COLLECTORS
WASTE COLLECTION SYSTEMS ASSESSED AND GOOD PRACTICES IDENTIFIED

D4.5. Guidelines for successful implementation

Guidelines for improving local waste collection systems

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Credits

Disclaimer

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Contents

Glossary

BB: bring bank

CAS: civic amenity sites

CDW: construction and demolition waste

DtD: door-to-door

EEE: electrical and electronic equipment

GDP: Gross Domestic Product

GWP: global warming potential

HDPE: high-density polyethylene

IT: information technology

KAYT: know-as-you-throw

LDPE: Low-density polyethylene

MCDM: multi-criteria decision making

MS: member states

NGO: Non-governmental organisation

PAYT: pay-as-you-throw

PC+P+M+C: paper/cardboard+plastic+metal+drinking cartons

PET: Polyethylene terephthalate

PMC or P+M+C: plastic+metal+drinking cartons

PP: Polypropylene

PPW: paper and packaging waste

PRO: producer responsibility organisation

RFID: Radio-frequency identification

WEEE: waste electrical and electronic equipment

Executive summary

Municipal waste management: guiding principles

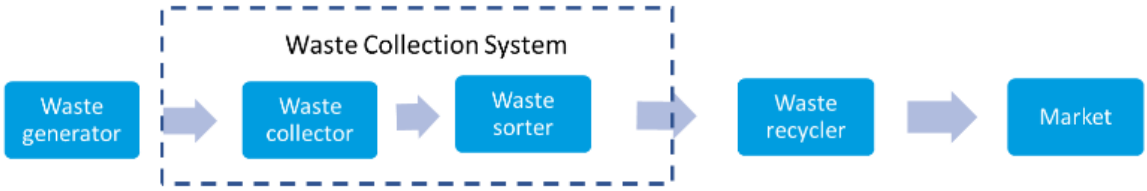
RECOMMENDATION 1: FOLLOW THE WASTE HIERARCHY

The environmental impacts associated with the production and consumption of products are generally significant compared to the ones associated with their end-of-life. While improving waste collection and recycling yields significant benefits, **prevention and re-use** represents the most relevant actions to mitigate the environmental impact linked with material resources.

Therefore, it is of utmost importance to ensure that the waste collection system consider this aspect e.g. by **promoting waste prevention as much as separate collection**, or by **including re-use schemes and organisations within the waste collection system.**

RECOMMENDATION 2: ALIGN WASTE COLLECTION SYSTEMS WITH THE RECYCLING VALUE-CHAIN

Waste collection systems should not be regarded as "insulated systems": one of their purposes is to provide quality materials in-line with recyclers' requirements, so that it can meet the demands of the end-users.



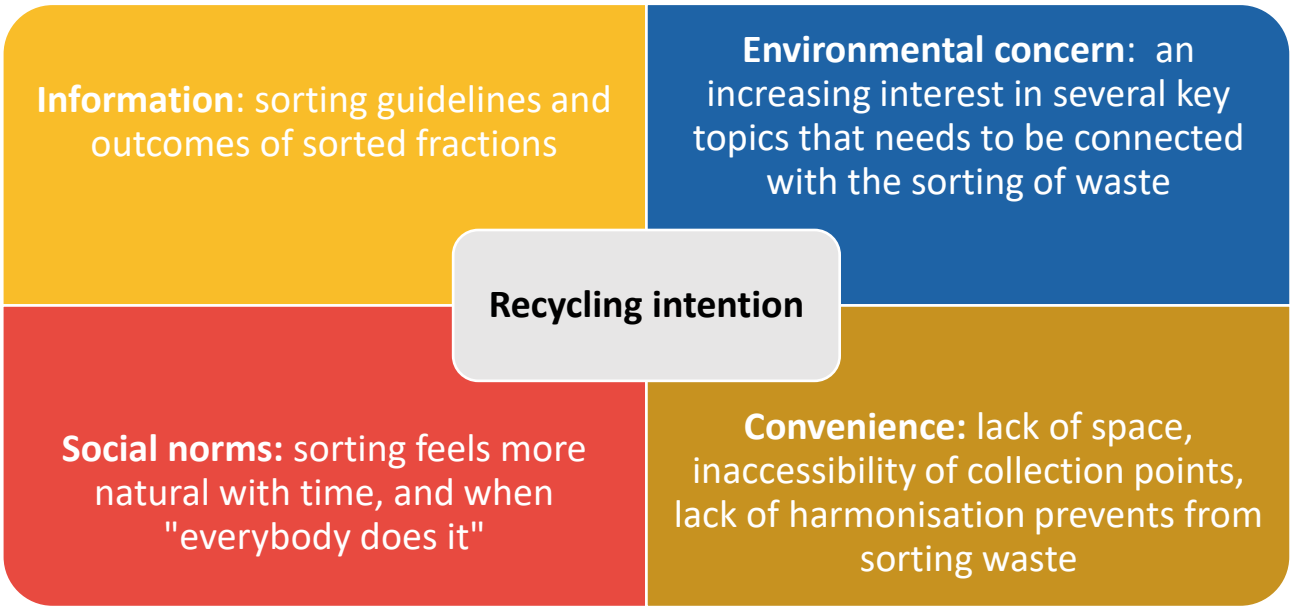
Three factors enable waste collection systems to create more value for the whole recycling value chain:

- **Traceability of the collected waste**: it is important to ensure that recyclers can obtain information on the sorted materials, as well as that there is a proper reporting of collected streams;
- **Supply of collected waste**: the collection system must aim at optimising capture rates to ensure a consistent supply of sorted material;
- **Quality of the sorted waste**: the sorted waste must meet some quality requirements to enhance recycling into marketable secondary materials.

