAS: 0,06 €/kg
- Paper & cardboard via door-to-door collection and CAS: 0 €/kg
- Plastics & metals packaging via commingled door-to-door collection and CAS: financed by EPR
- Packaging glass via street containers (glass banks): managed by EPR
- Textiles: managed by private sector
- WEEE & batteries via in-shop take-back and CAS: managed/financed by EPR
- HHW via periodic pick-ups and CAS: 0,85 €/kg
- Residual waste via door-to-door collection: 0,14 €/kg

This section now describes the success factors and risks for each collection facility.

Composting kitchen and green waste at home can be a cost efficient way of treating bio-waste because transport is avoided and bio-waste is typically a low-value material stream. The household manages the composting activity but the municipality can provide support[63]. The success factors for composting are discussed in the following chapter on bio-waste.

Good practice example

Oroso, A Laracha and Camariñas in the province of La Coruña in Spain set up successful home composting programs in rural areas. The program included free provision of composting bins to households, awareness campaigns and training programs. An estimated 126 kg/person year of bio-waste was avoided.[62]

[61] OVAM (2010), the collection system in Flanders resembles scenario 2.

[62] https://www.sciencedirect.com/science/article/pii/S0956053X17301691

[63] Rural municipalities can also support the procurement of chicken that eat most of the kitchen waste.

Door-to-door collection is commonly used for different waste streams: residual waste, kitchen waste, paper & cardboard, plastics packaging, textiles, bulky waste. Door-to-door collection can be organized and financed by municipalities (e.g. mixed waste and bio-waste) or EPR organizations (e.g. packaging). The operational execution can be done by municipal employees or be outsourced to private operators.[64]

Good practice example

In 2011, Milan (Italy) introduced the separate collection of kitchen waste for composting and anaerobic digestion. The kitchen waste is collected twice a week via small bin bins with a special airy structure that minimize the inconvenience related to the formation of odors and liquids. The system covers 1,4 million inhabitants and has been the main driver to push up the separate collection rate from 35% to 54%. Kitchen waste collected was 90 kg per inhabitant in 2014 with an impurity rate of only 4%.

Key success factors were the intensive communication to citizens (before and after implementation) and the focus on quality of the collected streams: a transparent bag to allow inspection of the content, quality controls by 24 trained staff and sanctions in case of irregularities.[65]

Although transport costs increase, the overall costs for the city of Milan decrease owing to the reduction of mixed waste to be disposed (100 €/ton) compared to treatment of bio-waste (70 €/ton).[66]

[64] The conditions for operation may differ substantially depending on the actor. For example, municipalities that collect waste are in countries such as Belgium exempted from VAT as they are considered providing a 'public service'. In contrast, private contractors that offer similar services are subject to VAT. This implies that the private contractors can recover VAT on procured assets, but also have to add VAT when pricing their services. Clearly, these skewed operating conditions do not create a level playing field.

[65] See https://www.municipalwasteeurope.eu/sites/default/files/Benchmarking%20big%20cities%20-%20Milan.ppt.pdf and https://ec.europa.eu/environment/waste/studies/pdf/Separate%20collection_Final%20Report.pdf

[66] Ellen MacArthur Foundation (2017)

Good practice example[67]

The city of Ljubljana (Slovenia) stands out with a 73% capture rate of recyclables, thanks to a door-to-door collection system of bio-waste and recyclables supported by CAS. Use of social media and SMS communication on collection dates that is customized to the citizen's profile have been important factors in achieving the high capture rate. Moreover, the underground collection units in the city center facilitate collection without visual nuisance.

One important rule in the city policy is that recyclables are collected more often than residuals, in order to incentivize sorting. Snaga, the public waste management company, also uses social media (internet, SMS-service, Facebook, Twitter) to improve the user friendliness of the collection services.

[67] http://www.snaga.si/en/separating-and-collecting-waste/biodegradable-bio-organic-waste

Table 6: door-to-door collection

Success factors	▪ The collection frequency determines comfort and incentives for households. A more frequent pick-up is considered more user-friendly. Consequently, the frequency of collection of recyclables and bio-waste should be at least as high as the frequency of collection of residual waste to incentivize sorting. ▪ A combination of short cycles for the pick-up of recyclables (e.g. once or twice a week[68]) and longer cycles for residual waste (e.g. 2 weeks) can optimize collection costs while maximizing the incentives for sorting at source. ▪ To optimize cost efficiency and give overall incentives to prevent/compost waste, the periodicity should decrease over time. For example, front running municipalities only collect waste once every two weeks. However, in warm climates, the frequency for kitchen waste should remain high enough to avoid odor and other nuisance. ▪ Especially in warmer climates, a high frequency of the collection of kitchen waste is important (e.g. twice a week) while in colder climates the frequency can be lower (e.g. once every two weeks[69]). ▪ During pick-up waste workers can execute a rough visual or weight-based control on potential impurities. ▪ If apartment blocks have joint waste collection services, then the presence of joint separate sorting facilities is essential. Municipalities that have densely populated regions should foresee a program to assist (historic) multi-apartment buildings to set up collection facilities: good practice guide, cheap or free support from specialized advisor, single point of contact at the municipality to deal with questions and projects. ▪ The collection of large volumes of high quality recyclables via door-to-door requires clear instructions and awareness campaigns (see 3.4), PAYT (3.1) and prosecution of improper sorting (3.2)
Risks	▪ Private actors apply cherry picking for the door-to-door collection by only focusing on high value materials (and sometimes even only in periods with high resource prices). Although private initiatives with respect to collection and recycling should be lauded, these initiatives should not be allowed to disrupt structural collection services by municipalities or EPR organizations. To avoid concerns municipalities can integrate clear instructions and conditions in the local police regulation. ▪ Waste sorting is part of daily habits. This implies that changes only go slow and that in transition periods impurities in collected waste streams increase. Municipalities best determine their collection system with the future in mind and then keep it stable for three years or more.

[68] Ellen MacArthur Foundation (2017)
[69] Ovam (2010)

Good practice example[70]

A 2012 citizens survey in Gothenburg, Sweden, found that the share of citizens donating used textiles for reuse and recycling to bring-to collection points is significantly lower for those living in multi-apartment housing than those living in detached houses

In 2014 a one-year pilot project run by Renova in association with Human Bridge on textile collection in multi apartment housing placed collection bins in 31 waste sorting rooms serving multi-apartment housing in socially and economically varying areas of the city. During the first pilot-project, 24 tons of materials of which 18 tons were textiles were collected. Monthly collection rates doubled during the pilot. The 31 sorting rooms served about 5000 residents giving approximately 3.6 kg of textile collection per capita per year. This collection rate is 50% higher than the average quantity collected in Sweden of 2.4 kg/capita/year. After the project period the bring banks were kept in place and rolled out at different locations.

In a post-initiative resident survey 15% citizens stated that the increased convenience of having textile bring banks close at hand seems to have had a positive effect. Moreover, clear communication is needed. Despite signage on bring banks only half of residents were aware that they could deliver worn out textiles along with reusable. Paradoxically, another quarter reported not delivering their good quality textiles to the bring banks because they believe that all the textiles delivered to them are recycled (and not reused). They delivered their good quality textiles elsewhere, which undermined the economy of collection. Moreover, partnership with a charity was found to be a key element for motivating residents since 60% deliver textiles because of humanitarian and social benefits and only 15% because of environmental benefits.

Importantly, secure bring banks have also been developed since in the pilot project theft was recorded at around 10% of the sites.

Periodic pick-ups typically apply for waste streams such as green waste, HHW and bulky waste. By organizing periodic pick-ups, municipalities offer a service to households while keeping the frequency of collection low, e.g. once a month. The location can be flexible (e.g. mobile trucks can periodically pick up HHW at central locations) or on demand (e.g. pick up already packaged bound asbestos at home). They are mostly organized or facilitated by municipalities but can be outsourced to private operators to improve cost efficiency.

[70] Watson et al (2018a)

Table 7: Periodic pick-up

Success factors	▪ Clear communication (see 3.4) and predictive planning. ▪ Enforcement to avoid fly-tipping outside the scheduled pick-up moments. (see 3.2) ▪ Adapting the frequency on seasonal fluctuations for green waste in order to optimize cost efficiency.
Risks	▪ Private waste management companies offer collection services for enterprises. In order to avoid competition of subsidized public services with private actors, municipalities can limit the amount of waste to be collected, e.g. 2 m3 per year of bulky waste, and introduce identity controls to ensure that collection is limited to citizens.

Municipalities, EPR compliance schemes and private actors place **street containers** or **bring systems** to collect a range of waste streams: Residual waste, kitchen waste, paper & cardboard, plastics, metals, glass packaging, textiles. By putting bins or containers at central public locations, households can drop off their waste any time while optimizing the logistics compared to door-to-door collection.

Flanders uses as a minimum number of 1 container per 1000 inhabitants for glass banks and textile containers[71]. In densely populated regions bins would best be placed such that every household has street container within 250 meter[72]. For textiles and packaging glass, the distances can be further away since households do not use them weekly.

Table 8: Street containers

Success factors	▪ Clear instructions and PAYT to foster sorting at source ▪ In low-density regions, street containers should be placed at central locations that are close to transport routes
Risks	▪ Due to the lack of control, the sorted fractions may contain impurities. By taking regular samples of the collected fractions to monitor the quality, municipalities can tune communication (4.4) and enforcement measures (4.2). ▪ Overground street containers can create disamenities; visual intrusion of street view, noise during the evening or fly-tipping next to the container. By imposing prohibitions of disposal during the night, providing regular cleaning and setting up an enforcement plan, municipalities can remediate to these disamenities ▪ In city centres or historic places, municipalities may find the visual disturbance of overground containers unacceptable. Underground containers can offer a costly but suitable solution for such a context.

[71] Ovam (2010)

[72] https://afvalscheidenheelgewoon.nl/waar-staan-de-ondergrondse-containers/richtlijnen-voor-het-plaatsen-van-containers
https://decentrale.regelgeving.overheid.nl/cvdr/XHTMLoutput/Actueel/Waalwijk/CVDR380218.html

EPR compliance schemes provide in-shop take-back facilities for a range of waste streams: Beverage packaging, WEEE, batteries, HHW… The take-back facilities offer user-friendly solutions for consumers with no or little extra transport needed.

Table 9: in-shop take back

Success factors	▪ In-shop take-back facilities are suitable for small consumer goods: batteries, small electronics, beverage packaging,… ▪ By ensuring that take-back facilities are widely present (e.g. in all medium and large stores), the communication can be strengthened
Risks	▪ Shop owners may resist take-back of new waste streams. In order to overcome such resistance and set up a level playing field, the responsibilities of shop owners should be stipulated explicitly in the EPR regulation.

Civic Amenity Sites (CAS) offer households a solution where they can drop off almost all sorted waste streams while the staff present on the collection site can control the quality of the incoming streams on impurities. The CAS can be run by staff of the local authority or it can be outsourced to a private contractor.

In the Netherlands an indicative number of 60.000 inhabitants per CAS is recommended[73]. Flanders uses one per municipality of minimum 10.000 inhabitants and one CAS per 30.000 inhabitants as reference numbers[74]. In cities, the amount of facilities per amount of inhabitants would typically be lower due to the high population density and the high cost of land.

Table 10: Civic Amenity Sites (CAS)

Success factors	▪ Training of staff to inform citizens correctly and maximize the quality of the sorted fractions ▪ Long opening hours including in weekends such that households can come during or after commuting ▪ Sufficient surface to offer facilities for a comprehensive range of waste streams
Risks	▪ A well-equipped CAS may attract waste from companies and professionals. Since the CAS is focused on household waste, such professional streams should be refused. Possible measures are identification with an ID-card or prohibition of large volumes.

[73] Amsterdam (2015)
[74] OVAM (2010)

3.4 Engaging communication

Communication is critical to inform and motivate households to sort waste. The following elements should be taken into account to develop impactful communication:

- EPR compliance schemes, local authorities, national and regional governments, communicate to the public about waste sorting. To create a synergetic effect, an agreement must be made to align the scope and topics for communication by each actor.
- Communication channels strengthen each other. Consequently, communication campaigns should occur simultaneously via different channels: TV, radio, Twitter, Facebook, websites, newspapers, local magazines, …
- The public is diversified: young, old, different cultural and social backgrounds … Therefore, the messages and use of language must be adapted to each of the target groups.
- Awareness raising needs permanent maintenance and creativity to keep inspiring. It is key to set indicators that measure awareness such that campaigns can be evaluated and priorities for communication can be determined.
- By measuring impurities in collected waste streams, municipalities can assess where and on which topics more communication to households is needed.
- By providing clear signage and instructions on bags and reception points, municipalities can reduce the impurities from collected waste.

Table 11: risks and pitfalls

• Communication is only communication: it is a necessary condition to inform citizens about sorting instructions and to build a support base. However, for sorting, communication is rarely strong enough to change behavior from a large group of households. Therefore, communication should accompany economic incentives and legal enforcement of obligations, rather than be a stand-alone activity.

Good practice example

Cyclamed is the EPR organization that coordinates and finances the collection of expired (or unused) medication. The intensive and sustained communication vis-à-vis all stakeholders has been key to achieve the high awareness and recovery rates (up to 62%)[1]. The communication is directly oriented towards the consumers as well as via via pharmacies, distributors and municipalities. The message has a double aim: incentivizing consumers to sort and return unused medication to pharmacies on the one hand and convincing the consumers to put the packaging (cardboard boxes) and prescriptions (paper) in the normal recycling bin at home. The communication actions for 2018 include:

- A short film (< 80 seconds) that is available at the website and can be displayed at TV screens in pharmacies even without sound. The film explains the sorting instructions in a simple and humoristic way.
- Spotfilms (12 seconds) for TV, social media and electronic billboards (e.g. at

pharmacies) to keep up the awareness and repeat the call for action. The broadcasting on television is timed in order to reach two target groups: parents and elderly.

- Posters, flyers and infographics that are available at the website and can be ordered for display at pharmacies or municipal sites. They depict the sorting instructions visually and summarize key numbers to motivate consumers to sort.
- Banners with the key message that pharmacies or other actors can easily import on their website.
- An illustrated comic book including some 'games' that can be filled in and increase the attractiveness.
- Stickers with a key sorting message (< 15 words) for pharmacies and delivery vans of distributors.
- A website with focus pages for the target groups and partners: consumers, pharmacies, distributors and municipalities. The website has interactive features such as a geolocation of pharmacies that participate and accept used medication, a quiz with questions & answer wizards and testimonials (including room to submit new testimonials). The effectiveness of the campaigns and website traffic will be measured by 'Google Adwords'.
- Social media: a blog, Facebook and Twitter. The amount of fans and followers is measured to evaluate the impact.
- A mobile app with a search engine for medication that is kept up to date in collaboration with the Ministry of Health, push messages that can be customized to the personal priorities and sorting instructions. The amount of downloads help to evaluate the success of the tool and the communication campaigns.
- Customized communication campaigns for the territories overseas
- A newsletter for the pharmacies containing news regarding the collection of unused medication but also many other articles to increase the relevance and coverage. The impact is measured by an external company that uses surveys at pharmacies.
- Publicity in the journal for the French pharmacists in order to do a call for 'collection ambassadors'.
- Regular meetings with the sector federations to keep the message high on the agenda, gather feedback to improve the service and ensure buy-in of all supply chain partners.
- Support for publicity campaigns and events organized by the Ministry and other EPR organizations to stress the importance of separate collection for all waste streams.
- Customized information for municipalities and presence at events organized by municipalities

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4 Separate collection of bio-waste

Bio-waste as defined in the revised WFD, includes two major fractions, namely garden & park waste and food & kitchen waste. It does not cover residues from forestry or agriculture and should not be confused with the wider term "biodegradable waste" which includes also other biodegradable materials such as wood, paper, cardboard and sewage sludge.

Garden and park waste characteristics:

- A content of 50-60% water and wood (lignocellulose);
- A low degradability;
- Generally lower density;
- A production rate that varies during the year
- A production that varies geographically

Food and kitchen waste characteristics:

- Contains up to 80% water, the variable moisture level affects the logistical and technical requirements for its collection and further processing.
- Contamination occurs often in households and impurities are difficult to extract;
- Unstable and a source of nuisance, e.g. odour and percolation.

Kitchen waste comes from households, restaurants, caterers and retail premises as well as comparable waste from food processing plants. However, in this guidance we focus on bio-waste streams within municipal waste.

Bio-waste is a challenging waste fraction for separate collection, not least due to its biodegradability. Collection systems and related recycling facilities must be set up in accordance with the type of bio-waste that the system will accept. For example, collection equipment and frequency of collection of kitchen waste should be designed to minimise the risk of odour.

Also with respect to treatment, the biological characteristics should be taken into account. For example, bio-waste high in lignin (for example bio-waste with high paper/wood content) cannot be treated in anaerobic digestion plants. Conversely, in compost plants, kitchen waste is best mixed with green waste to optimize the composting process and the value of the end-product.