Among these factors, quality seems to be the dominant one for enhancing the performance of the recycling value chain, by unlocking higher quality recycling.

RECOMMENDATION 3: SECURE THE PARTICIPATION OF CITIZENS

The intention to sort waste is mostly conditioned by four factors.



- **Information**: both the practical sorting guidelines and information on what happens to the sorted waste are important. Information should be easily accessible, distributed in a pro-active manner, clear, harmonised, and consistent, and adapted to the different target groups;
- **Environmental concerns**: an increasing number of people consider the environmental concern as an overarching factor. The positive outcome of their individual sorting behaviours on major environmental issues such as climate change should be highlighted;
- **Social norm:** when the waste collection system is properly implemented and most inhabitants participate, waste sorting actually becomes a part of local life and thus becomes a social norm that citizens are expected to follow.
- **Convenience:** waste collection systems must provide a convenient system limiting as much as possible the effort required to properly sort waste by ensuring the accessibility of collection points, taking into consideration the possible lack of space e.g. in vertical housing, and preventing possible nuisances.

It is also recommended to get a better hindsight on the population's perspective on waste management to understand their knowledge and motivations through regular surveys.

RECOMMENDATION 4: IMPROVE WASTE COLLECTION STRATEGIES THROUGH MULTI-CRITERIA DECISION MAKING

The principle of MCDM is to break down complex challenges into more comprehensive components. This allows assessing different dimensions of the problem one at a time, through a collaborative approach.

MCDM processes consist in several successive steps:

Definition of the problem

- The definition of a **general objective** for the decision-making exercise
- **The division in sub-objectives** reflecting different (technical, environmental, etc.) dimensions
- **The definition of criteria** that describe the performance of the different alternatives being compared, reflecting the selected dimensions.

Data collection stage

- Defining the different **alternatives** considered for the decision
- Collecting **data and information** to document these alternatives
- Creating a **matrix** to describe the performances of the alternative for the different dimensions.

Decision-making stage

- Assessing and measuring the **decision-makers' preferences** regarding the criteria weights
- Depending on the selected MCDM method, **further preferences** regarding the values of the criteria performances can be elicited.
- **Ranking** the different alternatives according the selected method.

It is recommended to consider the following clusters of criteria for MCDM applied to waste management:

Capture and recycling rates	How much waste is sorted/recycled compared to the quantities sent to disposal
Degree of separation and quality	Level of contamination and discarded quantities from the different sorting stages
Convenience and coverage of collection	Proximity and visibility of collection points, coverage of door-to-door schemes
Engagement and participation	Existence of feedback-gathering mechanisms, reach of communication actions
Environment, health and safety	Impact on climate change or local pollution
Socio-economic impacts	Costs, job creation

Paper and packaging waste (PPW)

ASSESSING THE SITUATION AND MONITORING

Improving local waste collection systems starts from a proper assessment of the initial situation, regarding the level of performances, but also regarding the current organisation of waste collection. Assessing the situation can be done by comparing the performances with legal targets, or by comparing performances with other "comparable territories".

Comparisons should take into account the following elements:

- **Local data might be calculated in an inconsistent way:** it is important to collect information on the definition of the indicators along with quantitative data;
- **The scope of PPW might be very inconsistent:** whether commercial PPW is included, the share of commercial PPW in municipal PPW, or the existence of parallel collection schemes can make comparisons less relevant.
- **The contexts can also impact the performances:** several contextual parameters are important to consider, such as population density, GDP per inhabitant, the number of overnight stays per resident population, or the share of secondary residences;

Waste fraction	Main contextual parameters for PPW production and capture rates
Glass packaging	Glass generation is significantly higher in territories with very high tourism activity, and high-density areas, and lower Glass generation tends to be lower in low-GDP areas, in low density areas, and in places in places with a parallel deposit-refund system (DRS)
Paper and cardboard	P/C generation tends to be higher in high-GDP areas and lower in low-GDP areas P/C generation tends to be higher in low density areas
Plastic packaging	Plastic packaging generation tends to be significantly higher in territories with very high tourism activity.
Capture rates	Capture rates tend to be lower in high-densely populated areas, and in low GDP areas

Key indicators to assess and compare different waste collection systems can be recommended:

Cluster	PPW Criteria	Comments
Capture and recycling rates	Capture rates of plastic, paper & cardboard, glass and metal	Recycling rates should be preferred to capture rates since they also include information on the quality of sorted fractions. If no data on quality is available, capture rates can be used along with information on quality requirements.
	Shares of PPW in mixed residual waste	This gives an indication on the unsorted quantities and the potential for improvement.
Engagement & participation	Citizen satisfaction	Establishing methods for systematic feedback collection is necessary for understanding the needs of the users, and evaluating their participation and acceptance.
Socio-	Annual waste fee per	Comparing the value of the annual waste fee per capita or

economic impacts	capita or per household, (€/capita or €/household)	per household across different territories might be difficult to do in a consistent way. It can be relevant to also identify how much the waste fees cover the collection costs
	Operational costs (€/tonne): collection and sorting costs for PPW, collection and treatment cost for residual waste	Data on collection and processing costs are generally calculated in heterogeneous ways or might reflect different costs (technical costs if reported by the operator of the collection, or cost charged by the subcontractor if reported by a local authority not operating the collection). However, comparing technical costs of two alternative scenarios is relevant if the costs are assessed and presented in a consistent manner.
	Employment impacts (no. of direct jobs)	Employment can be relevant to local elected representatives. However, data is generally limited and it might have trade-offs with cost-efficiency and productivity.
Convenience & coverage	Proximity (no. of bring points, door-to-door coverage and distance to bring points)	Data such as the number of bring points per inhabitant is generally highly valued by decision-makers and might give a first good indication on the convenience of the collection system.