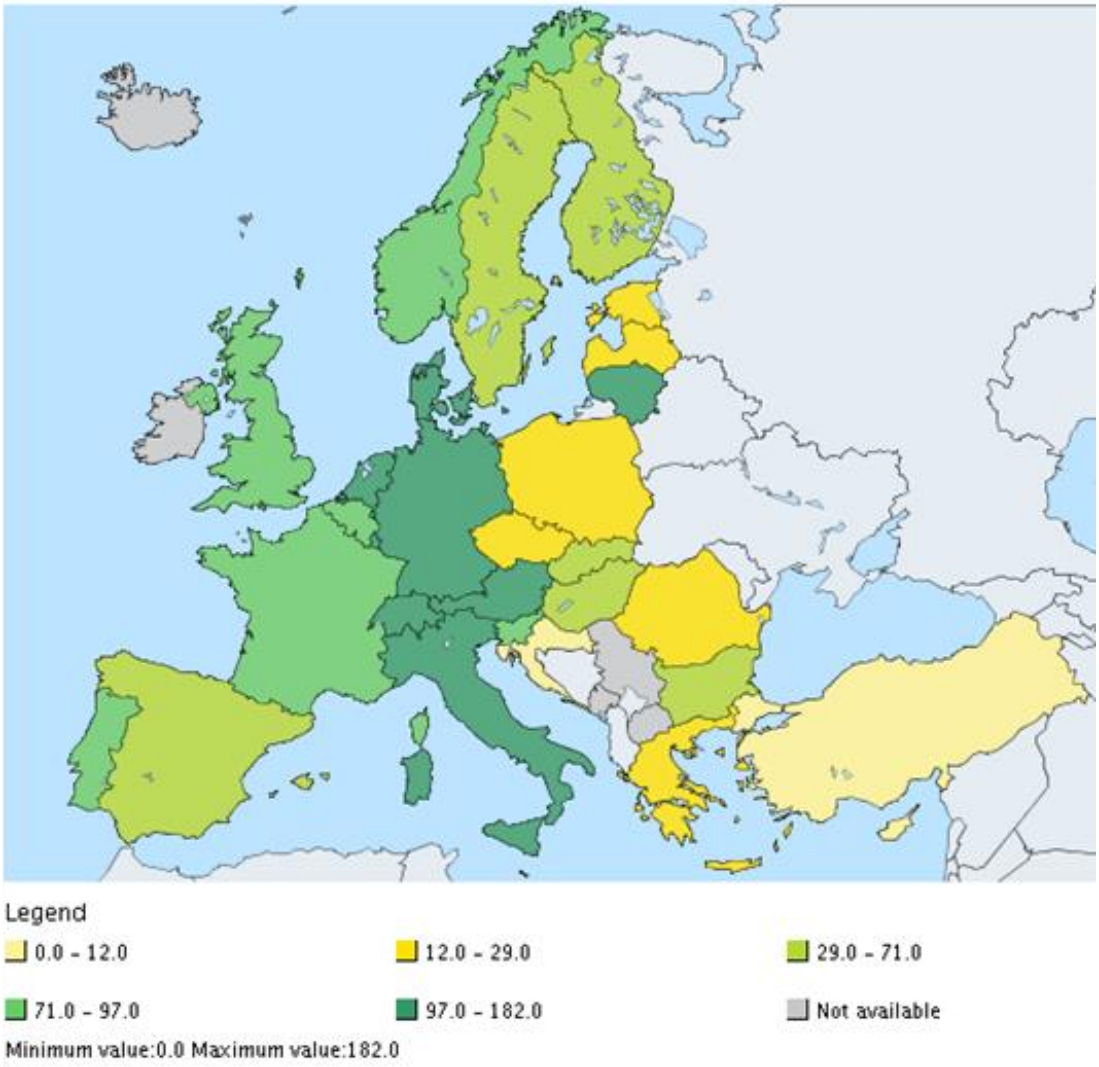
4.1 Volumes

Across the EU, between 118 and 138 million tonnes of bio-waste are generated annually (EC 2010), of which more than two thirds comes from municipal bio-waste, the reminder coming from the food and drink industry. Food waste is a major contributor: the Horizon 2020 project FUSIONS (2016) estimated that 88 million tonnes of food waste was produced in EU-28 in 2012.

In the EU, bio-waste constitutes 30-40% of municipal solid waste (with variations from 18% up to 60%) (JRC 2014, Eurostat 2019a).

In 2017 the recycling of municipal bio-waste across the EU-28 lay at 81 kg/capita or 41.5 million tonnes (Eurostat 2019b). Figure 8 demonstrates the large variation among EU-countries in separate collection and recycling of bio-waste per capita.

Figure 6: Recycling of bio-waste in Europe in 2017 (Kg bio-waste per capita)[75]



Countries such as Austria, Switzerland, Germany, the Netherlands, Flanders (Belgium), Sweden and Norway have more than 15 years' of experience with separate

[75] The indicator is measured as the ratio of composted and methanised municipal waste (in mass unit) over the total population (in number). The underlying assumption is that almost all treatment of concerns composting or anaerobic digestion.
https://data.europa.eu/euodp/data/dataset/D2ja6lfsx1PW8PRKUXPkA

bio-waste collection and treatment systems, whilst the UK, Italy, Finland, Ireland, Slovenia, Estonia and France have made significant advances over recent years[76].

Good practice example

Freiburg in the state Baden-Württemberg in Germany has set targets for the separate collection of 60 kg kitchen waste per inhabitant and 90 kg green waste per inhabitant. The separate collection of bio-waste has been one of the key drivers to reduce the volumes of mixed waste collected to 90 kg per inhabitant and total recycling rates to 69%[80].

The potential to increase separate collection via kitchen waste collection is substantial[77]. For example, Denmark collected 148 kg/capita of bio-waste in 2016 of which 93% was garden waste[78]. In Germany, around 78 % of all garden waste is collected as bio-waste whereas 'only' 56 % of food waste is collected[79].

The volumes of bio-waste collected depend on the volumes of waste generated. In lower-income EU MS, food waste constitutes around 30% of the total household waste, whereas in MS with a higher average income food waste constitutes only around 20%. The geographic disparity of collected volumes is also driven by collection services. For example, in suburban areas where households are offered free garden waste collection door-to-door, garden waste can constitute around 25% of household waste, whereas in the absence of free collection, the figure is typically less than 10%[81].

4.2 Recycling

Various solutions and technologies for treatment of bio-waste are being implemented around the EU. Such solutions include composting and digestion that recover nutrients and generate bioenergy. Best Available Techniques for treatment of separated collected bio-waste are described in the Refence Document for Waste Treatment (JRC 2018).

Bio-waste conversion to compost or digestate leads to positive environmental effects (e.g., resource protection, soil protection, climate protection) when the bio-material is used as, for instance, replacement of fertilisers[82]. Moreover, by substituting fossil-based products, bio-based products provide significant societal benefits: sustainable and safe products; local job creation and economic growth; reduced GHG emissions from bio-waste landfilling and from retaining the carbon content of bio-based products.

Composting is the dominant form of recycling of bio-waste in the EU. Over 90% of separately collected food and garden waste is processed into compost. This comprises 30 million tons of separately collected municipal bio-waste that are composted or

[76] European Compost Network (2019)
[77] European Compost Network (2019)
[78] DEPA (2016)
[79] Abfallbilanzen der Länder (2015)
[80] Lavigne et al. (2019), https://www.freiburg.de/pb/375928.html, Baden-Wurrtemberg (2017)
[81] Hogg et al. (2014)
[82] Dri et al. (2018)

digested annually in about 3.500 treatment plants across Europe. More than 50 % of this is represented by garden and park waste[83].

The compost produced has a positive but low price.[84] Depending on the energy prices, green subsidies and quality of the nutrients, the electricity from anaerobic digestion can contribute as much to the profit of the process as the end-product. Overall, composting is a less sophisticated process with low capital needs (Capex) while anaerobic digestion has the recovery of energy as an asset.

Some innovative technologies can potentially extract more value and products from bio-waste, e.g. chemicals, fertilisers, plastics and feed. Several Horizon 2020 and Bio-Based Joint Undertaking projects are developing technology and addressing technical, economic, social and environmental challenges related to the production of bio-based products:

- Horizon 2020 Project SCALIBUR (Scalable Technologies for Bio-Urban Waste Recovery): Horeca waste will be transformed to proteins, lipids and chitin from insect rearing, while the organic fraction of MSW will generate bio-pesticides and bioplastics by high-solid enzymatic hydrolysis followed by fermentation. The resulting biogas of will be upgraded by bio-electrochemical treatment to produce commodity chemicals and bioplastics. By cutting traditional linear waste management, new business models are created for the resulting circular value chains. http://www.scalibur.eu/
- Horizon 2020 Project VALUEWASTE (Unlocking new value from urban biowaste) implements three new value chains that will use urban biowaste as raw material for valorisation into high-value biobased products: food & feed proteins and other ingredients, and biobased fertiliser. http://valuewaste.eu/
- Horizon 2020 Project Project WaysTUP! (Value chains for disruptive transformation of urban biowaste into biobased products in the city context) showcases a portfolio of new processes starting from different feedstocks e.g. fish and meat waste, spent coffee grounds, household source separated biowaste, used cooking oils, cellulosic waste derived from municipal wastewater and waste treatment plants and sewage sludge. The processes will result in the production of food and feed additives, flavours, insect protein, coffee oil, bioethanol, biosolvents, polyxydroxyalkanoates, ethyl lactate, long chain dicarboxylic acid, bioplastics and biochar. End-product characterisation and safety assessment will be implemented. Life Cycle Assessment of the value chains will be conducted to assess their environmental impact.
- Bio-Based Industries Joint Undertaking (BBI JU) URBIOFIN project demonstrates the techno-economic and environmental viability of the conversion at semi-industrial scale (10 T/d) of the organic fraction of MSW into: chemical building blocks (bioethanol, volatile fatty acids, biogas), biopolymers (polyhydroyalkanoate and biocomposites) or additives (microalgae hydrolisated for biofertilisers). By using the biorefinery concept for MSW (urban biorefinery), URBIOFIN will exploit the organic fraction as feedstock to produce different valuable marketable

[83] European Compost Network 52016)
[84] See WRAP (2009) and European Commission (2009) for studies on costs, prices and markets

products for different markets such as agriculture and cosmetics https://www.urbiofin.eu

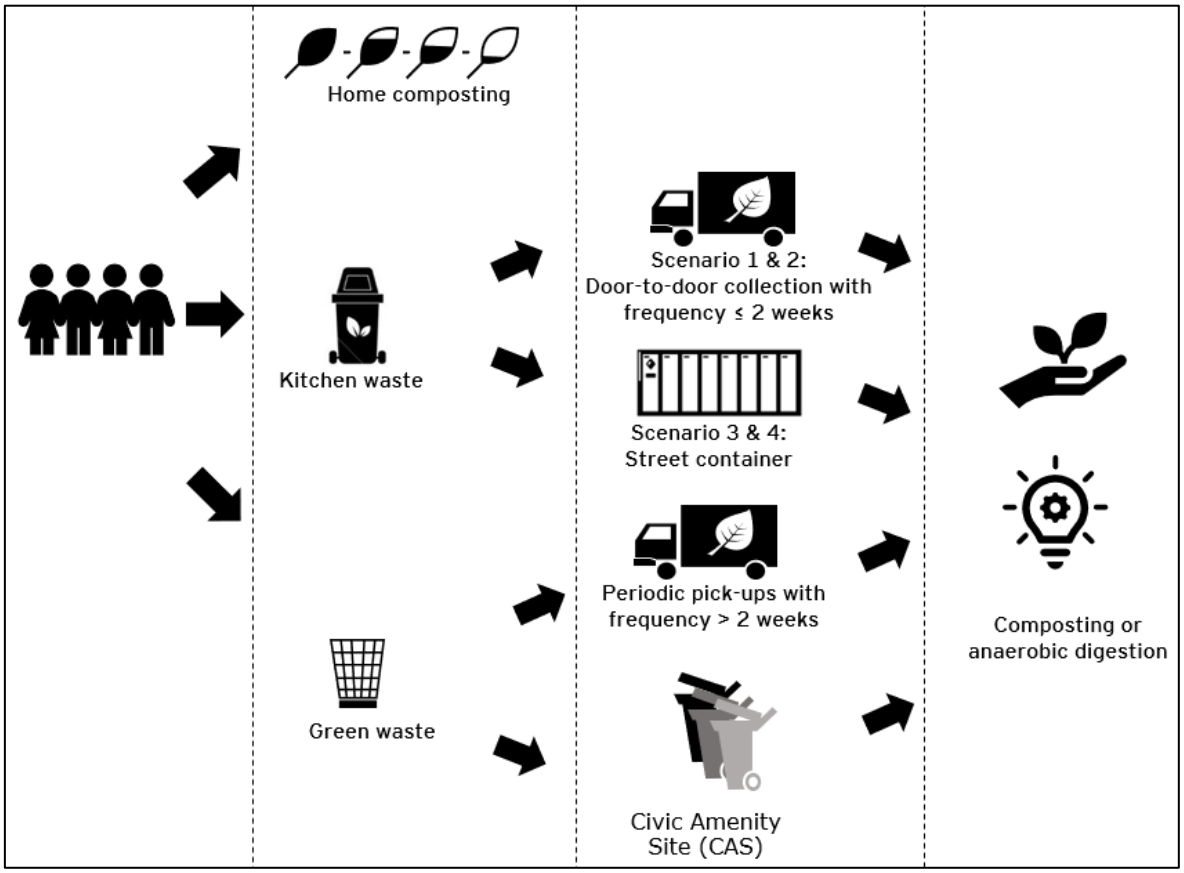
- Other examples of innovative research projects on recycling technology are Project RES URBIS (REsources from URban BIo-waSte) http://www.resurbis.eu/ and Horizon 2020 DAFIA project: http://www.dafia-project.eu/

A number of innovative processes for treatment of bio-waste are already included in the Best Available Techniques described in the Reference Document for Waste Treatment (JRC 2018). For example, organic waste can be converted to short-chain carboxylates, carboxylic acids (e.g. lactic acid) or polymers (e.g. polyhydroxyalkanoates - PHA) for use as feedstock for chemicals production.

4.3 Success factors for separate collection of bio-waste

Optimal solutions for *collection* of bio-waste depend to on geographic and demographic conditions such population density and types of housing. Nonetheless, the good practices highlight some key elements for performant collection systems. The figure below details the collection scenarios put forward in Table 1 and illustrates how the bio-waste collection flow should be organized.

Figure 7: the collection flow and facilities for bio-waste from households



In low-density areas great distances have to be covered per amount collected which increases the costs and reduces the overall environmental benefit[85] . In rural areas home composting can often be easily implemented and the recovered nutrients can be used locally[86]. A Spanish study[87] of home composting demonstrated a capture rate of 77% of household organic waste with 126 kg/ person composted each year.

In highly-populated areas, door-to-door collection is more optimal and cost effective. However, living space especially in high-rise buildings, may not allow for storage of

[85] JRC (2011), Dri et al. (2018)
[86] See EU project Mini waste that inventories good practices regarding (bio-waste) minimization in Europa (Mini-waste 2012), or bio-waste analysis in Spain (Association Fertile Auro 2019*).*
[87] Vázquez and Soto (2017)

several waste streams, inhibiting source separation. Milan and Ljubljana have solved this through customized systems for separate collection of bio-waste (see boxes on these cities).

Quality is a key issue: bio-waste with more than 10% of impurities makes valorisation hardly feasible as this degrades the value of the produced fertilizers[88]. On average, biowaste collected via local collection points (e.g. underground containers for biowaste) has a higher share of contaminants than biowaste collected through door-to-door systems. Underground containers can be an option in city centres, but require intensified follow-up to improve the quality of the collected fractions.

Biodegradable plastics can be collected jointly with bio-waste (see chapter 2). However, at this point, most bio-plastics degrade slower than normal kitchen waste, which slows down the process or induces elements that are not yet fully degraded. Proper certification and clear instructions for handling bio-plastics are therefore important to incorporate such materials in the collection system.

4.3.1 *Economic incentives*

- Encouraging and enabling home composting can be a good solution for bio-waste in rural areas from both an economic and environmental point of view owing to the current low value of collected bio-waste and the avoided costs/impacts of collection and treatment[89].
- Free or cheap provision of home composting containers enhances their application, just as free collection of bio-waste incentivizes sorting at source.
- Economic incentives, especially PAYT systems[90], are effective drivers behind the implementation of source separation of bio-waste since households always pay less for bio-waste collection than for residual waste collection.
- Incineration taxes and landfill restrictions incentivize municipalities to take additional actions to separately collect bio-waste.