To conduct comparisons, individual factsheets presenting the waste management organisation and performances of all the documented waste collection systems are accessible on the COLLECTORS webplatform.

SETTING PRIORITIES

The new EU packaging Waste Directive has set ambitious targets, along with a new calculation method excluding contamination from the recycling figures. The COLLECTORS project assessed the corresponding collection targets required to reach them.

Fraction	Recycling target in 2030	New calculation points	Associated collection targets for 2030
Glass	75%	Input of a glass furnace, or the production of filtration media, abrasive materials, glass fibre insulation and construction materials.	94%
Ferrous Metal	80%	Input of a metal smelter or furnace.	-
Aluminium	60%		64%
Paper and cardboard	85%	Input of a pulping operation	86%
Plastics	55%	Plastic separated by polymers entering pelletisation, extrusion, or moulding operations; or plastic flakes input in their use in a final product.	76%

The different PPW fractions yield different benefits regarding quantities, costs, and environmental impact. The potential environmental benefits arising from the improvement of the capture rate or of the quality of the sorted fractions also differ from one PPW fraction to another:

Waste fraction	Associated benefits	Environmental benefits from improving the sorted quantities or its quality
Glass packaging	Large quantities, lower collection and processing costs compared to the other PPW fractions, and possibly to residual waste	Comparable benefits
Paper and cardboard		More benefits from improving capture rates
Plastic packaging	Higher impact on climate change, especially for plastics	More benefits from improving quality
Metal packaging		More benefits from improving capture rates

These considerations have to be regarded as average situations; A case-by-case evaluation of the optimal measures to improve waste collection, sorting, and recycling activities is, therefore, recommended.

IMPROVING CAPTURE RATES AND QUALITY

Waste collection systems should be adapted to the specific contexts where they are implemented, meaning that different collection modes should be defined depending on the typologies of the different areas of one given territory. The main recommendations to improve capture rates and quality are the following:

SEPARATION SYSTEM

- Source separation is highly recommended for glass packaging, and paper and cardboard;
- No notable difference could be identified between systems separating glass by colours and systems collecting all different colours of glass together when it comes to capture rates and quality;
- For plastic, metal, and drinking cartons, no evidence could be found on the advantage of source-separation over co-mingled collection;
- Collecting all types of plastic packaging together, possibly with metal and drinking cartons, seems relevant if the sorting processes are adapted accordingly.

COLLECTION MODES

- Every collection mode has advantages and drawbacks. Door-to-door systems are usually perceived as more convenient and associated with higher participation rates, but might also be more expensive and space-consuming for households. Bring bank systems can be seen as more flexible for inhabitants and less expensive, but might lead to less participation and higher contamination;
- For glass packaging, bring bank systems slightly lower capture rates than door-to-door systems, however the quality is higher in average;
- For plastic packaging, both the capture rates and quality obtained with door-to-

door systems seem higher than with bring bank systems;
- Reducing collection frequency of residual waste can have a positive impact on the capture rate of door-to-door systems;
- To be effective, bring systems needs to ensure a good proximity and visibility of bring points, along with strategic location (next to shops, public buildings, schools, or on the way to transport hubs);
- In very dense area where there is limited available space, combining a door-to-door system with punctual or permanent bring points can contribute to improve the sorted quantities.

Figure 1: one of the eco-station in Parma (source: G. Folli, 2016)

INCENTIVES

- Strong incentivising instruments such as pay-as-you-throw (PAYT) schemes or sorting obligations are highly recommended to improve sorting performances;
- PAYT systems can be implemented in various manners, depending on the context and typology of housing. Such implementation requires significant efforts on communication, and a close monitoring of contamination and illegal behaviours. These side effects tend to decrease over time;
- Alternatively, “know-as-you-throw” systems where individual sorting behaviours are monitored to provide individual feedback can be implemented.

IMPLEMENTING CHANGES

- **Assess the impact of changes on the following elements**: available space in households and buildings, additional time and efforts for inhabitant to comply, and accessibility of collection points, if any;
- Focus communication on the **practical modifications and implications on inhabitants, and on the reasons behind the changes**. Direct communication activities (e.g. door-to-door campaign) can be recommended to ensure that the information reaches the inhabitants;
- Monitor the participation and reception of the changes, through a **feedback-gathering mechanism** (e.g. webpage or phone number to address complaints).

TOWARD A CIRCULAR ECONOMY APPROACH

As for the alignment of PPW collection systems with the rest of the value-chain, the following recommendations can be formulated:

- Easily sortable fractions, such as PMC, can be collected together without hindering the quality of the separated fractions; however, glass and paper/cardboard should be source-separated to secure the quality.
- The number of collected materials for each stream should be limited ("do's and don'ts) to allow more homogeneous fractions.
- Ensure the alignment of the various steps: collection, sorting, and recycling, by:
  - Making clear agreement on the scope of each fraction;
  - Securing the transfer of information between the consecutive steps;
  - Ensuring clarity on the specifications for the outputs of collection, sorting, and recycling;
- Control the quality of the collected fractions, by using transparent equipment, asking collection operators to visually check the quality of the content of the sorted fractions before collection, and organising punctual controls of the content of the bins with corrective actions (information on sorting guidelines, or fines).

ECONOMIC BALANCE OF WASTE COLLECTION SYSTEMS

The analyses conducted by COLLECTORS and the review of previous studies highlighted the following elements:

- Collection and processing of PMC is generally the most expensive fraction per unit of mass, while costs per tonne for glass and paper cardboard are comparably less expensive, and cheaper than the cost per tonne for residual waste collection and treatment;
- For most case studies, the waste fee paid by the inhabitants is the main source of incomes for the waste management of paper and packaging waste;
- For all five case studies increasing the separate collection of PPW lead to higher collection costs, that were compensated by increasing revenues and savings on treatment costs for residual waste. Therefore, the waste fees remained stable, or decreased;
- Based on available data from France and the Netherlands, it appears that bring bank systems seem to be cheaper options for glass and PMC.

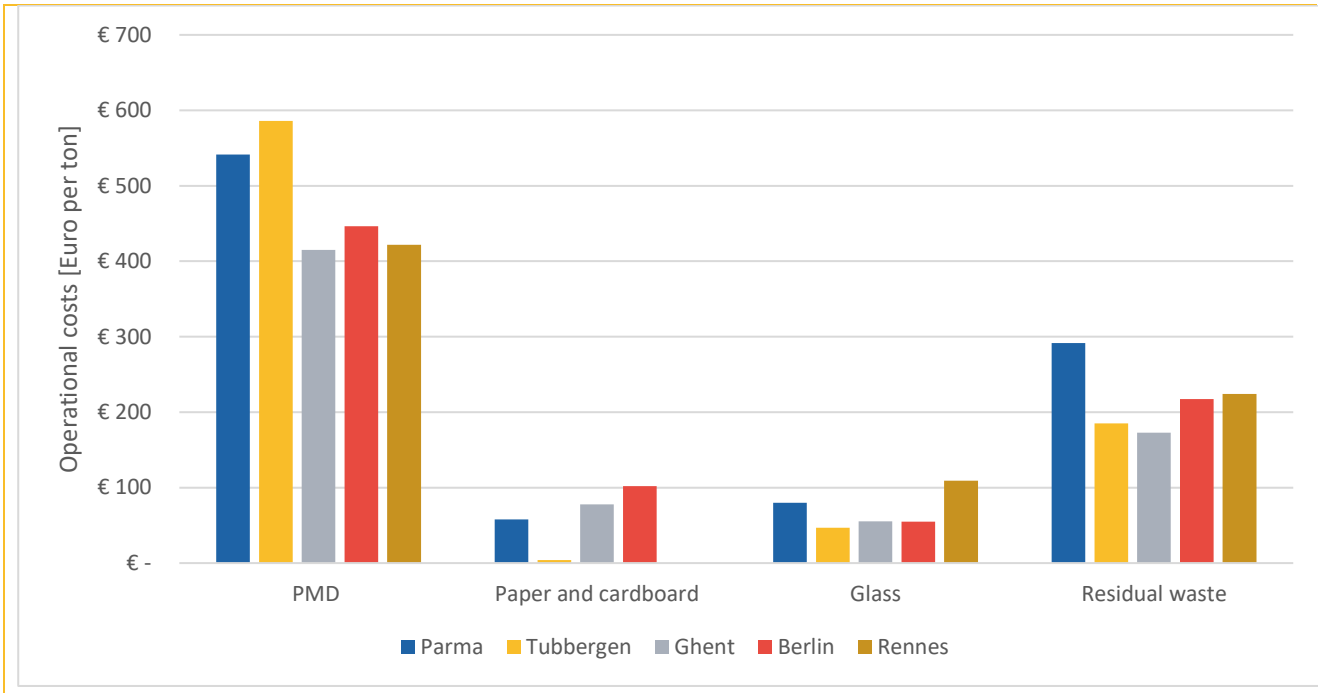


Figure 2: Operational costs per tonnes for each PPW stream, for the documented case studies

Waste Electrical and Electronic Equipment

ASSESSING THE SITUATION AND MONITORING

Improving local waste collection systems starts from a proper assessment of the initial situation, regarding the level of performances, but also regarding the current organisation of waste collection. Assessing the situation can be done by comparing the performances with legal targets, or by comparing performances with other "comparable territories".

Comparisons should take into account the following elements:

- **Local data might not be reported in a consistent way:** the exact scope of data might be very heterogeneous among local territories. The share of non-household WEEE, the collection points included or not, or the codification used for reporting might be inconsistent;
- **Significant data gaps** linked with illegal practices or mislabelling of WEEE streams can also lead to discrepancies;
- **The contexts can also impact the performances:** local consumption patterns can lead to more or less WEEE generation, or the presence of big retailers as collection points can lead to the collection of WEEE from outside of the administrative border of the considered territory. Besides, high-densely populated areas and low-GDP cities generally present lower collection rates compared to other territories.

Key indicators to assess and compare different waste collection system can be recommended:

Cluster	WEEE Criteria	Comments
Capture and recycling rates	WEEE capture rate WEEE collection rate	Capture rate is regarded as one of the most relevant indicators, yet it is generally uncertain as what is put on the market on local level is an estimation. Monitoring the share of large WEEE received non-intact can also help to identify scavenging. Besides, WEEE ending up in scrap dealers can be considered as another relevant criterion.
	Share of WEEE in mixed residual waste (%)	WEEE in mixed residual waste can give a hindsight on the potential for improvement.
Engagement & participation	Existence of feedback gathering system	Identifying efforts to establish a communication with the inhabitants can give good indications of a waste collection system performing well in terms of social acceptance and general communication.
Environment, Health & safety	Climate impact	Climate impact is a relevant criterion for early phase prioritisation of improvement actions regarding WEEE collection on a case region with developing collection system.