Good practice example

Covar 14, a public waste management company of in Piemonte Italy, has fostered home composting in the rural areas via awareness campaigns, via compost training courses and by giving a financial discount of 20% on waste taxes for families that joined the composting program. [91]

[88] BGK e.V. (2019)

[89] See EU project Mini waste that inventories good practices regarding (bio-waste) minimization in Europa (Mini-waste 2012), or bio-waste analysis in Spain (Association Fertile Auro 2019*).*

[90] A practical toolkit for cities can be found at https://www.operate.it/payt/

[91]http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=LIFE08%20ENVF000486_Miniwaste_good_practices_inventory1.pdf

Good practice example

Freistadt in Austria set up a project where local farmers collect bio-waste from local towns, including both kitchen and canteen waste supplemented by wood, tree and bush cuttings. The collected fraction is composted in facilities for consumption at the farm or for sale. Key success factors were the legal framework (mandatory training and requirement of a contract with the municipality) and the involvement of local stakeholders. Reported data show a collection rate of 149 kg/cap/y while 80% of the compost produced is used in agriculture and 20% is sold to private customers.[92]

4.3.2 *Legal enforcement*

- A clear legal framework is needed to set up quality certifications for bio-waste valorisation
- Monitoring at aggregated level and communicating quality issues minimize non-biodegradable impurities and prevent loss of value of the recovered nutrients.
- Sample inspections at household receptacle level and follow-up sanctions in case of pollution strengthen a quality-driven approach.
- A transparent bag allows the waste worker to carry out a visual control for impurities

Good practice example

Evergem (Belgium) set up community composting to serve 14 apartment blocks. The project redirected 80% of the kitchen waste away from the residual waste. Success factors were the involvement of the inhabitants and the appointment of a site manager that controls quality and manages the distribution of ripe compost. [93]

4.3.3 *Adequate infrastructure*

- Home composting only works if people have a garden or a place to put a composting bin. Community composting offers home composting solutions in cities but it has remained an anecdotical activity up to now. A guided approach is needed to activate local stakeholders and inspirational cases should be put in the spotlight.
- Municipalities can encourage composting by providing information on local stores that sell compost bins or by offering a home delivery of compost bins.
- High periodicity of bio-waste collection (see earlier: once or twice in high-temperature regions and once every week or two weeks in colder climates) encourages separate sorting by avoiding biodegradation issues (odours, flies, leaks) and improving user-friendliness.

[92] http://www.biowaste-scow.eu/SCOW/userdata/SendFile.asp?DBID=1&LNGID=1&GID=782
Other examples can be found in Flanders, France and Austria (MINIWASTE 2012). Furthermore, Association Fertile Auro (2019) has published guidance on community composting as an alternative for local management of bio-waste. Similar solutions are found in Larrabetzu, Basque Country – Spain (Plana 2018).

[93] https://leefmilieu.brussels/themas/afval-grondstof/mijn-afval/composteren/gemeenschappelijk-composteren

- Door-to-door collection of bio-waste is an expensive system in terms of operational costs, but also results in the highest capture rates while allowing for a minimization of the impurities.
- Underground collection facilities in public areas can reduce visual and odour nuisance in the cooler underground while also simplifying waste collection by minimizing the need for manual work and thus reducing costs. Underground facilities also minimise problems with pests such as mice, rats and seagulls. However, intense monitoring and follow-up is required to avoid higher contamination rates than in door-to-door collection.
- Provision of properly sized (small) collection receptacles (e.g. bags of 15 L or portable containers of 40 L) provide ease-of-use for apartment blocks or houses without gardens, while larger bags wheelie bins (e.g. 140 L or 240 L) are convenient for larger houses[95].
- Collection costs and performance for garden and park waste collection services can be optimize by tailoring these to fit specific local characteristics (rural/urban) and variation in volumes generated in different seasons,
- Promotion of home composting via communication campaigns reduces the publicly collected waste volumes and costs in both rural and urban areas (see following section on communication).
- CAS can provide solutions for larger volumes of garden waste from households that are too large to be picked up by the regular collection service
- Control on the composting facilities avoids the occurrence of anaerobic conditions and methane emissions that reduce the environmental benefit
- Biogas plants and composting facilities are the main technologies on the market and can be further rolled out by 2023. The location, performance and scale of the new capacity will affect the overall environmental gains of separate collection.

Good practice example

Cities such as Parma (Italy), Ljubljana (Slovenia) and Graz (Austria) have shown that door-to-door collection can lead to high collection rates (between 70% and 85%) of municipal bio-waste.[94]

4.3.4 *Engaging communication*

Good practice example[96]

The app 'Too good to go' prevents food loss by connecting, in a user friendly way, restaurants that have left-over meals with citizens that are looking for a last-minute meal at a

[94] https://ec.europa.eu/environment/waste/studies/pdf/Separate%20collection_Final%20Report.pdf

95 See for example https://www.antwerpen.be/nl/info/52d5052039d8a6ec798b480e/groente-fruit-en-tuinafval-gft

96 See https://toogoodtogo.co.uk/en-gb

- Improper composting leads to smell, vermin and compost that is unsuitable for use in the garden. In the long run this will hamper the penetration of composting. By disseminating user-friendly instructions and providing training services such as 'compost masters', regional and local authorities can improve the quality of home composting[97].
- Communication and new digital applications can prevent food waste by providing practical information on how to plan food purchases, store food and utilize leftovers.[98] More prevention reduces the overall costs for collection as less waste needs to be transported and treated.
- Communication on the benefits of bio-waste collection (less landfilling and less incineration, local jobs, less emissions, renewable energy and local fertiliser) increases household support.
- Focused communication and collection facilities that take into account site-specific constraints (e.g. room available in common rooms, garages and basements) allow greater separate bio-waste collection in high-rise buildings and other areas with high population density

reduced price.

Good practice example[99]

Afval Afhaal ("Waste Collection") introduced an innovative online platform in Amsterdam, the Netherlands, to connect restaurants and small enterprises that produce bio-waste with companies that can valorize the waste, e.g. the use of citrus peels for the production of soap. Via a user-friendly app street cleaners can pick up bio-waste from restaurants and deliver it to interested companies.

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5 Separate collection of Plastic waste

The high functionality, versatility and relatively low cost of plastic have made this group of materials ubiquitous in everyday life. Despite its use in many durable applications, the growing use of plastics in short-lived applications, which are not designed for re-use or cost-effective recycling, leads to wasteful and linear consumption practices.

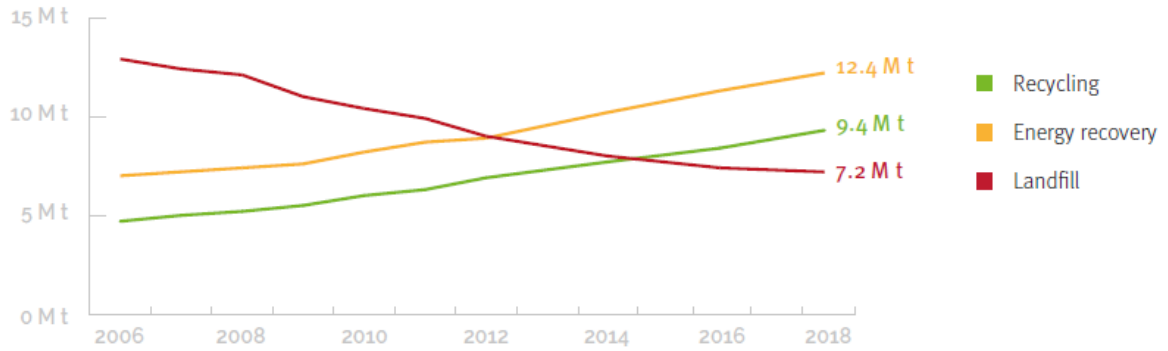
5.1 Volumes

The production of plastic has grown exponentially in just a few decades - from 1,5 million tons in 1950 to 360 million tons in 2018 worldwide. The EU is one of the world's crucial players in plastic manufacturing with a production of 62 million tons of plastics[100] in 2018[101].

Europeans each year buy 51 million tons of plastic, which is found in all kinds of goods, in particular in packaging (39,9%), building and construction materials (19,8%), automotive (9,9%) and electric and electronic equipment (6,2%) (Plastics Europe 2018).

From 2006 to 2018 the volumes of plastic waste that are collected for recycling in the EU, have doubled while energy recovery increased by 77%. In contrast, landfilled plastics decreased by 44%. In 2018 42.6 % of post-consumer plastic waste was incinerated with energy recovery, 32.5% was recycled, (hereof 81% within EU and 19% outside EU) and 24.9 % went to landfill as illustrated in the figure below.

Figure 8: Evolution of post-consumer plastic waste treatment in EU28+NO/CH



Source: Plastics Europe (2019) The circular economy for plastics

Notwithstanding the strong improvements, a recycling rate of 32,5% is low. Overall, the end-of-life treatment of plastics is underperforming, especially when compared to

[100] Includes plastic materials (thermoplastics and polyurethanes) and other plastics (thermosets, adhesives, coatings and sealants). Does not include: PET fibers, PA fibers, PP fibers and polyacryls-fibers (plastics Europe 2019).
[101] EU28+NO/CH

more homogenous materials such as metals or glass[102]. Separate collection of different waste streams is seen as a pre-condition for fostering high-quality recycling and achieving higher recycling rates for packaging waste and other plastics.

Plastic can be made of numerus polymers, the most common of which in household waste are polyethylene terephatalate (PET), polyethylene (PE), polypropylene (PP) and polystyrene (PS)[103].

5.2 Recycling

Since plastics are easily customised to the needs (functional or aesthetic) of each manufacturer, an infinite number of specific plastic types exists. However, plastic processors using recycled plastics desire large quantities of homogenous plastics with strictly controlled specifications, so a sorting step is needed after collection to separate into specific plastic fractions, e.g. PP, PET, PS, PE etc. for optimal recycling conditions[104].

Problematic plastics include black plastics, which are generally not collected as some sorting machines are not able to detect them.

Current demand for recycled plastics only accounts for 6% of plastics demand in Europe[105], but many corporates are making pledges about future use of recycled content, e.g. members of the UK Plastics Pact plan to use 30% of recycled content in their plastics packaging. This new market demand for recycled plastics may unlock the market for recycling and generate economies of scale needed for new technologies.

Current plastics recycling relies mainly on mechanic recycling, i.e. shredding and cleaning the plastics before the use as feedstock. However, a range of chemical technologies is emerging. Chemical recycling can go back to the monomers and can handle difficult to recycle or mixed waste streams[106]. The chemical recycling technologies still have to prove their profitability for large scale plants[107] and some chemical recycling techniques are subject to environmental concerns as they are close to incinerating the materials. Nonetheless, investment funds and large corporations are already investing heavily in the area[108].

The capacity of plastic recycling facilities in EU-28 was in 2015 3.7 million tons according to data from Plastics Recyclers Europe[109]. Additional capacity for plastics recycling will be needed to meet the WFD revised in 2018 requirements.

Different plastics have different melting points and chemical additives are used to give the plastic specific characteristics. Moreover, in contrast to recycling materials such as aluminium, a recycling cycle via the current applied technologies often degrades the quality of the plastics. Therefore, substantial investments are made in new facilities

[102] Deloitte Sustainability (2017)
[103] van Velzen et al. (2013), Edjabou et al.(2015)
[104] Plastic Recyclers Europe (2018)
[105] Europarl, 19.12.2018
[106] Rahimi and Garcia (2017)
[107] Milios et al. (2018)
[108] Closed Loop Parters (2019)
[109] Bio (2015)

and research for recycling technologies that seek new and innovative ways to deal with plastic waste. Some examples:

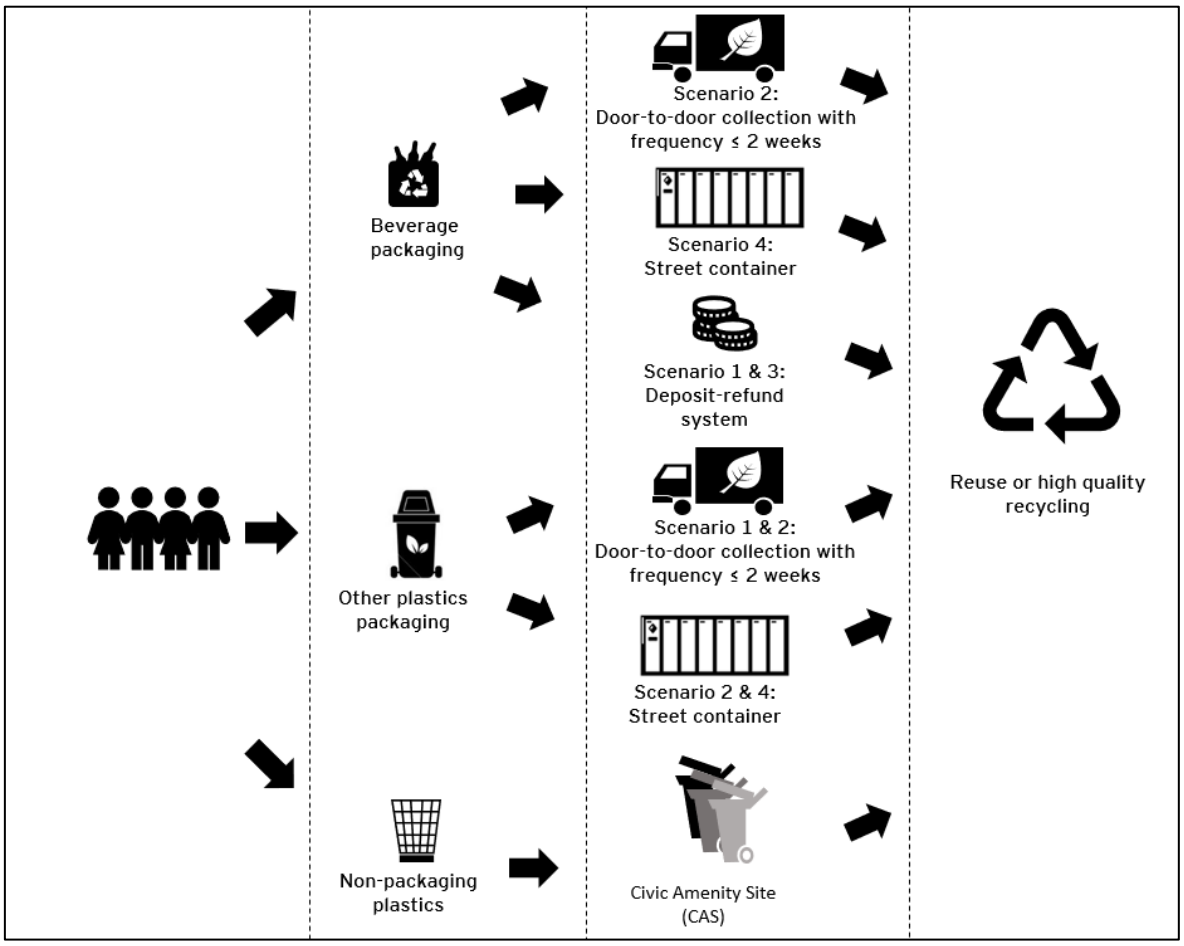
- VTT Technical Research Centre of Finland has developed a chemical recycling technology that promises to provide an environmentally friendly alternative to incineration that is the most commonly used treatment of plastic waste in Finland today due to technical limitations of mechanical recycling. VTT demonstrated the feasibility of the new chemical recycling technology during its two-year Business Finland WasteBusters' project, in which the long polymer chains of plastics were broken down into smaller ones to a pyrolysis wax or oil, which can replace virgin fossil raw materials in a sustainable manner[110].
- The Scottish Project Beacon (supported by Zero Waste Scotland, and the Circular Economy Investment Fund) is developing a system that uses new state-of-the-art separation systems to support mechanical recycling but fuses this with a game-changing chemical feedstock recycling process. This includes a patented process based on thermal cracking, which recycles end-of-life plastic waste that typically cannot be recycled using mechanical methods – for example, mixed, laminated, black, film and even contaminated plastic waste. This new process produces a range of chemical constituents that can be used to reform new virgin plastics, or other chemical products[111].
- A new extrusion line for mechanical recycling of post-consumer thermoplastics by INTERSEROH Dienstleistungs GmbH and EREMA Engineering Recycling Maschinen und Anlagen Ges.m.b.H was recognised by the judges at the Plastics Recycling Show Europe 2019 as the most innovative combination of processing technologies that delivers cost-effective recycling of post-consumer plastic to produce high quality plastic material[112].
- Carbon black packaging waste causes problems in recycling streams, as it cannot be detected by the NIR sensors used by most recyclers. The multinational company Ampacet Corp has developed black masterbatches[113] that contain no carbon black pigment, rendering them near-infrared (NIR) transparent, and therefore detectable and able to be sorted. Ampacet's NIR (near-infrared) detectable black colorants' are part of the company's sustainable development programme.
- A "biorecycling" factory in France has created a process that lets any plastic be recycled into any other plastic. This could change the market for recycling and help increase the volume of plastic that's recycled. Unlike traditional recycling, which degrades materials, this type of "biorecycling" can happen repeatedly without a loss in quality. [114]

[110] VTT 11.06.2019
[111] Zero Waste Scotland
[112] Erema 2019
[113] Ampacet 2019
[114] ZME Science 30.10.2019

5.3 Success factors for separate collection of plastics

The figure below details the collection scenarios put forward in Table 1 and illustrates how the collection should be organized to achieve high-quality recycling of plastics.

Figure 9: the collection flow and facilities for plastics



The division between plastics packaging and non-packaging plastics is mainly driven by a financing issue coming from the EPR regulations. The packaging producers pay for the separate collection of the packaging waste, not for the other fractions. From the recycling perspective and the view of the consumers, this is not always logic. In reality often the difference is made between soft plastics (including all plastics packaging and all plastics similar in size and characteristics) on the one hand and hard plastics (including toys, garden tools, etc.) on the other. Allowing all 'soft' plastics in the plastic bag is easier for consumers and generates more separately collected volume. However, it may also increase slightly the impurities because recycling inhibitors such as PVC would end up with other plastics. However, sorting techniques are improving, so in the future collecting also hard plastics via door-to-door or street containers will probably become more common.

In a Swedish study door-to-door collection in single-family homes was shown to generate plastic packaging waste with less contamination compared to plastic

packaging waste sorted out through the bring system. The quality of plastic packaging waste sorted out by kerbside collection from apartment buildings was varying[115].

Norwegian experience shows that the purity of plastic packaging waste collected through both kerbside and bring systems varies and can be large depending on the collection system. Grønt Punkt Norge collects reports the following average impurities data for 2013: 12% for kerbside collection with transparent plastic bags, 10%, for kerbside collection with colored bags prior to optical color sorting and 20% for bring systems[116].

Finally, the implementation of separate collection can be a challenge for products consumed outside home (on-the-go consumption). A survey of Local Authorities in the UK demonstrated that 'On the Go' collection infrastructure is typically considered inadequate or inconvenient for sorting and recycling waste. There are many examples of recycling 'On the Go' units being removed due to increasing levels of contamination and maintenance costs[117].

The implementation of the Single Use Plastics (SUP) Directive on the reduction of certain plastic products on the environment (Directive (EU) 2019/90) has a number of measures to reduce the amount of plastic used in the on-the-go sector including bans and targets to ensure increased separate collection[118].

5.3.1 *Economic incentives*

- Pay-As-Your-Throw (PAYT) contributions incentivizes households to sort all waste including plastics at source
- Deposit-refund schemes have a high initial investment cost and can also entail high maintenance costs but can lead to collection rates at almost 100% while also reducing litter[120]. The five best performing Member States with deposit schemes for PET bottles (Germany, Denmark, Finland, the Netherlands and Estonia) reached an average collection rate for PET of 94% in 2014 (EC 2018). Deposit-refund schemes are, however, typically limited to beverage packaging.
- Modulation of fees in Extended Producer Responsibility (EPR) systems for packaging can contribute to eco-design, related waste minimisation, and to promote the use of recyclable (or reusable) packaging.

Good practice example[119]

Thanks to intensive communication on sorting by the EPR organization Fost Plus, combined with existing PAYT schemes for residual waste (see earlier), have led to high recycling rates in Belgium: in 2015 for 82% for all packaging waste 43% and for plastic packaging waste.

[115] NCM (2015)
[116] NCM (2015)
[117] Recoup (2017)
[118] European Commission (2019)
[119] Watkins et al. (2017)
[120] Ovam (2014), Ovam (2015), ACR+ (2019)

5.3.2 *Legal Enforcement*

- Prohibition of littering and application of fines to individuals that litter or put impurities in the recyclables bin, reduce leakage of plastics.
- Monitoring of impurities (food-residues and others) of collected plastics - and enforcement in case of irregularities - improve the quality and value of recovered plastics (see chapter 3).

5.3.3 *Customized facilities*

- An overall review of literature from 2015 shows that door-to-door collection systems result in the highest capture rates and yields of recyclables but collection costs are higher (Bipro 2015).
- Plastics and metals can be commingled during collection without spoiling the quality of the collected materials. Technological progress has improved the accuracy and speed of central sorting of such commingled waste materials, leading to cleaner fractions after central sorting.
- By collecting all plastics instead of focusing on highly visible and valuable streams (such as PET from beverage packaging), collection rates will steeply increase; however, a subsequent sorting will be necessary to allow processing of the recyclable plastics. Many sorting facilities have experiences difficulties in sorting soft plastic foils from hard plastics, since the soft plastic can become entangled in the sorting machine. However, the quantities of the collected plastics has shown to increase with a more open collection scheme as seen in Copenhagen, Denmark.
- Innovative collection infrastructure (underground bins, underground piping infrastructure, …) can achieve high collection rates while minimizing visual nuisance and transport externalities.
- Collection of plastics goes beyond packaging waste, but some product types may not be recyclable (e.g., mixed products made from many different plastic types like some plastic toys).
- Civic Amenity Sites or local collection points offer a low-cost collection method for all plastics, especially for the non-packaging plastics that are not collected door-to-door.

The Municipality of Copenhagen has separately collected plastic since 2012 and the collection rates has been increasing every year. When the municipality in 2017 decided to also collect soft plastic / foils the collection rate increased with 30%, however only 10% of the plastic collected was soft plastic. This showed that a more simple information on what plastic to collect can significantly increase the separating at source.

Good practice example

The city of Bergen, Norway, is a UNESCO heritage city with narrow streets and high population density complicating waste collection transportation in vehicles. Bergen has in 2017 started using an underground pipe system, Bossnettet of almost 8 km in total pipe networks length, covering more than 5.000 households (as of January 2019). Private households, plus more than 100 business customers have been connected to an increasing amount of inlets for residual waste and paper, beverage carton and plastic. Bossnettet carries waste to a collection terminal using air thereby abolishing the need for bins or waste vehicles.

The system accepts all clean plastic packaging packed in the registered bags (for the central sorting), including detergent bottles, crisp packets, coffee bags, plastic jugs, trays, plastic bags, cling film, and bubble wrap. The registered bags are available free of charge at local grocery stores and at the mobile recycling station. Any plastic that is not packaging, such as toothbrushes or pens, can be disposed of as residual waste (see chapter 2 for obligations of the new WFD: in the future, municipalities should offer their citizens the possibility to store these plastics and bring them to a CAS).

The scheme operates with a "Pay as you throw" (PAYT) system using a key chip. Residents must use the key chip every time they dispose of waste.

This innovative facility coupled with a PAYT system and intensive communication campaigns proved to be successful. In overall the waste management company BIR reports a stable reduction in general waste generation by 8.4%, an increase of separate collection by 28% for plastic and by 10% for glass and metal.

The implementation price is high (the investment is about €127 million) but over time the initial investment costs should be offset by reduced costs: manual handling results in low operating and maintenance costs; increased sustainability credentials; possibility of better use of space; and increased property values with cleaner local environments. The annual fee that the citizen has to pay to the municipality has increased around €10 . The system may be an innovative niche solution for municipalities with specific constraints on transport in the centre.[121]

[121] https://bir.no/ny-avfallsloesning/bossnettet-i-bergen-sentrum/
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5.3.4 *Engaging communication*

- Collection bags can be used as a communication tool to present the information as close to the sorting gesture as possible.
- Positive communication has demonstrated to be more motivating than excluding or negative statements. Furthermore information regarding the destination of the collected plastics is highlighted as positive for citizens, collectors and employees to obtain an overall understanding of the importance of proper sorting (PlanMiljø 2016).
- Simple consistent messages that do not confuse consumers with the infinite diversity of plastics lead to high collected volumes.
- Frequent or permanent communication will integrate plastics sorting in daily habits.

Good practice example[122]

Fredericia Municipality (Denmark) has collected plastic waste since 1986 and has continuously improved the system. The municipality collects two plastics fractions: 1) cleaned plastic packaging and canisters and 2) Plastic film: film, bags, and bubble wrap. The plastic is collected in two separate containers at multi apartment buildings or two different plastic bags for single family housing.

The Municipality requires in a competitive tender a guarantee from the collector that the plastics are recycled for new materials.

The recovered materials include 3,4 kg of plastic canisters, 3 kg of plastic foils and 1,3 kg of polystyreen.

Key actions: consistent communication over time, a user-friendly digital tool, easy instructions (plastics only need to be 'clean' – instructions printed on the collection bag) and free collection. Moreover, the cleanliness is incentivized because the citizen must store the waste for up to a month before collection.

[122] https://genanvend.mst.dk/media/191139/sortering-af-plast-fra-husholdninger-i-fredericia.pdf

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6 Separate collection of textile waste

The scope of textile waste in this guidance encompasses used garments and home textiles (bed linen, towels, tablecloths etc.) and similar used textiles from private companies and public organisations e.g. hospital linen, uniforms or workwear. Products where textile fibres are not the dominant material are excluded, e.g. carpets with non-textile heavy backing material duvets and pillows and textiles that are integrated into furniture e.g. upholstery. Textile waste includes both used textile waste and discarded unsold textiles.

6.1 Volumes

The consumption of textile products in the EU is estimated at 9 to 13 million tons which corresponds to 19 kg and 27 kg per inhabitant per year[123]. 71% would be clothing and 29% are home textiles (bedlinen, toilet-linen, curtains etc.). This figure included carpets with heavy non-textile backing and gives an indicative upper level for the quantities of textile waste products available for separate collection.

Actual separate collection of used textile products across the EU is not known. Only in MS where collection of used textiles is defined as waste collection, reporting on collection quantities is mandatory. The table below provides an overview of collection quantities and collection rates in selected countries.

Table 12: Consumption of new textiles and separate collection of used textiles in EU Member States with available data [124]

Country and (data year)	Flanders(2016)	DE (2013)	DK (2017)	EE (2018)	FR (2018)	IT (2015)	LT (2018)	LV (2018)	NL(2012)	SE (2013)	UK (2010)
Consumption new textiles (ktons)	-	1347[i]	85	15.0	624[i]	881[iii]	14.5	9.2	240	121	1693
Consumption new textiles (kg/capita)	-	16.7[i]	15.0	11.4	9.5[i]	14.5[iii]	5.1	4.7	14.0	12.6	26.7
Separate collection used textiles (ktons)	53[i]	1011[i]	37	4.4	239[i]	133[iv]	2.1	0.4	89	23	619[i]
Separate collection used textiles (kg/capita)	8.1[i]	12.5[i]	6.4	3.3[i]	3.6[i]	2.2[iv]	0.7[i]	0.2[i]	5.4	2.4	11[i]
Share of quantity placed on market (%)	-	75%	43%	29%	38%	11%[v]	14%	4%	37%	19%	31%[ii]

[i] *Includes footwear*
[ii] *Shoes included in both denominator and numerator*
[iii] *Clothing only. Taken from WRAP (2017)*

[123] JRC (2014) and EEA (2019)
[124] Derived from Watson et al (2018a) but with new data for Denmark, France, Estonia, Latvia and Lithuania. Data sources: Flanders (OVAM, 2017b), Germany (BVSE, 2015), Denmark (Watson et al, 2018b), France (EcoTLC, 2019), Italy (ISPRA, 2017), Netherlands (FFACT 2014) and consumption figures from branch organisation Modint), Sweden (Elander et al, 2014), UK (Bartlett et al, 2012), Estonia, Latvia and Lithuania (Watson et al, in print)

[iv] *This is the figure reported as part of waste statistics. In Italy any collection of textiles via bring banks is considered as waste and must be registered. However direct delivery across the counter in charities will probably not be registered so this is likely an underestimate*
[v] *Assumes that clothing represents ¾ of textiles put on the markets based on UK and Danish split between clothing and home textiles*

For the countries/regions with available data, collection rates range from 4% in Latvia to over 70% in Germany[125]. The differences between countries are driven by a myriad of factors including cultural differences, the intensity of activities of collectors and reporting practices[126] (Watson et al, 2018a). However, strong policies can also have a significant effect: collection rates have increased increase by 370% in France, since mandatory EPR regulations were adopted in 2007[127]. Collection has increased by 56% since 2014. No other countries have reliable time series data.

With respect to unsold textiles from retail, the industry does not report annual quantities.

6.2 Reuse and recycling

6.2.1 *Used textiles from households*

The textiles collected in unmanned collection points will comprise a mix of reusable and non-reusable textiles. Following collection, textiles are sorted into the various fractions.

Reuse raises a far higher price per kg than recycling and textiles are therefore sold for reuse as much as possible[128]. Second-hand shops typically sort out the best quality textiles out for resale locally. The remaining lower quality textiles may be sold for further sorting in other parts of Europe, typically the Baltic States and Eastern Europe, but there are also large sorting facilities in Germany, the Netherlands, the UK and Belgium. These wholesale sorting companies then sell the sorted fractions on for reuse and recycling on global markets.

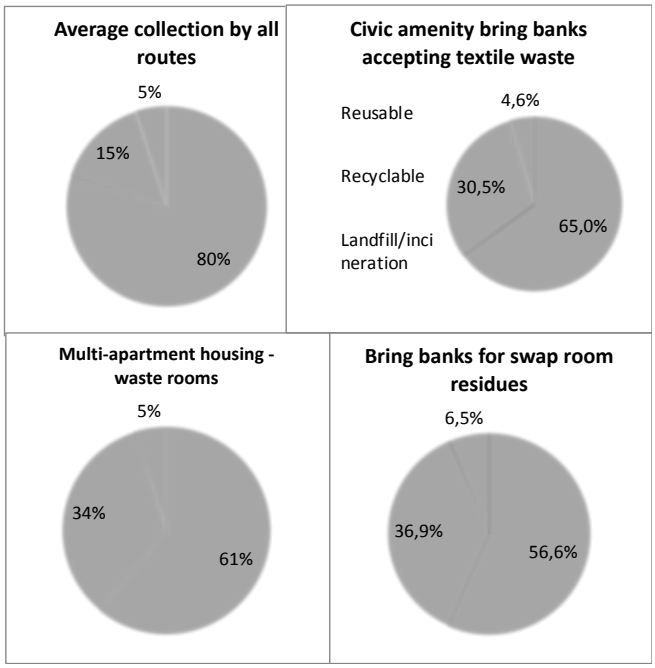
Current recycling markets include cutting of cotton-based fabrics into industrial wipes, or mechanical recycling of fibres into non-woven insulation, padding in upholstery, fleece blankets or other low grade products[129].

Non-reusable textiles currently present an economic burden for collectors due to the low or zero price which can often barely pay for transport to recycling facilities. Textile collection is purely funded by the reusable fractions. As a result, increasing the share of non-reusable textiles can undermine the economic viability of used textiles collection[130].

The split between reuse, recycling and other waste management for a typical tonne of collected textiles differs depending on how and where used textiles have been collected. The figure below gives an example of differences even within a single city.

[125] The figure for Germany is based on a survey of just 40% of collectors and therefore somewhat uncertain. A new mapping is currently underway.
[126] Watson et al. (2016)
[127] Derived from Bukhari et al. (2018) and EcoTLC (2019)
[128] Watson et al. (2016)
[129] Watson et al. (2016)
[130] Watson et al. (2018a)

Figure 10: Differences in reusable and recyclable shares of textiles, depending on location and collection type (reported by a Danish collector)[131]



The 2025 separate collection requirement from the WFD has been estimated to result in 1.3 million tonnes of additional non-reusable textiles for which markets need to be found[132]. Current global recycling markets for textiles waste are already close to saturation[133].

One way to handle the increasing waste volume without destroying the economics of textile collection is through the investment in large scale fibre-to-fibre recycling technologies and plants. This will allow the non-reusable textile waste to be recycled into textile production and can be further supplemented by open-loop recycling of fibres other applications[134].

Several European projects are developing automatic sorting of non-reusable textile waste by fibre type and by colour. Other research are focusing on chemical recycling of textiles waste, including difficult fibre blends, into valuable products and high-quality fibres. Some examples:

- RESYNTEX aims to produce textiles from secondary raw materials from unwearable textile waste with industrial ecology approaches. Funded under Horizon 2020. http://www.resyntex.eu/the-project
- FIBRESORT aims to close the loop in the textiles industry by research on automatic sorting of large volumes of mixed post-consumer textiles by material composition. Funded by Interreg North West Europe:

131 Watson et al, 2018a
132 GftZ (2019)
133 Ljungkvist et al (2018)
134 Maud Hardy, EcoTLc, pers. comm. with David Watson, 4th November 2019

https://www.nweurope.eu/projects/project-search/bringing-the-fibersort-technology-to-the-market/

- TELAKETJU furthers the new era of recycling by setting up a recycling ecosystem for the collection, sorting and further processing of textiles in Finland. Funded by Finnish Ministry of Environment https://telaketju.turkuamk.fi/about-telaketju-3/
- SIPTex Phase 2 scales up a pilot for automated sorting of mixed post-consumer textile waste by fibre type and colour to industrial scale. Funded by Swedish innovation fund Innova. https://www.vinnova.se/p/svensk-innovationsplattform-for-textilsortering-siptex2/
- BLEND RE:WIND focuses on chemical recycling of polycotton blends currently that are currently at laboratory scale. Funded by Mistra Fund under Mistra Future Fashion in Sweden. http://mistrafuturefashion.com/rewind-recycles-cotton-polyester/
- WORN AGAIN investigates chemical recycling of used garments into textile fibres. Funded by H&M Clothing Company and Future Tech Lab http://wornagain.co.uk/

Various open and closed loop recycling projects funded by the French Producer Responsibility Organisation EcoTLC: https://www.ecotlc.fr/ressources/

Documents_site/Chemins-Innovation2019_EN_BD.pdf

6.2.2 *Unsold textiles*

The treatment of unsold textiles from retail is somewhat different. In principle all unsold textiles are fit for use. There are several options for dealing with unsold textile products:

- Discounting prices to enhance sales to consumers
- Returning to original suppliers
- Sending to separate outlet stores and external actors such as charities.
- destruction through recycling or incineration.