	Getting the hazardous substances out of the loop and critical materials recycled	It is regarded as relevant for early phase prioritisation of improvement actions regarding WEEE collection on a case region with mature collection system
Socio-economic impacts	Increase in local employment	This criterion is especially relevant for re-use and disassembly activities that are job-intensive and can play a relevant role for the social economy.
	Total costs of WEEE collection (€/tonne)	The cost of collection is an important parameter, especially when considering the waste collection system in a low-GDP area.
Degree of separation & quality	Number of WEEE categories collected in CAS	This parameter can give an interesting hindsight on the quality of the separation system.
	Share of WEEE collected in CAS in relation to total WEEE collected	The quality of WEEE received through retail bring-points is in general of better quality when compared to other sources.
Convenience & coverage	Number of inhabitants / 1 retailer bring point and non-retail bring points	In parallel with the number of bring points per inhabitants, information on their proximity be also considered
	Easy access to collection (for consumers)	Other indicators for assessing the proximity (such as the average distance to bring points), opening hours, visibility, availability of different collection modes, etc. can give an overview of the convenience of collection.

To conduct comparisons, individual factsheets presenting the waste management organisation and performances of all the documented waste collection systems are accessible on the COLLECTORS webplatform.

SETTING PRIORITIES

The fate of a large share of WEEE is unknown, as shown on the following figure mapping the stream of small WEEE and lamps in Helsinki:

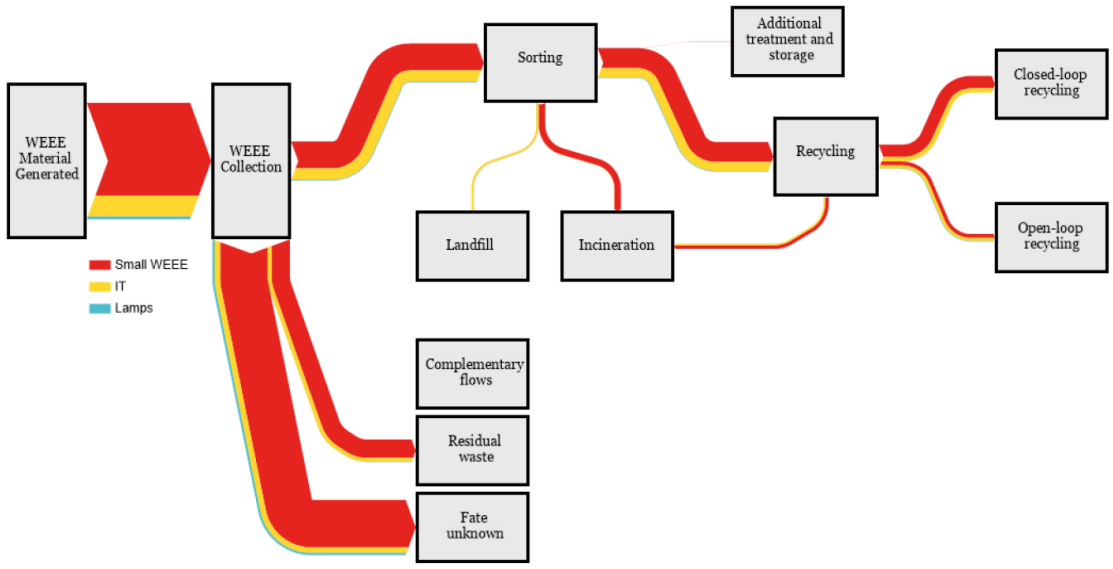


Figure 3: streams of small WEEE, IT equipment, and lamps, in Helsinki, Finland

WEEE might be hoarded or passed on, illegally managed (scavenged or treated as scrap metal), or illegally exported. It is therefore relevant to better monitor these unreported quantities, and improving local management of WEEE must focus as much on improving collection than on tackling illegal practices.

From an environmental point of view, recycling of specific WEEE fractions such as IT equipment has a limited environmental benefit due to technical limitations. For such fractions, re-use yields a significant potential to improve the environmental impact linked with EEE products. On the other hand, the environmental balance of re-use might be more nuanced with equipment with different range of energy efficiency. It might be more environmental beneficial to replace an old appliance with a low energy efficiency, by a new one with a better energy efficiency, especially if the "consumption phase" of the product has a significant contribution.

IMPROVING CAPTURE RATES AND QUALITY

COLLECTION MODES

Waste collection systems must be adapted to the specific contexts where they are implemented. Many different collection modes are available, ranging from on-demand collection to permanent collection points. The key to success lies in the proper combination of complimentary modes, and their adequation with inhabitants' constraints

Several guiding principles can be listed when it comes to the design and implementation of collection systems:

- **Proximity and accessibility**: proximity is especially important in densely-populated areas. It includes different criteria, such as opening hours fitting the constraints of inhabitants, or specific services to people that might experience difficulties in carrying their waste;
- **Visibility:** collection points should be visible, e.g. following a proper, possibly consistent visual identity, designed with clear instructions. Visibility is also a matter of information on the location of collection points;

Figure 4: one of the Eco-van collecting small WEEE in Genoa, Italy

- **Security:** collection points should also be located in secured locations to preserve the value of the collected WEEE and avoid scavenging;
- **Simplicity:** using the collection schemes should be as simple as possible: conditions to use them should be easily available information. Having trained employees able to help the users with WEEE sorting greatly contributes to their user-friendliness;
- **Motivation:** a better understanding of their perspectives and motivations, as well as their possible misconception on WEEE management, will contribute to more adapted messages to promote sorting behaviours;
- **Cleanliness:** dirty collection points will deter inhabitants from using them. Collection points should be associated with "resources" more than with "waste".