Some brands place requirements on collectors not to sell this clothing in countries where they have shops. Moreover, there have been several cases in recent years of both high-end fashion and fast fashion companies incinerating unsold textile products to avoid informal flows of cheap clothes that could damage the brand image [135].

In the Netherlands, 31% of clothing is sold at reduced price via various outlets, while 4% of clothing placed on the market is not sold. Of the unsold clothing, 48% is donated to charities for reuse, 18% to commercial collectors for reuse, 4% collected by recyclers and 2% is incinerated. The remainder is kept in stock for possible sale later. Approximately 5% of textiles recycled in the Netherlands was unsold inventory coming from apparel retailers and brands[136].

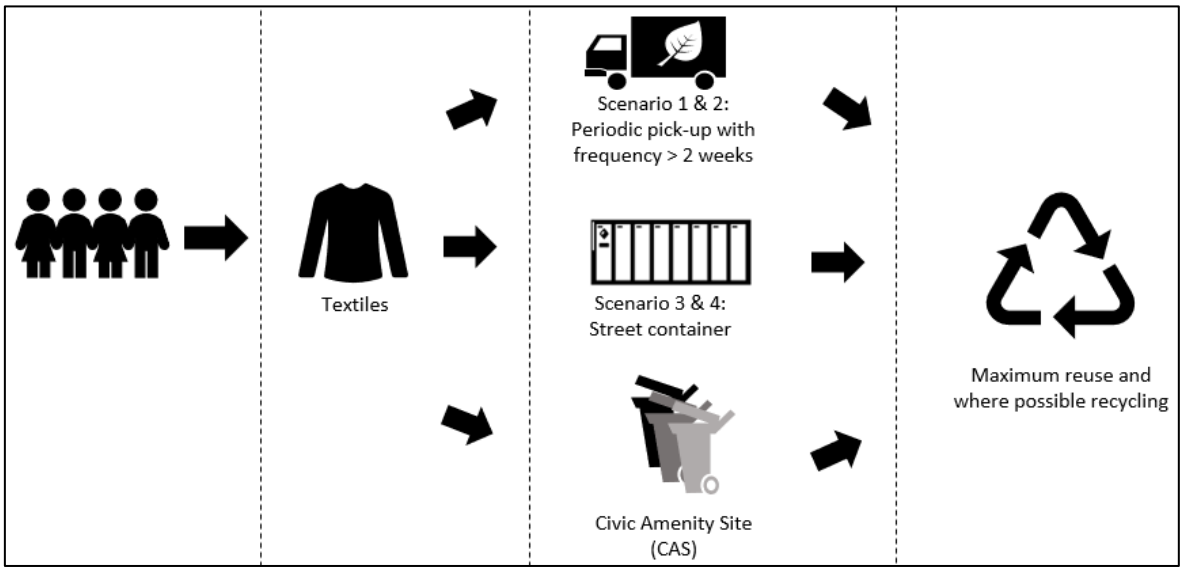
[135] See e.g. Siegel et al (2018 and 2019), Cooper (2018) and Engell et al (2017)
[136] Wijnia (2016)

Studies elsewhere suggest higher incineration rates of unsold textiles: 30% in Denmark[137] and at least 14% in Norway[138].

6.3 Success factors for separate collection of textile waste

The figure below details the collection scenarios put forward in Table 1 and illustrates how the collection should be organized to achieve reuse and recycling of textiles.

Figure 11: the collection flow and facilities for textiles



[137] Watson et al (2018b)
[138] Watson et al (2020)

6.3.1 *Economic incentives*

- Reuse is the main economic driver for current textiles collection.
- Investments via EPR and research funds in automated sorting of fibre types and in open loop and closed loop recycling technologies can improve the economic viability of collecting non-reusable fractions. Funding should focus especially on mixed fibres and should have a horizon that is long enough to ensure maturity and scaling up of technologies.

Good practice example

Under the French EPR system, producer fees have been earmarked for R&D into recycling technologies. 44 projects have been funded since 2009 with €3.9 million[142].

- EPR can provide financing for collection, communication with citizens, research, development, demonstration and scaling up recycling technologies. Modulated producer fees for eco-designed products can incentivize eco-design but only if the fee modulation more than covers the cost of adopting and adequately documenting the eco-design elements.
- A review of tax and VAT rules for retailers can identify drivers that disincentivize retailers to donate or sell unsold collections for reuse and /or recycling. These drivers Incineration taxes, landfill taxes and other instruments can help to increase the volume of separately collected non-reusable textiles that are recycled rather than incinerated or landfilled following sorting. The taxes need to be more than sufficient to offset the costs of transport to recycling facilities (that may be in another MS). Such taxes will also increase incentives to reuse and recycle unsold clothing collections in retailers.

Good practice example

Waste regulations in Estonia[139] require municipalities to organise the separate collection of 13 different types of waste including textiles. The collection can occur via door-to-door, periodic pick-up or CAS. Municipalities often collaborate with charities to provide the collection facilities[140]. For textiles, the collaboration fosters reuse, rather than incineration. Reuse is the main economic driver for the system, while recycling is not viable on its own[141].

Good practice example

Collection of unsold stock by charities for reuse has increased in Denmark since VAT rules, that had penalised donations, were changed in 2015[143].

[139] RT I 2007, 9, 140, https://www.riigiteataja.ee/akt/12779785?leiaKehtiv

140 Kristiina Martin, Stockholm Environment Institute, Personal Communication, 3rd April, 2019

141 Watson et al (2020)

142https://www.ecotlc.fr/ressources/Documents_site/Chemins-Innovation2019_EN_BD.pdf

[143] Watson et al (2018b)

- Social, circular economy and environmental gains can be made by combining wage support for long-term unemployed or disadvantaged groups in employment/training in collection, sorting, processing and sale of used textiles.

Good practice example

France has leveraged EPR to substantially increase collection rates of textiles by 370% from 65.000 tonnes in 2006 to 239.000 tonnes in 2018[144]. The EPR includes ambitious targets for separate collection of textiles placed on the market and for reuse and recycling rates of collected textiles that producers are obliged to meet. Moreover, it includes minimum targets for collection point (CP) densities (one CP per 1500 people by 2019) to assist in meeting collection targets. CP targets are supported by economic incentives: municipalities can receive financial support from the PRO in return for communicating on textile collection to citizens, but only if they also have ensured that the minimum CP density has been achieved[145]. Municipalities have a strong influence on CP density through granting of permissions to collectors. Finally, producer fees are modulated such that producers of eco-designed products pay less. However, these have so far had little impact[146].

6.3.2 *Legal Enforcement*

- By monitoring theft from bring banks in public areas, investigation and prosecution of infractions can happen in a focused and forceful way.
- In order to upgrade quality or recycled volumes, providing permission for placement of bring banks on public land or for door-to-door collections can be made dependent on meeting minimum requirements for reuse and recycling of collected textiles. Moreover, conditions for traceability and reporting can be imposed.
- Setting minimum collection point density can ensure higher collection rates. This can be imposed on municipalities or included in tenders for collection services.

Good practice example

The Nordic Reuse and Recycling Commitment is a pilot code of conduct for collectors of used textiles that sets requirements for environmental performance, transparency and traceability[147]. Gothenburg City, Sweden included these as minimum requirements in accreditation for collectors in the city[148].

144 Derived from Bukhari et al (2018) and EcoTLC (2019)
145 EcoTLC (2019)
146 WRAP (2018)
147 https://www.norden.org/da/node/7628
148 Watson et al (2018b)

- Minimum eco-design standards can increase the durability, reparability and recyclability of textiles placed on the market and thus increase the value of separately collected textiles.
- If MS harmonise how and when used textiles are defined as waste, uncertainty for international collectors, transporters and sorters can be reduced which may optimize trade and reuse.

Good practice example [149]

In 2016 the City of Antwerp issued a tender for the collection of used textiles a in order to gain more control on collection practices (which was in some cases being carried out without authorization), to promote sustainability and to foster local engagement.

A consortium called De Collectie, of 5 public and private actors won the tender thanks to their commitment to transparency on the fate of textiles, their engagement with respect to local and social solutions and the gradual shift from bring banks to manned collection points in post offices, libraries etc.

De Collectie is struggling to keep its targets for local reuse and recycling. 16% of best quality textiles are sold locally, but the lower quality grades and recyclable textiles are mostly sold on global markets. One successful local example concerns a manufacturer that produces jeans with 50% recycled denim.

The collaboration within the consortium has led to a common brand that simplifies and amplifies the communication with citizens. The consortium increased collection by 29% during the first two years of operation, despite a 50% reduction in the number of bring banks. The shift towards manned collection points has also reduced contamination of collected textiles by non-textile waste, moisture and mold. Moreover, the initiative has created 30 new jobs for people with employment difficulties.

6.3.3 *Customized facilities*

- Separate collection is mainly handled by large private operators and NGOs that know how to maximise reuse and recycling on global markets. Collaboration with these partners and making use of their knowledge rather than reinventing the wheel can ensure high reuse and recycling levels.

Good practice example

In Flanders[150], municipalities have to establish separate textile collection in civic amenity centres supplemented by a minimum of four door-to-door collections per year. Alternatively a municipality can opt for a minimum collection point density of one

[149] Watson et al (2018a)
[150] OVAM (2017a)

- Textiles can be collected via a range of complementary methods that reach out to different kinds of citizen and enhance collection rates: door-to-door, bring banks, CAS, mobile units, small-scale informal initiatives in work places, schools and nurseries, reuse centres and high street fashion shops. Citizens differ in their daily habits and motivation for delivery. Urban landscape may differ from high to low density and suitability of different collection types.
- Contamination of collected textiles by water or non-textile waste can be reduced by collecting textiles door-to-door or by setting up manned collection points in libraries, post offices and other service points. Contamination can also be reduced by better bring-bank design.
- A combination of collection methods can be used to strike a balance between convenience and costs. Street-side bring banks have a relatively low cost per ton of collection and will be used by motivated citizens, but less-motivated segments of the population may only deliver to collection points that
- are located within their buildings, work places, places of education or supermarkets that they regularly visit.
- Collection close to the citizen can be more expensive than bring banks, but the extra cost can be partially offset by lower contamination by non-textile waste. Moreover, door-to-door collection costs can be decreased where collection is combined with other clean, dry waste streams for reuse or recycling such as paper, plastics, electronics etc. However, collectors should be aware of the risks of theft when carrying out door-to-door collection.
- To avoid contamination and increase quality of collected textiles, citizens should be encouraged to deliver textiles in sealed bags. This is particularly necessary where textile collection is combined with other dry recyclables. Municipalities/collectors can provide sealable bags to citizens. However, the cost of providing a bag can have a significant cost impact on the collection.

collection point per 1000 people.

Good practice example

Paris uses a spectrum of collection methods to reach different segments of the population: bring banks in streets, mobile pick-ups, civic amenity centres, supermarkets, reuse shops, bring banks inside social housing and in schools. Other cities also collect used textiles in libraries and post offices.[151]

Good practice example[152]

Two Dutch municipal-owned companies, Rd4 and Circulus Berkel, combine door-to-door textile collection with collection of other waste streams (books, small electronics, toys) to improve the cost efficiency. Householders receive a BEST bag with an individualized QR code for free. Textiles make up roughly half of the collected items (by weight). About 10% of the textiles are suitable for resale in local Kringloop shops and the remainder are sold to global reuse and recycling markets. The user friendly system increases collected volumes and reaches high quality levels since donators

[151] Watson et al (2018a)
[152] Watson et al (2018a)

can be identified. Although theft of the bags can be an issue, monitoring and pragmatic instructions to only put out the bag shortly before collection seem to effectively deal with the problem. The identification via QR code also allows to send households that participated a new individualized BEST bag.

6.3.4 *Engaging communication*

- Carrying out a citizen survey before designing measures for increased collection can better ensure success. Reasons for non-delivery of used clothing and textiles may be complex and include unexpected factors. Many citizens care what happens to their textiles and what the money is used for. Some may want to see them support local jobs and social activities. Others may wish them to support development projects abroad.
- Using a common brand for all types of collection activities, containers and actors can reduce confusion/inaction among citizens and strengthen messages on collection.
- To avoid quality losses due to mould or other contamination, communication should incentivize putting donated clothes in bags to keep them dry and clean.
- Transparency about the valorisation of the donated textiles and destination of the money raised helps to increase citizen trust.
- The perceived profile of reuse centres leads to the collection of higher quality (reusable) textiles than in CAS. Bringing the right message and framing can increase quality and volumes collected for recycling.

Good practice example

Gothenburg City carried out a citizen survey in 2012 and again in 2017. The surveys found a significant share of the population will only deliver used textiles if it is convenient and that social/ humanitarian motivation is of far greater importance than environmental concerns for delivering textiles. Moreover, citizens seem confused about the instructions for non-reusable textiles and the destination of donated textiles. This knowledge allowed the city to make its collection systems more effective.[153]

Good practice example

In Rotterdam it was found that by giving all bring banks the same single color and placing them above ground

[153] Watson et al (2018b)

- Similarly, street side bring banks tend to collect better quality textiles (more suitable for reuse) than those in CAS. This is likely because in the latter, it is clearly communicated that worn out textile waste is also welcome.

away from containers for waste, contamination by non-textile waste was reduced. [154]

- Clear communication on the management of non-reusable textiles is needed. Careful well-designed communication can ensure that citizens realise that 1) both reusable and non-reusable waste textiles are accepted 2) that delivered textiles will be used in the most environmentally optimal way possible –good quality textiles will be reused and worn-out textiles will be recycled.

Good practice example [155]

In 2016, WRAP UK developed a guide for used textile collectors. The aim was to help local authorities (LA) and textiles collectors to increase textile re-use and recycling. Examples of concrete tips for **kerbside collection**:

Tips to increase quantities: ensuring the service is easy to use and residents do not have to go out of their way to participate; improving communications to increase householder awareness and engagement; making it easy for householders to donate a wide range of items; increasing service coverage so a higher proportion of residents can use it.

Tips to increase quality: provide clear information to householders on the types of materials accepted and the condition these items should be in; consider the use of transparent containers so that collection crews can spot potential contamination instantly; provide crews with clear instructions on what should be rejected.

Tips to reduce theft and bogus collection: Advise householders to place bags outside as close to the scheduled collection time as possible and to take bags back into the house or take them to a bring bank or charity shop, if a collection is missed; Advise householders that if they have any concerns about illegal collections or fraudulent bags, they should contact their local authority; Require all licensed collectors to provide information about their organisation, either printed on bags or in accompanying literature. This should contain a company number and/or a charity registration number.

Examples of concrete tips for **bring bank collection**:

Tips to increase quality: provide clear information on the types of materials accepted at the bring bank, and the condition these items should be in state on or close to banks whether textiles should be deposited in bags.

Tips to reduce theft and bogus collection: put a monitoring system in place to regularly visit and review each bring bank site under an organisation's control; where

[154] Watson et al (2018b)
[155] http://www.wrap.org.uk/sites/files/wrap/MST1561_Textiles_Guidance_2015_UPDATE_21.pdf

banks have been sited without permission, take action to have them removed.

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7 Separate collection of household hazardous waste

HHW includes a wide range of materials which display diverse hazardous properties. The classification of waste as non-hazardous or hazardous waste is outlined in the EU WFD - Article 3(2). Classification criteria relating to the properties that may render waste hazardous are noted in the revised Annex III to the WFD, while classification criteria relating to the waste source and waste type are outlined in the European List of Waste (LoW).

WEEE is a substantial fraction of total HHW that is commonly reported separately and therefore not in scope of this chapter. Similarly, since the management of batteries is extensively covered by stream-specific take-back legislation, it is not further discussed.

7.1 Volumes

The HHW volumes excluding WEEE typically range around 1% of municipal waste[159]. However, the data available at the country level are difficult to compare as countries have different reporting processes and categories (e.g. including WEEE or edible fats). The reported volumes of hazardous waste from households range between 1 and 6 kg per inhabitant in the EU[160].

HHW is mainly collected at CAS, typically around two-thirds. About one-third is collected via mobile collection and period pick-ups.. Furthermore, collection points within retail shops exist for some waste streams such as batteries.[161] The remainder being discarded via the residual waste bin or, for a small fraction, via inappropriate disposal routes that generate safety hazards and environmental damage

Good practice example[156]

The Grand Duchy of Luxembourg has an integrated waste collection system that foresees extensive and free collection facilities for HHW: 18 stationary collection points where citizens can bring their hazardous substances (i.e. one point per 35.000 inhabitants), mobile pick-ups carried out 4 times a year and even a home pick-up on demand.

Communication campaigns levering digital tools create awareness and specific support services are foreseen for focus groups such as inhabitants of apartment buildings. For example, in the most comprehensive collection systems, inhabitants of apartment buildings can deposit up to 27 different types of waste separately[157].

The system succeeds in collecting more than 5 kg HHW per inhabitant[158].

[156] http://ec.europa.eu/environment/waste/studies/pdf/20180227_Haz_Waste_Final_RepV5_clear.pdf
https://www.sdk.lu/index.php/fr/the-news-at-a-glance-5/623-les-centres-de-recyclage-luxembourgeois

[157] https://www.sdk.lu/images/PDF/Telefonberatungsordner/Info-national-waste-management/ReDesign-Flyer-Residenzen-2018-03-16-FR.pdf

[158] D'emweltverwaltung (2018)

[159] https://www.researchgate.net/profile/Magdalena_Vaverkova2/publication/295812178_Household_Solid_Waste_Composition_Focusing_on_Hazardous_Waste/links/595dd5b0aca27230851535a0/Household-Solid-Waste-Composition-Focusing-on-Hazardous-Waste.pdf

[160] EEA (2015) and D'emwelverwaltung (2018)

[161] http://ec.europa.eu/environment/waste/studies/pdf/household_report.pdf

such as disposal by flushing down the toilet. [162] Overall, in mature systems only a part of the HHW is separately collected. [163] [164] *[165]*

Flanders reports that it collects 3,1 HHW separately per inhabitant per year with the following composition: 32% vegetable oils and animal fats; 32% paints; 9% batteries; 7% mineral oil; 3% solvents; 2% car batteries directly collected from citizens; 2% spray cans; the rest being a mix of products. Moreover, sorting analysis has shown that in Flanders another 3 kg of HHW is disposed of via the residual waste bag[166].

Luxembourg indicates that it collects 5,4 kg per inhabitant: 35% paints; 13% edible fats; 9% bound asbestos; 7% lubricants; 5% printer cartridges, 5% medical waste; 4% car batteries; 4% roofing; and miscellaneous small streams. Another 2 kg per inhabitant is lost in the mixed waste bag[167].

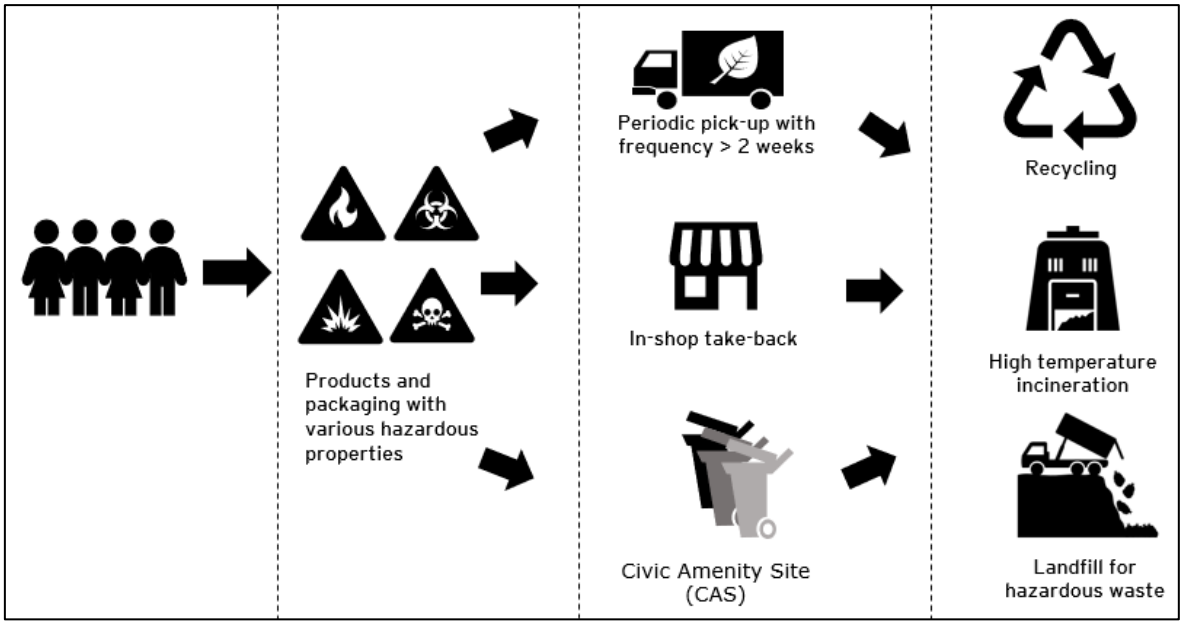
7.2 Management of classified HHW streams

The LoW is a document that establishes a harmonized classification system for wastes within the EU, including a list of hazardous and non-hazardous wastes. Each type of waste is assigned a six-digit code, while hazardous wastes are also marked with an asterisk (*).[168]

Both the characteristics and the management of hazardous waste categories differ substantially. However, the collection facilities for HHW can be grouped as depicted in Table 1 and illustrated in the figure below.

[162] https://ec.europa.eu/environment/waste/studies/pdf/household_report.pdf
163 https://pdfs.semanticscholar.org/39cd/d5d64644d5af35242be91d4f7468cb32b289.pdf
164 Letcher and Vallero (2019)
165 Benchmark derived from own comparison of collected data for German and Austrian HHW collection systems and is in line with a German benchmark study on HHW with 33 participating public waste management companies executed by IA GmbH - FORUM Z in July 2015 – Auswertung zumThema Erfassung und Beseitigung von Problemabfällen, 33 counties and urban municipalities
[166] OVAM (2018)
[167] D'emwelverwaltung (2018)
[168] The WFD stipulates that the European Commission should be notified if any individual MS deviate from the hazardous and non-hazardous entries in the LoW.

Figure 12: Separate collection for Hazardous Household Waste (HHW)



7.2.1 *Hazardous Household Chemicals*

Most of the MS already oblige their municipalities to collect household chemicals separately. This typically occurs via periodic pick-ups (e.g. see box) and CAS. [169]

Good practice example[170]

In Brussels, Belgium, citizens can drop off household chemical waste at the mobile "Proxy chimik" truck. The truck stops periodically at some 100 locations in Brussels and stays during 45 minutes at the same location. The truck passes once or twice each month depending on the location.

In 2012, the amount of HHW collected via this type of mobile collection was estimated at 0.4 kg / capita. The waste sorting is checked on site in the truck to maximize recovery. From all the hazardous waste collected selectively in Brussels, 79% is incinerated, 11% is landfilled and 10% is recycled.

Conditions for success:

- Strict acceptance criteria to avoid contamination and health hazards, e.g. Liquids and solids need to be brought separated and in their original packaging; if unreadable the name of the product has to be written on the packaging
- Clear instructions to citizens and staff that has received some chemistry training to answer questions accurately
- Brochures, websites and apps to inform citizens about the planning of the mobile pick-ups

[169] http://ec.europa.eu/environment/waste/studies/pdf/household_report.pdf
[170] https://www.arp-gan.be/images/upload/files/Proxy_chimik_2019_BIL_V2_WEB.pdf
https://environnement.brussels/sites/default/files/rie_fr.pdf
http://document.environnement.brussels/opac_css/elecfile/IF_201605_REP-DDM-Fr_1.pdf

- Public financing to keep HHW collection free

➢ *Household cleaner and personal care products*

As they refer to the same categories of waste in the LoW, cleaning products and personal care products (cosmetics, hair dye, nail polish, nail polish remover, etc.) are addressed at the same time. The relevant LoW codes are:

- 20 01 13* - Solvents
- 20 01 14*- Acids
- 20 01 29* - detergents containing hazardous substances

Cleaning products are used daily within households. As they are so common, their hazardous nature is often overlooked. These products may contain solvents, acids/bases, abrasive materials, surfactants, brighteners, perfumes and other elements that can be flammable or corrosive. Should these substances come into contact with human skin and/or eyes, or should they be inhaled, they can be harmful to human health. Some of these substances are also suspected to be carcinogenic.[171]

The collection and treatment of hazardous chemical waste is mainly financed by the public sector (municipalities). In France, an EPR system has been in place since 2011 for hazardous household chemical waste. Within this system, all producers are financially and operationally responsible for the collection and treatment of relevant products (at end-of-life) that they place on the French market.

Treatment: Cleaning and personal care products are either incinerated or reused. A poor or incomplete burning of waste materials can result in environmental and health issues through the release of hazardous chemicals, including dioxins and acid gases. To ensure that hazardous substances are treated as effectively as possible, incineration plants need to burn waste under controlled conditions and at sufficiently high temperatures.

If not incinerated, waste solvents are often used as secondary fuel for cement industry, as in Germany and in the UK. The reuse of personal care products, such as cosmetics, is not a common practice, but some NGO driven initiatives exist.

➢ *Household and garden pesticides*

Under the term 'pesticides' are grouped substances used to suppress, eradicate and prevent organisms that are considered harmful. They include biocidal products and plant protection products (PPPs). The code in the LoW is:

- 20 01 19*- Pesticides

Even though household pesticides are formulated specifically for non-professional/home use, they still contain active ingredients that are toxic to other plants and animals than the targeted pests. Some pesticides can be persistent and

[171] http://ec.europa.eu/environment/waste/studies/pdf/household_report.pdf

bio-accumulative. In terms of human health, they can be harmful if swallowed and irritating to eyes and skin. The risks to health and the environment during the disposal of these products depend strongly upon compliance by consumers with instructions for disposal. [172] [173]

It is not unusual to find in households obsolete pesticides containing active ingredients that have been banned for years due to their initial high toxicity and persistence (e.g. DDT). Packaging labels are sometimes no longer readable, or the packaging itself is no longer strong enough to safely hold the product.

Good practice example

In order to minimize pesticide use and exert more control on the disposal practices, Denmark has imposed an obligatory certificate for professional operators using pesticides[174]

Households can typically deposit garden chemicals at a local CAS.

Treatment: Waste household garden pesticides and chemicals are not usually suitable for recycling and waste management schemes have in general focused on reducing their use and on their correct disposal at end-of-life. In most cases, obsolete pesticides should be destroyed by (expensive) high temperature incineration.

Good practice example

Thanks to engaging communication and user-friendly collection facilities (CAS and periodic pick-ups), Luxembourg collects about 14 tons of waste pesticides, which is about 30 g per person per year[175]

- ***Paints, varnishes, inks, glues and resins***

Waste paints and solvents are a substantial source of HHW. For example, roughly 150 million litres of decorative coatings (all paints and varnishes) are sold in the UK for domestic use each year with, an estimated 25% (38 million litres) remaining unused[176].

Paint and ink are a mixture of solvents, pigments, minerals, resins, surfactants and additives.[177] These decorative coatings can be stored for lengthy periods of time, but ultimately the majority of the surplus is discarded, usually when moving property or during house clearances.

Throughout production, use and end-of-life Volatile Organic Compounds are emitted, especially by solvent-based paints. A fraction of the paint ends up in the sewers and surface water following the cleaning of brushes and buckets. The code in the LoW is:

- 20 01 27* - Paint, inks, adhesives and resins containing hazardous substances

[172] https://www.scribd.com/document/83164241/Household-Report
[173] French Institute of the Environment (2001)
[174] The Chemicals Act, cf. Consolidated Act No. 115 of 26 January 2017, https://danishbusinessauthority.dk/professional-operator-pesticides-fertiliser-sample-expert
[175] SuperDrecksKëscht fir Biirger - https://ec.europa.eu/food/plant/pesticides/sustainable_use_pesticides/nap_en
[176] http://ec.europa.eu/environment/waste/studies/pdf/household_report.pdf
[177] http://ec.europa.eu/environment/waste/studies/pdf/household_report.pdf

Treatment: The most commonly used treatment for end-of-life paint in the EU-28 is incineration, but re-use and recycling also occur. It is estimated that 61% of the 1.6 million tons of waste paint generated every year in Europe is recycled or undergoes energy recovery. In most MS landfilling paints with solvents (20 01 27*), is not authorized. The disposal of solvents in Europe (and of other substances, such as titanium dioxide, used as an opacifier in paints and other products) is regulated by the 2010 EU Industrial Emissions Directive (IED Directive 2010/75/EU)[178].

Good practice example[179]

RePaint is a UK wide paint reuse network, sponsored by Dulux (paint distributor). The aim is to collect leftover paint and redistribute it to the benefit of individuals, communities and charities.

Citizens can dispose of leftover paint via drop off points such as CAS or facilities run by volunteers. After centralization of the collected volumes, the paint will go to one of the two remanufacturing centres, set up in 2015 and 2016 respectively. Leftover paint is reprocessed and turned into ReColour, the network's remanufactured paint brand, which is available in 20 colours and a variety of paint styles.[180] Repaint redistributes the recovered paint into their communities at a zero or low price.

Currently the network in London is made up of over 74 drop-off points and redistributes over 300.000 litres of paint each year. The annual cost of operating a drop-off point can be kept low thanks to the involvement of many volunteers. It costs close to 10.000 euros depending on the scale and location.

Conditions for success*:*

- Strict acceptance criteria to avoid contamination and quality issues with the reprocessed paint, e.g. paint will only be accepted if it still is in its original container.
- A sponsor such as Dulux that brings in expertise, visibility and financing
- The enthusiastic collaboration of voluntary staff

[178] http://www.europarl.europa.eu/EPRS/EPRS-Briefing-564398-Understanding-waste-streams-FINAL.pdf
https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1432715526151&uri=CELEX:02010L0075-20110106
[179] http://ec.europa.eu/environment/waste/studies/pdf/household_report.pdf
https://communityrepaint.org.uk/i-have-leftover-paint/give-leftover-paint-new-life/
Link on the website of city London:
https://www.cityoflondon.gov.uk/services/environment-and-planning/waste-and-recycling/household-waste-and-recycling/Pages/Hazardous-Waste.aspx
http://ec.europa.eu/environment/waste/studies/pdf/household_report.pdf
[180] https://resource.co/article/community-repaint-celebrates-25-years-keeping-paint-going-waste-13158

➢ *Automotive products, surface polish, anti-freeze fluids*

Many chemical automotive products are dangerous for health and the environment. For example, the primary ingredient in anti-freeze is ethylene glycol, a toxic substance. Anti-freeze eventually becomes ineffective in a car/vehicle radiator and needs to be changed. If the resulting waste anti-freeze is dumped on the ground, it can contaminate ground and surface water. The associated LoW codes are :

- 16 01 13* - brake fluids
- 16 01 14*- anti-freeze fluids containing hazardous substances

Automobile repair workshops and parts stores often take back used motor oil and filters. Some petrol stations also accept small amounts of household antifreeze.

Treatment route: Used antifreeze can be recycled, and its original properties can be reclaimed. Recycled antifreeze can be used again as engine coolant or the ethylene glycol can be extracted and reused in the plastics industry.

Motor oil can be filtered and recycled (regenerated), but much oil is lost along the life cycle. For example, only a third of motor oils sold via retailers to Do-It-Yourself motorists (about 16.500 tons) is reported to be recovered in the UK[181]. Improper disposal of waste oil includes pouring waste oil down household drains, pouring it onto the soil, burning it in bonfires or in oil burners, and disposing of the waste oil together with spent filters via the residual waste bin.

➢ *Photochemicals*

This category of hazardous waste has decreased since the appearance of digital photography. Occasionally some households still develop their pictures consuming a high amount of chemicals. Wastewater from the photographic process contains contaminants such as: hydro-quinine, sodium sulfite, silver, mercuric chloride, cadmium, ferrocyanide, acids, and formaldehyde. The types of wastes that are concerned include: process bath wastes, colour developer wastes, bleach, fixer and fixer wastes[182]. All are toxic and highly alkaline. Like other HHW chemicals, photochemicals can contaminate ground and surface water. The code in the LoW is:

- 20 01 17*- Photochemicals

Several MS such as Germany and Denmark have a take-back system that is free of charge for households. It is the owner of the photography shop that is responsible to dispose this waste according to the legislation.

Treatment route: The usual treatment for photochemical waste is recycling which is financially driven by the extraction of silver. Electrolysis is a commonly used, but capital intensive method to recover silver.[183]

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[181] http://ec.europa.eu/environment/waste/studies/pdf/household_report.pdf

[182] https://mde.state.md.us/programs/water/water_supply/Source_Water_Assessment_Program/Documents/www.mde.state.md.us/assets/document/Symposium2006/Sue_Allen_06gws.pdf

[183] https://pdfs.semanticscholar.org/281b/12e7c3f91bb726a70ab2a06831748785f151.pd

Good practice example

Helsinki Region Environmental Services (HSY) has installed 50 centrally located containers in the metropolitan area to collect, free of charge, a wide range of waste streams including HHW.[184] [185] [186] The containers are located at petrol stations, supermarkets and other shops for optimal accessibility. However, to maintain control, the containers are only accessible during opening hours. The HHW allowed are:

- cooling, brake and clutch fluids
- waste oils, oil filters and other oily waste
- solvents such as turpentine, thinner, acetone (also nail polish removers) other
- solvent based washing liquids
- paints, glues, varnish, wood preservative substances
- strong acids such as sulfuric acid
- pressure containers containing gas and that has contained gases
- spray cans
- alkaline washing liquids
- pesticides and disinfectants
- photography chemicals

There are also some HHW that can only be disposed of at CAS: electric and electronic waste (free of charge), impregnated wood (free of charge) and waste containing asbestos (€10 for every 100 litres). Expired medication needs to be brought to pharmacies, free of charge.

For this collection scheme the collaboration with stakeholders such as petrol stations and shops is essential to receive permission to install a container and notifications if issues occur. Moreover, follow-up of reported amenities by local police is needed to keep a support base for the unmanned facilities.