There is no "perfect", one-size-fits-all collection system, and each of them has advantages and drawbacks. It is recommended to avoid collection options with which WEEE are handled with other items, get damaged or that can lead to scavenging. For instance, collecting WEEE with regular kerbside collection of mixed bulky waste might not enable qualitative recycling.

COMMUNICATION

As with other waste fractions, communication is a key element for a successful local waste collection system. Communication activities focus on several aspects:

- Provide **practical information** on WEEE collection to waste producers, and ensuring a consistent communication covering the different collection options, regardless of the operator (city, retailers, charity organisation);
- **Promote proper sorting behaviours**, by lifting mistrust and doubts on WEEE management, and raising awareness on the negative outcomes of illegal practices;

- **Collect feedback from inhabitants** on their behaviour, perspective, and motivations.

PRESERVING THE QUALITY

Ensuring a good quality for the sorted WEEE is very important to guarantee its proper re-, use, recycling, and recovery of materials. Quality is impacted by **scavenging**, i.e. the removal of valuable parts from EEE products, **improper collection and storage conditions**, and **contamination by non-WEEE** in the collected streams. Preserving quality can be done through:

- **Adapted collection equipment and proper segregation**, such as specific containers for lamps, small WEEE, and small IT equipment, and collected separately from bigger appliances;
- **Training of staff at municipal collection points,** in identifying the different products, informing the users, and properly storing and handling the different fractions;
- **Better communication** on collection points, with clear indications on the different banks and containers;
- **Securing collection points;**
- **Better monitoring of contamination** in the different fractions, e.g. on specific key types of WEEE;
- **Standards for collection.**

Quality of collected WEEE is generally higher in retail collection points, where the staff is trained and security is higher than in civic amenity sites.

PROMOTING RE-USE

One third of WEEE, furniture, and leisure goods disposed at civic amenity sites could be prepared for re-use. Integrating re-use into WEEE collection systems is necessary to increase the quantities made available for re-use organisations.

When it comes to collection, preserving the integrity of collected items must be the main focus. Several recommendations can be listed:

- In civic amenity sites, train the staff on re-use, better inform the users on the re-use options, and improve the handling and storage of WEEE (in closed, secured areas);
- Define other collection schemes for re-usable products: on-demand collection, mini recycling stations located in urban centres, punctual collection events on the public space, or collection in stores.

Figure 5: punctual WEEE collection point in Paris (source: ecosystem)

TACKLE ILLEGAL PRACTICES

Illegal practices such as scavenging and theft have a significant impact on both the capture rate and the quality of sorted fractions, which seriously hinder the further possibilities for re-use or recycling.

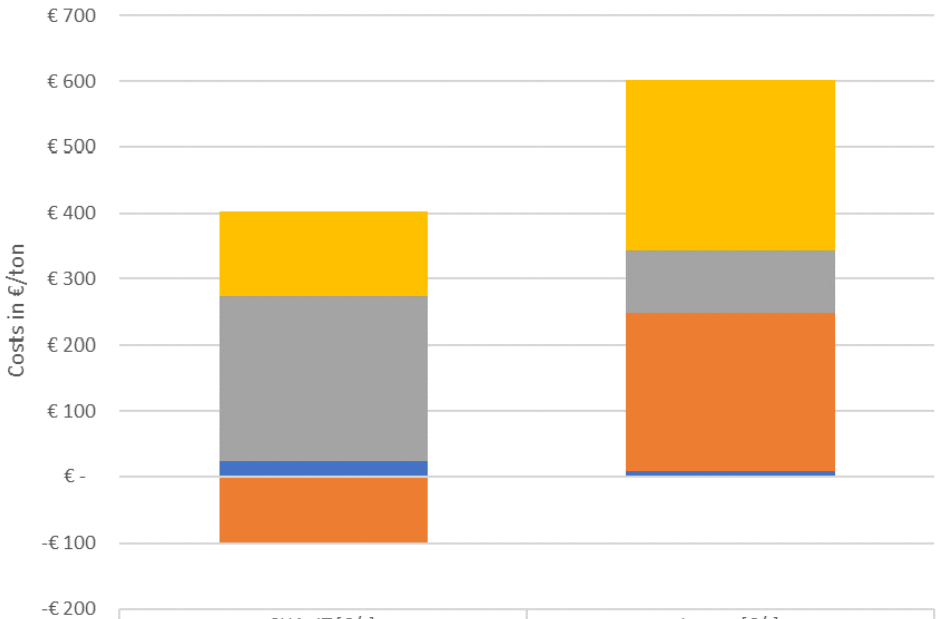
- **Improve surveillance and training of collection staff** in municipal collection points to reduce the level of scavenging, aligning with the practices in retail points;
- **Marking of WEEE** received on the CAS to allow traceability;
- **Cooperation with local police,** that can perform regular checks to monitor the presence of illegal activities;
- **Better monitor the level of scavenging** by identifying missing parts in key fractions and monitoring the individual performances of collection points;

Figure 6: marking of WEEE on CYCLAD's civic amenity site, France (source: Cyclad)

Additionally, other flows of unreported WEEE are associated to WEEE that is collected together with scrap. Specific measures have been set in place in some MS, like for example the ban on cash transactions in France or the requirement to scrap facilities for reporting the WEEE received separately. Enforcement is key for ensuring these measures are implemented.