➢ *Non-empty packaging for hazardous waste and other packaging*

Most empty plastic, metal and glass containers that have held hazardous substances such as solvents, acids or bases are recyclable. However, when the packaging is not empty, it is considered as hazardous waste, and must be collected as such. The following categories in the LoW apply:

- 15 01 10* - packaging containing residues of or contaminated by hazardous substances

[184] FI HSY 2015- About HSY, website accessed on 09.10.15 https://www.hsy.fi/en/abouthsy/Pages/default.aspx - http://ec.europa.eu/environment/waste/studies/pdf/Separate%20collection_Final%20Report.pdf

[185] FI Helander 2015- Information provided by e-mail from Merja Helander, Lassila & Tikanoja Plc, 8 October 2015 - http://ec.europa.eu/environment/waste/studies/pdf/Separate%20collection_Final%20Report.pdf

[186] https://lca-consulting.fi/wp-content/uploads/2017/12/Pan_European-Networks.pdf

All empty packaging for households fall under the EPR regulations for packaging waste. Consequently, they are typically integrated in the overall EPR collection scheme. Non-empty packaging would be collected via the CAS or periodic pick-ups.

7.2.2 *Unused pharmaceuticals, medicines*

Households possess and use pharmaceuticals containing antibiotics, hormone replacing drugs, cancer medicines, medicine for depression, etc. There is no Europe-wide overview of amounts of unused pharmaceuticals and their return rate, but the German Umweltbundesamt estimates that in total about 30% of sold amounts are not used and thrown away. A survey within the START project (2008) based on 1.306 interviews in Germany found that 34% never return their unused pharmaceuticals to a pharmacy while the others return them always or at least occasionally.

A lack of understanding about the environmental risks and concerns about the accidental poisoning of children have resulted in practices such as flushing pharmaceuticals down the toilet or via the kitchen sink into the sewage system. Wastewater treatment plants are designed primarily for the removal and treatment of natural human excrements, not the various pharmaceutical substances. Consequently, these substances are potentially discharged to surface waters.[187] The codes in the LoW are:

- 20 01 31* - cytotoxic and cytostatic medicines
- 20 01 32*- medicines other than mentioned in 20 01 31*

Article 127b of Directive 2004/27/EC requires that EU Member States "shall ensure that appropriate collection systems are in place for medicinal products that are unused or have expired." Additionally Article 54j requires that "reference to any appropriate collection system in place shall appear on the outer packaging of medicinal products or, where there is no outer packaging, on the immediate packaging".

Good practice example

In France the organization Cyclamed is financed by producers to coordinate the separate collection[188]. Cyclamed sets up awareness campaigns for patients and partnerships with all actors in the pharmaceutical supply chain. Over 21.000 pharmacies, 200 distributors and 190 laboratories participate in the system. Cyclamed succeeds in collecting 62% of the unused medication. The total collected volume is 10.500 tons or 162 g par inhabitant.

The total cost is around 10 million euro which comes from a contribution by the producers of 0,0032 € per medication box excluding VAT. About 50% of the cost is related to the waste disposal (250 €/ton) that includes the incineration cost (120 €/ton), storage and transport.[189] The procurement of the collection boxes given to

[187] https://www.ncbi.nlm.nih.gov/pubmed/29890607 - An extensive study of German sewage plants for 14 common drugs indicated a range of removal efficiency of 7–96%, depending on the active substance. The average for all 14 drugs was approximately 60%. Other reports indicate removal efficiencies of 38–80%.

[188] Cyclamed (2019)

[189] https://www.cyclamed.org/wp-content/uploads/2019/09/CYCLAMED_INFOGRAPHIE_2018-3-1024x1024.jpg

the pharmacies costs about 25%, communication costs 10% and overall management 5%. The remainder concerns studies, research and miscellaneous.

Most MS' citizens can deposit their expired medicines at pharmacies or CAS[190]. Slovenia and Malta[191] ask citizens to bring the pharmaceutical waste to CAS. In contrast, in the United Kingdom unused pharmaceuticals must be given back to a pharmacy and CAS are not allowed to collect them. Other collection locations applied in the EU include nursing homes and retirement communities. Collection periods vary from 1-day collection events, continuous collection, or periodic gathering.

In order to finance the collection and internalize the costs, several MS have installed Extended Producer Responsibility (EPR) for expired medication[192].

Treatment: collected expired medication is typically incinerated at high temperature.

7.2.3 *Contaminated absorbing materials and used filters*

Car oil filters can originate in household waste when Do-It-Yourself motorists service their own car. For example, in the UK 7 million people service their car at home per annum[193]. These people are estimated to dispose of 1100 tons of oil in spent filters per annum, often via the residual waste bin. The code in the LoW is:

- 15 02 02*- absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by hazardous substances
- 16 01 07*- oil filters

The UK garages and the few CAS that collect oil filters, have drums that are supplied by a waste management company. Many auto repair stations and parts stores take back used motor oil and filters but sometimes ask a fee.

Treatment route: Used oil filters are recyclable because they are made of steel. Any oil that is left in them can be recovered using oil filter presses. They squeeze out the oil and then flatten the remaining metal filter, which can then be recycled with other steel.

7.2.4 *Asbestos waste*

The term asbestos describes a group of naturally occurring mineral silicate fibres of the serpentine and amphibole series. It is a hazardous mineral with a fibrous structure, which produces severe, potentially fatal, long terms health effects when inhaled, including cancer.. It was widely used in the past for insulation and other purposes, owing to its resistance to fire and heat. Directive 1999/77/EC enacted a ban

[190] Health care without harm (HCWH) Europe has produced a database that aims to provide an overview of current and past initiatives by local, regional, and national NGOs, European projects, and national/regional authorities of EU Member States to tackle pharmaceuticals in the environment and pharmaceutical waste: http://saferpharma.org/pie-initiatives-database/?_sft_area_of_interest=unused-expired-pharmaceutical-disposal-practices

[191] WasteServe Malta Ltd

[192] Ademe (2017)

[193] http://ec.europa.eu/environment/waste/studies/pdf/household_report.pdf

on the use of asbestos that has been in place in the EU since 1 January 2005. This ban is currently defined in entry 6 of Annex XVII to the REACH Regulation.

The health effects from long-term asbestos exposure are well documented. Inhalation and ingestion are the primary routes of exposure to asbestos. The WHO estimates that 107 000 global annual deaths are caused by mesothelioma, asbestos-related lung cancer and asbestosis. In 2005, occupational exposure to asbestos was estimated to cause 43 000 mesothelioma deaths and 7000 deaths due to asbestosis worldwide.[195]

Good practice example

The city of London provides an on-demand collection service for wrapped asbestos. Citizens can ask for one subsidized pick-up per year of 15 square meters of asbestos or seven builders' rubble bags picked up at home for free. To optimize the cost efficiency, the service is outsourced to competitively selected private contractors. [194]

From the point of view of Annex III, waste is 'Hazardous Waste' when it contains more than 0.1 % asbestos.

The codes in the LoW are:

- 16 02 12*- discarded equipment containing free asbestos
- 16 02 15*- hazardous components removed from discarded equipment
- 17 06 01*- insulation materials containing asbestos
- 17 06 05*-construction materials containing asbestos

Although production of asbestos is banned in the EU, it is still widely present in a range of products with long life cycles, e.g. materials found in buildings and industrial plants. Citizens engaging in Do-It-Yourself activities also deliver (bound, non-friable) asbestos waste to CAS in different countries.

Treatment: Although there is research for alternative treatment methods, landfilling asbestos waste is still the BAT[196]. Before landfill, additional stabilisation measures can be taken to reduce the risk of release of fibres, the friable asbestos is encapsulated in concrete blocks before landfilling (OVAMb 2016).

[194] https://www.cityoflondon.gov.uk/services/environment-and-planning/waste-and-recycling/household-waste-and-recycling/Documents/asbestos-information-sheet.pdf https://www.cityoflondon.gov.uk/services/environment-and-planning/waste-and-recycling/household-waste-and-recycling/Documents/Chemical-information-sheet.pdf

[195] https://www.who.int/bulletin/volumes/92/11/13-132118/en/

[196] Clearly, landfilling needs to occur in a proper way. In 2016, researchers mapped asbestos landfill sites in Italy and identified inconsistencies in the waste classification. Either waste is categorized correctly but nevertheless disposed of in an unsuitable manner. Or waste is categorized incorrectly, so that hazardous waste is disposed of at non-hazardous landfill sites. Moreover, seven out of 19 Italian landfill sites operating as non-hazardous waste landfills have been authorized by the competent regional/provincial authorities to accept certain types of hazardous waste.
http://ec.europa.eu/environment/integration/research/newsalert/pdf/asbestos_products_waste_new_classification_system_465na3_en.pdf

Good practice example[197]

Flanders has an ambitious policy to become 'asbestos safe' in 2040. One of the policy measures focuses on the collection of non-friable asbestos waste coming from Do-It-Yourself householders (DIY) that renovate their house. DIY can drop off their non-friable (bounded) asbestos via CAS, but can also request a pick-up at home using registered bags that can be bought upfront at the municipality. It is about 30 € for one bag that has the capacity to collect about 20 corrugated corrugated roof plates.

7.2.5 *Treated wood*

Treated waste wood is natural wood that has been impregnated with wood preservatives, such as window frames, exterior doors, wood from awnings and other outdoor applications. Arsenic treated wood (chromated copper arsenate - CCA) has been widely used for outdoor structures, such as decking and playground equipment. However, arsenic is a major pollutant in MSW and ranks high on the list of carcinogens in leachate from landfills, in airborne emissions from incinerators and in ash from MSW incinerators.

The use of classical wood preservatives (CCA, creosote, PCP) has been limited and even banned in some countries, but disposal of the wood that was treated with these preservatives in the past decades is still required[198] [199]. The corresponding LOW code is:

- 20 01 37* - Treated wood

Citizens can take treated wood to the local CAS.

Treatment route: The preferred treatment method of CCA treated wood is incineration with state-of-the-art air pollution control given the volatility of arsenic in flue gas.

7.2.6 *Mercury-containing waste (other than WEEE)*

Mercury is part of the fourteen hazardous substances that were identified as priority substances of concern for MSW disposal based on an emission inventory from landfills

[197] https://www.vlaanderen.be/nbwa-news-message-document/document/090135578024769a

[198] https://www.researchgate.net/publication/279340427_Regulations_in_the_European_Union_with_Emphasis_on_Germany_Sweden_and_Slovenia

[199] A detailed study for the German Environmental Agency (Giegrich et al., 1993) concluded that arsenic is the most important contributor to carcinogenic property of landfill leachate, given the relatively high concentration of 1,6 mg/l in MSW landfills. The study estimates that over a total of 100 years, a 1,2 g arsenic will be emitted per ton of waste, which is equivalent to 24% of the arsenic content of MSW.

and incinerators[200]. Mercury is highly toxic to human and animals, if ingested or inhaled.

Mercury-containing waste from households concerns batteries or thermometers. Dental amalgam is also a source mercury in waste.[201] In the European waste catalogue mercury-containing equipment is included in a waste category together with fluorescent lamps. The LOW code in scope is :

- 06 04 04* - wastes containing mercury *(e.g. thermometers)*

Information of the volumes of mercury-containing waste is difficult to extract since the waste quantities are totally overshadowed in the reporting by the large quantities of waste of fluorescent lamps.

The total consumption of mercury in measuring devices in 2007 in the EU27 was estimated at 7-17 tonnes. The main applications were sphygmomanometers, barometers for households, medical thermometers and thermometers for laboratory and industry applications. However, the presence of mercury in household applications has diminished strongly. The medical thermometers and the majority of the barometers (used in households) are now banned[202], and the mercury consumption for these application ceased in 2009. [203] [204]

Most MS collected this equipment together with other types of hazardous waste and separate it out for recycling afterwards. However, a substantial part of mercury in thermometers and other measuring equipment used in households is disposed of via mixed residual waste.

Treatment route: Hg containing waste would typically be recycled or incinerated in a facility specialized in hazardous waste. Mercury recovery units are found, for example, in Germany, France, Austria, and Sweden.

88 t of mercury enters into the landfills of the EU through waste and residues from waste incineration.[205] Mercury in waste is generally pre-treated to obtain better stability before landfilling.

Trade in mercury is highly regulated and controlled under Regulation (EU) 2017/852 of the European Parliament and of the Council of 17 May 2017. Metallic mercury and Hg-bearing waste can be exported and imported between MS, except for export from Sweden, where it is banned by national legislation.

[200] http://ec.europa.eu/environment/waste/studies/pdf/household_report.pdf
[201] http://ec.europa.eu/environment/chemicals/mercury/pdf/study_report2008.pdf
[202] See 18a, Annex XVII to REACH
[203] https://core.ac.uk/download/pdf/14900221.pdf
[204] http://ec.europa.eu/environment/chemicals/mercury/pdf/study_report2008.pdf
[205] https://core.ac.uk/download/pdf/14900221.pdf

Good practice example[206]

In Odense, Denmark, every household has received a 40-liter red box for storage and transport of hazardous waste. The red box can be collected in four ways:

- collection on demand directly at the household at a fee
- collection at apartment blocks with a mobile truck customized for HHW
- delivery by households to one of two manned HHW reception points
- delivery by households during certain weekends to ordinary CAS

The amount of hazardous waste has been stable for many years in Odense: 300 tons per year corresponding to about 1,6 kg per year and inhabitant. The largest hazardous waste fraction concerns paints and varnishes, which account for 66 to 75 % of the total hazardous waste collected. The rest is a mix of acids, pesticides, spray cans, and various other chemicals.

Since the hazardous waste is delivered to trained staff, the quality and homogeneity of the collected streams are high. The collection of hazardous waste is mainly financed by the general household waste fee paid by all households in the municipality. The cost per inhabitant is approximately 3.3 Euro.

7.2.7 *Coal tar and tarred products*

Coal tar was commonly used as a binder in road construction, prior to being superseded by bitumen. In addition to roads, coal tar was extensively used for other hard structures, such as pavements, carparks and airfields. Wooden railway sleepers have been treated with coal tar creosote, as a preservative, for a long time.. Creosote to treat wood is regulated under Reach annex XVII, entry 31.

Used railway sleepers have been installed as a form of reuse in gardens for example, to stabilize walls or ground, but also in products like coal tarred board. Coal tarred board or roofing felt was used e.g. as part of roofs at garden houses in garden plots. All of these may give rise to considerable amounts of hazardous waste, when being repaired or replaced. [207]

Coal tar is classified as hazardous waste as it contains significant quantities of polycyclic aromatic hydrocarbons (PAHs), a group of carcinogenic compounds[208]. Asphalt waste containing coal tar is considered to be hazardous waste where the level of coal tar is >0.1%, even when they are treated, normally through encapsulation using a cold recycling bound mixture. The code in LoW is :

- 17 03 03* - coal tar and tarred products

[206] https://www.regions4recycling.eu/upload/public/Good-Practices/GP_Odense_hazardous-waste-collection.pdf

[207] http://www.wrap.org.uk/sites/files/wrap/WRAP%20RE%20Case%20Study%20-%20Tar%20Bound%20Planings.pdf

[208] http://adeptus.co.uk/reuse-road-planings-containing-coal-tar-pahs-permit/

The main collection type is via CAS.

Treatment: Depending on the regulations and infrastructure in the MS, this waste category is either thermally treated (incineration) or deposited in landfills.

7.3 Success factors for separate collection of HHW

7.3.1 *Economic incentives*

- Providing safe disposal options for HHW at a low or zero cost increases collection rates
- Making producers responsible for the management of HHW via EPR, ensures sustainable financing of the collection facilities and raises the incentives for eco-design.
- Investigating the opportunities to outsource door-to-door or on demand services for HHW collection to private waste operators can improve the cost efficiency.
- Innovative collection facilities (e.g. trimobiles as used in Paris or customized sea containers as used in Tallinn) can be effective in collection while being cost efficient.

Good practice example[209]

France has introduced EPR obligations to deal with the risks coming from potentially infectious medical products. By collecting medical waste separately, safety hazards and health risks for waste workers can be minimized.

In 2012 the EPR organization DASTRI was set up to collect the home generated medical sharps via collection points across France. DASTRI provides patients with dedicated containers called "Needle Boxes". The free distribution of needles is a regulatory obligation on the part of pharmacies. These special containers, once filled, are collected at participating pharmacies and safely disposed.

89% of patients claim to sort and store their used needles in a dedicated container, of which 81% of patients bring their container to a DASTRI collection point. In 5 years, 10 million sharps containers have been distributed to the patients and in 2016, 77% of the sharps have been safely collected and treated.

Similarly, the EPR organization Cyclamed has been set up to collect and safely dispose of unused medication. In 2017, just over 13 tons of expired medication were collected in Paris. [210]

[209] https://www.morressier.com/article/dastri--unique-system-collect-patients-medical-sharps-waste/59d51841d462b80296ca2e25

[210] https://www.paris.fr/services-et-infos-pratiques/environnement-et-espaces-verts/dechets/la-collecte-44#rapports-annuels-sur-le-prix-et-la-qualite-du-service-public-de-gestion-des-dechets-a-paris_9

7.3.2 *Legal Enforcement*

- A legal obligation to foresee infrastructure for sorting at source in apartment buildings, incentivizes the manager or syndicus to take action. Combining such an obligation with hands-on support services (on-site visit, communication templates) enhances sorting of HHW in apartment blocks.
- By taking samples and monitoring the concentrations and types of HHW in residual waste, local authorities can identify priorities focus their attention.
- By investigating fly-tipped waste, traces of the waste producer can (sometimes) be found. Penalization or the risk of penalization induces behavioural change.