ECONOMIC BALANCE OF WASTE COLLECTION SYSTEMS

The average cost-benefit balance for the management of small WEEE and lamps are very different, as shown on the following graph:



	SHA+IT [€/t]	Lamps [€/t]
Transport and collection	€ 129	€ 259
Shredding, sorting, dismantling and pretreatment	€ 249	€ 95
Recycling and recovery	-€ 98	€ 240
Incineration and landfill	€ 24	€ 8

Figure 7: average European technical costs for WEEE management, 2008

For small WEEE, treatment costs outweigh collection and transport costs, while the revenues from sorted materials only cover a small part of these total costs. For lamps, collection costs are much more significant, and the fact that they contain hazardous content makes their treatment more expensive, while producing no revenues.

The analysis of five case studies has shown that implementing good practices (such as new collection options, or communication campaigns) lead to positive economic outcomes, due to savings on the cost of WEEEE lost due to improper collection and scavenging (€1,480 per tonne).

Construction and demolition waste (CDW)

MUNICIPAL MANAGEMENT OF CONSTRUCTION AND DEMOLITION WASTE

There are significant differences when it comes to the handling of construction and demolition waste by local authorities. Among the diversity of organisations, several trends can be highlighted:

- Many local authorities only collect CDW through their civic amenity sites;
- Most of them limit the CDW handled by the municipal service: only household waste is accepted, with limited quantities, and only certain fractions (e.g. rubble or asbestos);
- Some do accept non-household waste, but with limits on volumes or weight, or as a paying service. In some cases, quantities beyond a certain limit are charged;
- In many cases, larger quantities (even generated by households) have to be collected by an authorised private company.

Comparing different CDW collection systems can contribute to the identification of good practices, yet the significant differences when it comes to the operational role of local authorities makes it challenging. Besides, several contextual parameters are relevant to be considered as well: the type of housing, population density, and local GDP.

Individual factsheets presenting the waste management organisation and performances of the documented waste collection systems are accessible on the COLLECTORS webplatform.

GYPSUM RECYCLING IN REIMERSWAAL (NETHERLANDS)

Reimerswaal is a municipality in the province of Zeeland in the south-western Netherlands on Zuid-Beveland. The municipality had a population of 22,432 in 2017, and has a surface area of 242 km2 of which 140 km2 is water. The municipality of Reimerswaal is responsible for the collection and management of household waste and outsourced the operation to private scheme the Zeeuwse Reinigingsdienst (ZRD).

ZRD collects about 25 separate waste streams at the civic amenity site, amongst which are gypsum, wood, bricks and concrete, glass, plate glass, hard plastics, metals. ZRD focusses on collecting clean gypsum waste, free from contamination, such as tiles and wood, and instructs the citizens and other users of the CAS to separate gypsum accordingly. After collection in a separate container, all gypsum waste from ZRD is transported to New West Gypsum Recycling in Kallo, near Antwerp. It is essential that the recycled gypsum achieves a pre-determined quality suitable for the manufacturing of new gypsum products. The collection of gypsum is considered as very good, reaching almost 6 kg/cap in 2017.

The initial reason for source-separation of gypsum was the introduction of a ban on landfilling for waste fraction with a potential for recovery, which is the case for gypsum.

Overall, the low investment costs and transport costs, but mostly the high costs for landfilling, makes the practice economically viable.

RECOVERY OF BRICKS, INSULATION AND SANITARY WASTE IN ODENSE (DENMARK)

Odense is the 3rd largest city in Denmark with a population of 204,200 inhabitants. Municipal waste is managed by a public waste company, Odense Renovation A/S. Odense has 8 recycling stations (CAS), with over 40 containers for collecting different waste materials.

Figure 8: container for toilets and washbasins in one of the civic amenity site in Odense, Denmark (source: Odense Renovation)

Odense is a good example of a municipality involved in innovative CDW management schemes, leading the way in the reuse of old bricks which are being refurbished in Odense Renovation A/S's recycling centres. Discarded bricks have their own dedicated containers at the recycling centres, and is then sent to a factory in Svendborg on Funen, where they are cleaned and sorted before being stacked on pallets ready for reuse in new constructions.

Odense also collects both waste mineral wool insulation and waste ceramic sanitary ware separately in order to repurpose this material. In 2016 Odense started working with two companies for the recycling of both these materials streams.

Odense has reached one of the country's highest recycling rate for bulky waste, with about 87% of bulky waste/CDW being recycled. Then environmental analysis shows that

the avoided impacts linked with the re-use of bricks (and thus the avoided primary production of new bricks), and of insulation materials are extremely significant. For both fractions, the impact of additional transport is negligible. The impact of the recycling process of insulation material is noticeable, but small compared to the avoided impact thanks to the displacement of primary production. The environmental benefit from the use of sanitary ceramics in concrete, on the other hand, is rather limited.

The cost-benefit analysis shows the importance of transport and landfill costs for the economic balance of CDW recycling. The presence of close-by recycling units and competitive gate fees for recycling allow reaching a positive economic balance.

RECOMMENDATIONS FOR CDW MANAGEMENT

The starting point for the separate collection of specific CDW is the availability of a clear market for the final end-application and a clear business-case, in combination with landfill taxes or bans. Defining the waste collection systems according to these end-applications and their associated requirements is strongly recommended.

The approach developed by Odense, were separated fractions are determined according to the new potential routes for valorisation and end-application, seems extremely relevant when it comes to the design of the CDW collection service.