7.3.3 *Customized facilities*

- CAS are key collection facilities for the large diversity of potential HHW streams, but user-friendliness is key: long opening hours, accessible location and a high density CAS grid increase the collected HHW volumes.
- If door-to-door services are provided for HHW, the collection costs increase, but the collection rates also, especially in high density areas.
- Periodic pick-ups and mobile CAS can overcome space constraints in high density areas. However, the periodicity and location of the collection facilities need to be well communicated via conventional channels as well as by user-friendly digital tools to make it as easy as possible for householders to return HHW.
- In addition to CAS and periodic pick-ups, local authorities and EPR collection schemes can foresee user-friendly collection channels via in-shop take-back and on-demand collection at home.
- For certain HHW such as asbestos, local authorities can minimize health risks and illegal disposal by providing stream-specific services, e.g. collection of bound asbestos at home in a standardized packaging.
- Although the costs will differ substantially depending on the stream and the location, the following cost ranges give an indication of the order of magnitude: CAS: 0,1-1,7 €/kg; door-to-door: 1,7-10 €/kg; take-back systems: 2-3 €/kg; Mobile pick-ups: 2-10 €/kg[211]. Municipalities from different European countries report that the overall cost for hazardous waste management ranges between 200 and 2000 €/ton[212].

Good practice example[213]

In addition to the existing CAS and collection on demand, the "Trimobiles" (mobile CAS) offer the citizens of Paris a user-friendly way to collect HHW. The Trimobiles (car on three wheels) can be transformed in less than one hour into a CAS for HHW. In 2012, the network consisted of 6 sets of mobile CAS that were used on 30 different locations.

[211] European Commission (2002a)
[212] European Commission (2002b), OVAM (2010)
[213] http://www.regions4recycling.eu/upload/public/Good-Practices/GP_ORDIF_mobile-CAS.pdf

The mobile CAS stays at the same public location for a half day. The frequency of opening depends on local circumstances and varies from once to seven times a month. Several fractions can be collected including construction and demolition waste, WEEE and wood.

The service is provided for free to citizens. Waste from companies is not accepted.

The implementation of mobile CAS has been rapid and successful: in the targeted areas 65% of all collected HHW comes from the Trimobiles. In 2017, 323 tons of hazardous waste were collected.[214]

The cost per ton is about 300 €/ton, while the cost of a traditional CAS is assessed at about 75 €/ton in Paris. The system is mainly funded by the local authorities and amounts to about 2 € per capita for both the mobile and traditional CAS. The EPR scheme for WEEE provides a small part of the overall financing.

Good practice example[215]

Tallinn uses reconditioned sea containers that are fitted with shelves, drawers and other reservoirs to receive HHW to optimize cost efficiency while going closer to the citizens. The sea containers that are placed at central locations, contributed to the increase in collection from 12 tons (0,03 kg/cap/year) in 2000 to 158 tons (0,4 kg/cap/year) in 2013. In addition, the quality of materials received in the collection points is good.

The cost of one sea container (collection point) varied from 3 700 € to 4 500 € in 2005 depending on the size of the container (20-30 m^3). The cost for managing a single collection point ranged from 46 € per month in 2004 to 70 € per month in 2013.

7.3.4 *Engaging communication*

- By training staff at CAS, the quality of the recovered resources improves as well as the credibility vis-à-vis households
- In order to reach all segments of the population and to strengthen the message, local authorities and EPR compliance organizations should communicate the instructions and available facilities for HHW via different channels including social media.
- By involving local stakeholders (neighborhood associations) and social groups (disabled workers…) in the collection of HHW, awareness and engagement of citizens will improve.

214 http://filer.paris.fr/parisfr/rapport_sur_le_prix_et_la_qualite_du_service_public_de_gestion_des_dechets_2017.pdf

215 https://www.regions4recycling.eu/upload/public/Good-Practices/GP_Tallinn_hazardous-waste-collection.pdf

- Children have a high impact as recycling ambassadors. By educating children on the importance and instructions to collect HHW (courses, site visits, …) older generations will be indirectly incentivized to sort waste.
- Local authorities and EPR compliance organizations should use simple messages in their communication to avoid confusion of consumers faced with the broad range of HHW.
- Sorting behavior can be encouraged by highlighting the hazards of throwing HHW in sewers or other inappropriate disposal routes.

Good practice examples[216]

There are many examples of engaging communication tools and documents available:

- *http://www.epa.ie/pubs/reports/waste/wpp/Household_%20hazardous_waste_booklet.pdf*
- *http://www.snaga.si/en/separating-and-collecting-waste/hazardous-household-waste*
- *https://communityrepaint.org.uk/help-support/paint-calculation/*
- *https://communityrepaint.org.uk/i-have-leftover-paint/give-leftover-paint-new-life/*
- *https://www.ademe.fr/sites/default/files/assets/documents/produits-chimiques-donnees2015-synthese_8907.pdf*
- *https://www.aha-region.de/entsorgung/oeffnungszeiten/?L=0*
- *https://www.aha-region.de/entsorgung/sonderabfall/*
- *https://www.arp-gan.be/pdf/memo_tri.pdf*
- *https://www.cityoflondon.gov.uk/services/environment-and-planning/waste-and-recycling/household-waste-and-recycling/Documents/asbestos-information-sheet.pdf*
- *https://www.cityoflondon.gov.uk/services/environment-and-planning/waste-and-recycling/household-waste-and-recycling/Documents/Chemical-information-sheet.pdf*
- *https://www.est-ensemble.fr/decheteries-mobiles*
- *https://www.hsy.fi/en/residents/sorting/instructions/hazardouswaste/Pages/default.aspx*
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- *https://www.kierratys.info/*
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- *https://www.tallinn.ee/eng/A-Guide-to-Sorting-Waste*
- *www.dastri.fr*
- *www.raportaredeseuri.ro*
- *http://geodechets.fr*

[216] https://www.regions4recycling.eu/upload/public/Good-Practices/GP_Tallinn_hazardous-waste-collection.pdf

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8 Annex

Household waste – separate collection schemes in the 28 European Capitals (2013)

Legend:

- *Bring collection point: BCP*
- *Civic amenity Site: CAS*
- *Door-to-door collection: DtD*
- *Deposit refund system: DRS*
- *Mobile collection stations: MCS*

	Amsterdam	Vienna	Brussels	Sofia	Prague	Berlin	Copenhagen
City	799.345	1.741.246	1.154.635	1.256.667	1.243.201	3.398.526	570.171
Paper							
Type of collection system	BCP, CAS	DtD, BCP, CAS	DtD	BCP	BCP, CAS	DtD	DtD, CAS
NB collection	3.000	92.178	539.702	166	3.316	-	
Population per collection point	266	19	2	7.570	375		
Total collected in	19.752	127.062	40.886	64	22.870	170.992	18.318
Collected in t per 100.000 inhab.	2.471	7.297	3.541	5	1.840	5.031	3.213
Glass							
Type of collection system	BCP	DtD, BCP, CAS	BCP	BCP	BCP, CAS	DtD BCP	BCP, CAS
NB collection	3.000		560	166	3.316	-	2.326
Population per collection point	266		2.062	7.570	375		245
Total collected in	15.827	28.213	20.327	82	16.260	66.607	8.270
Collected in t per 100.000 inhab.	1.980	1.620	1.760	7	1.308	1.960	1.450
Plastic							
Type of collection system	BCP	DtD, BCP, CAS	DtD	BCP	BCP, CAS	CAS	DtD, CAS
NB collection	226	7.818	-	166	3.316	15	17
Population per collection point	3.537	223		7.570	375	226.568	33.539
Total collected in	723	9.934	12.927	73	12.101	85.377	1.502
Collected in t per 100.000 inhab.	90	571	1.120	6	973	2.512	263
Metal							
Type of collection system	CAS	DtD, BCP, CAS	with plastic	with plastic	CAS	with plastic	DtD, CAS
NB collection	6	3.738			16		
Population per collection point	133.224	466			77.700		
Total collected in	104	12.360			818		4.461
Collected in t per 100.000 inhab.	13	710		0	66	0	782
Bio-waste							
Type of collection system	CAS	DtD, BCP, CAS	DtD	None	CAS	DtD	CAS
NB collection	6	83.318	-		16	1	17
Population per collection point	133.224	21			77.700	4.248.158	33.539
Total collected in	3.780	106.590	1.267		4.520	75.942	12.758
Collected in t per 100.000 inhab.		6.121	110	0	364	2.235	2.238
Household hazardous							
Type of collection system	CAS	CAS	CAS	CAS	CAS	CAS	CAS
NB collection	6	18	2	4	16	15	17
Population per collection point	133224	96736	577318	314167	77700	226568	33539
Total collected	-	6164	-	1885	-	-	-
Collected per 100.000 inhab.	-	354	-	150	-	-	-

	Tallinn	Madrid	Paris	Athens	Dublin	Budapest	Rome
City	419.830	3.165.235	2.274.880	664.046	527.612	1.744.665	2.863.322
Paper							
Type of collection system	DtD, CAS, BCP	BCP	DtD	DtD, BCP	DtD, BCP, CAS	DtD, BCP, CAS	DtD, BCP, MCS
NB collection	300	10.498		115	11	316	16.818
Population per collection point	1.399	302		5.774	47.965	5.521	170
Total collected in	32.006	36.369	54.548	35.737	21.716	19.627	254.386
Collected in t per 100.000 inhab.	7.624	1.149	2.398	5.382	4.116	1.125	8.884
Glass							
Type of collection system	DtD, CAS, BCP	BCP	DtD, BCP	DtD, BCP	DtD, BCP, CAS	BCP, CAS	DtD, BCP
NB collection	300	6.044	946 BCP	677	100	429	16.708
Population per collection point	1.399	524		981	5.276	4.067	171
Total collected in	25.163	40.334	66.889	6.114	9.565	5.524	14.245
Collected in t per 100.000 inhab.	5.994	1.274	2.940	921	1.813	317	497
Plastic							
Type of collection system	BCP, DRS	DtD, BCP	DtD	DtD	DtD, CAS	DtD, BCP, CAS	DtD, BCP
NB collection	300	-		-	10	316	-
Population per collection point	1.399				52.761	5.521	
Total collected in	12.629	64.316	3.854	6.369	4.520	9.705	34.319
Collected in t per 100.000 inhab.	3.008	2.032	169	959	857	556	1.199
Metal							
Type of collection system	BCP, DRS	with plastic	DtD	DtD	DtD, BCP, CAS	with plastic	with plastic
NB collection	300			-	43		
Population per collection point	1.399				12.270		
Total collected in	3.940		1.018	1.501	1.226		
Collected in t per 100.000 inhab.	938	0	45	226	232	0	0
Bio-waste							
Type of collection system	DtD	N/A	BCP, CAS	DtD	DtD, CAS	DtD	DtD, BCP, CAS
NB collection	1		196	-	10	-	-
Population per collection point	419.830		11.607		52.761		
Total collected in	573		3.608	214	15.290	21.567	140.297
Collected in t per 100.000 inhab.	136	0	159	32	2.898	1.236	4.900
Household hazardous							
Type of collection system	CAS	CAS	CAS	CAS	CAS	CAS	CAS
NB collection	5	16	9	0	10	16	15
Population per collection point	83966	197827	252764		52761	109042	190888
Total collected	-	6986	-	-	-	-	-
Collected per 100.000 inhab.	-	221	-	-	-	-	-

	Vilnius	Luxembourg	Riga	Valletta	Warsaw	Lisbon	Bucharest
City	537.152	107.340	643.368	412.985	1.724.404	511.667	1.919.352
Paper							
Type of collection system	DtD, BCP, CAS, DRS	DtD, BCP, CAS	DtD	DtD, BCP, CAS	DtD	DtD, BCP, CAS	BCP
NB collection	-	63	-	405	-	479	988
Population per collection point		1.704		1.020		1.068	1.943
Total collected in	6.894	8.014	33.240	1.620	2.999	14.868	8.413
Collected in t per 100.000 inhab.	1.283	7.466	5.167	392	174	2.906	438
Glass							
Type of collection system	DtD, BCP, CAS, DRS	DtD, BCP, CAS	DtD	DtD, BCP, CAS	DtD	DtD, BCP, CAS	BCP
NB collection	-	62	-	405	-	1.357	988
Population per collection point		1.731		1.020		377	1.943
Total collected in	6.732	4.761	3.345	2.294	9.112	9.593	3.282
Collected in t per 100.000 inhab.	1.253	4.435	520	555	528	1.875	171
Plastic							
Type of collection system	DtD, BCP, CAS, DRS	DtD, CAS	DtD	DtD, BCP, CAS	DtD	DtD, BCP, CAS	BCP
NB collection	-	1	-	405	-	479	988
Population per collection point		107.340		1.020		1.068	1.943
Total collected in	2.734	1.203	20.550	884	1.152	9.035	9.202
Collected in t per 100.000 inhab.	509	1.120	3.194	214	67	1.766	479
Metal							
Type of collection system	DtD, BCP, CAS, DRS	with plastic	-	DtD, BCP, CAS	DtD	with plastic	BCP
NB collection	-		-	405	-		988
Population per collection point				1.020			1.943
Total collected in	4.550		-	1.236	145		915
Collected in t per 100.000 inhab.	847	0		299	8	0	48
Bio-waste							
Type of collection system	CAS	DtD, BCP, CAS	-	CAS	DtD	DtD	-
NB collection	5		-	5	-	-	-
Population per collection point	107.430			82.597			
Total collected in	8.320	5.541	-	1.042	15.344	238	-
Collected in t per 100.000 inhab.	1.549	5.162		252	890	47	
Household hazardous							
Type of collection system	CAS	CAS	CAS	CAS	CAS	CAS	CAS
NB collection	5	1	3	5	2	28	0
Population per collection point	107430	107340	214456	82597	862202	18274	
Total collected	-	-	-	-	90	-	-
Collected per 100.000 inhab.	-	-	-	-	5	-	-

	Stockholm	Ljubljana	Bratislava	London	Nicosia	Helsinki	Zagreb
City	897.700	309.261	415.589	8.173.941	55.014	1.090.616	790.017
Paper							
Type of collection system	BCP, CAS	DtD, CAS, BCP	BCP, CAS	DtD, BCP, CAS	DtD	DtD, BCP, CAS	BCP, CAS, DRS
NB collection	269	7.877	5.608		-	135	4.274
Population per collection point	3.337	39	74			8.079	185
Total collected in	59.865	12.676	7.701	366.330	1.065	66.002	62.762
Collected in t per 100.000 inhab.	6.669	4.099	1.853	4.482	1.936	6.052	7.944
Glass							
Type of collection system	BCP, CAS	BCP, CAS	BCP, CAS	DtD, BCP, CAS	BCP	DtD, BCP	BCP, CAS, DRS
NB collection	269	7.877	3.862	1.692	115	130	4.274
Population per collection point	3.337	39	108	4.831	478	8.389	185
Total collected in	55.232	5.087	6.375	136.422	430	3.200	33.146
Collected in t per 100.000 inhab.	6.153	1.645	1.534	1.669	782	293	4.196
Plastic							
Type of collection system	BCP, CAS	DtD, CAS, BCP	BCP, CAS	DtD, BCP, CAS	DtD	-	BCP, CAS
NB collection	269	7.877	5.492	1.692	-		4.274
Population per collection point	3.337	39	76	4.831			185
Total collected in	7.068	13.119	3.907	57.731	692	-	22.277
Collected in t per 100.000 inhab.	787	4.242	940	706	1.258		2.820
Metal							
Type of collection system	BCP, CAS	with plastic	CAS	DtD, BCP, CAS	with plastic	DtD, BCP, CAS	CAS, DRS
NB collection	269		13	1.692		135	5
Population per collection point	3.337		31.968	4.831		8.079	158.003
Total collected in	9.333		170	44.118		4.362	1.524
Collected in t per 100.000 inhab.	1.040	0	41	540	0	400	193
Bio-waste							
Type of collection system	DtD, CAS	DtD, CAS	CAS	DtD, CAS	-	DtD, CAS	DtD, CAS
NB collection	15	2	13	35	-	5	5
Population per collection point	59.847	154.631	31.968	233.541		218.123	158.003
Total collected in	23.628	23.656	1.795	310.617	-	46.449	249
Collected in t per 100.000 inhab.	2.632	7.649	432	3.800		4.259	32
Household hazardous							
Type of collection system	CAS	CAS	CAS	CAS	CAS	CAS	CAS
NB collection	15	2	13	35	1	5	5
Population per collection point	59847	154631	31968	233541	55014	218123	158003
Total collected	3592	140	-	-	-	-	-
Collected per 100.000 inhab.	400	45	-	-	-	-	-

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