Measures to maintain waste collection and separation in COVID-19 pandemic

KEY RECOMMENDATIONS

The results of the COLLECTORS survey, the review of measures implemented at national, regional, and local level, and other studies and guidelines identified allow to list the following key recommendations for handling waste collection in time of pandemics:

- **Flexibility** is key to ensure the continuation of priority collection services, and the territories that could maintain good collection were the ones that could re-allocate resources among the different collection schemes (e.g., from commercial waste to household waste collection). It might be relevant to multi-skilling the operational staff to help them to fulfil different operational roles to improve the resilience of the service.
- **Keeping civic amenity sites open** with adequate measure can be recommended. Online booking systems received very positive feedback from users, but also from staff.
- **Define priority levels** for collection services, focusing on collection modes limiting the interactions with inhabitants, or on specific waste fractions (e.g., residual waste, food waste, etc.). Keeping collection frequencies for sorted fractions greatly contribute to keep sorting performances steady.
- **Give priority to online communication** to reach inhabitants, provide clear information and simple, coordinated messages, and explaining the reasons behind changes. Taking advantage of the local media can also be recommended. It is also recommended to take the opportunity for giving the priority to messages on waste prevention.
- **Establish a consistent and continuous reporting** of the evolution of quantities.
- **Tackle illegal practices** such as fly-tipping by setting a closer monitoring, the enforcement of the regulation, an adequate communication, and ensuring that alternatives collection systems are still available (such as civic amenity sites).
- **Take advantage of guidance**, support systems and networks, to identify good practices and recommendations.
- **Follow UNEP recommendations** regarding the management of waste from COVID-positive households.

Introduction

The COLLECTORS project aims to identify and highlight existing good practices of waste collection and sorting. It focuses on three waste streams: paper and packaging (PPW), waste electrical and electronic equipment (WEEE), and construction and demolition waste (CDW). In particular, the objective of the project is to harmonize and disclose available information on different waste collection systems; to gain better insight into the overall performance of systems; and to support decision-makers in shifting to better-performing systems via capacity-building and establishing implementation guidelines.

To reach its objective, COLLECTORS underwent a three-step approach:

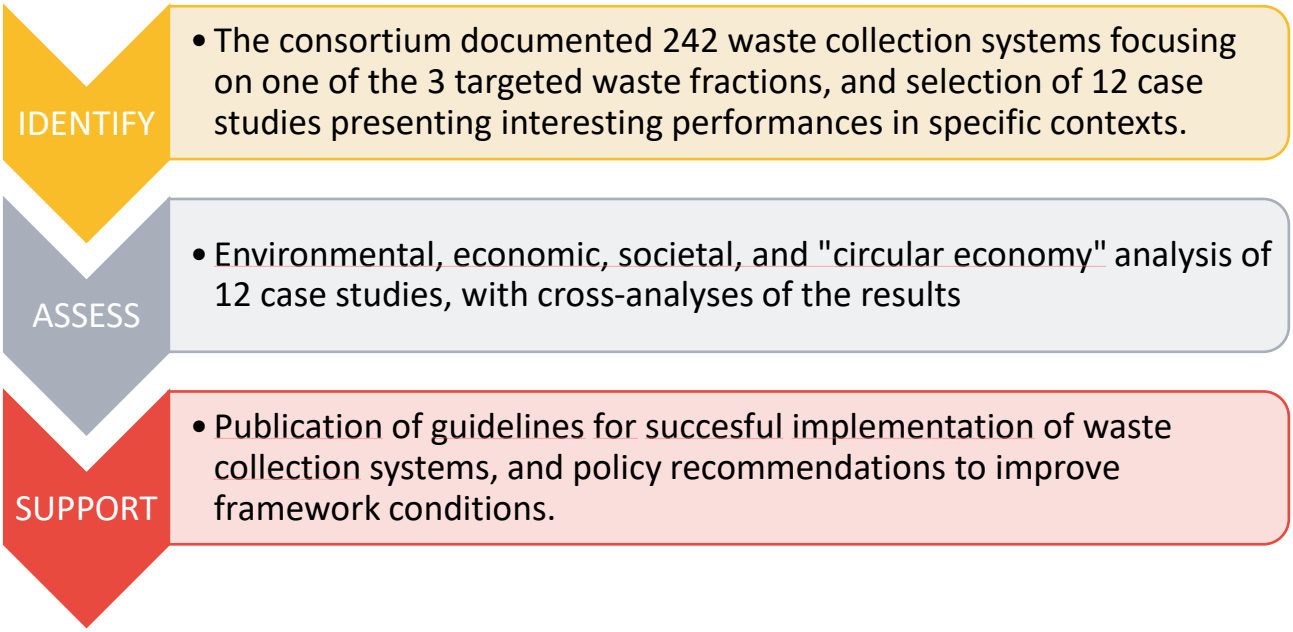


Figure 9: the 3 steps of the COLLECTORS project

The COLLECTORS project aims to contribute at two main general objectives:

- **Improve separate collection of municipal waste**, especially in territories lagging behind or facing specific challenges;
- **Improve the contribution of waste collection systems to the circular economy**, by shifting from “waste push” approach to more “market-oriented” strategies.

These guidelines aim to help local players with these two general objectives, by capitalising the findings of the project and making them available and accessible to stakeholders. It provides practical guidance and examples for local authorities and PROs in charge of coordinating and conducting municipal waste management, so that they can better assess their situation, define their priorities, and improve the overall performances of the system.

The guidelines will present general principles leading to improved performances for municipal waste management, as well as specific focus on the three waste fractions covered by the project. They are based on the research work led by the COLLECTORS consortium, which included the documentation of many European local waste collection system, the in-depth analysis of 12 specific case studies, as well as the involvement of different players of the recycling value chain.

Data collection

The first step of the project focused on the documentation of different waste collection systems across Europe for the three targeted waste fractions, to develop a database of consistent information, enabling the identification of case studies to be further analysed. The consortium aimed to analyse situations as diverse as possible, in terms of locations and typologies, even though the process was limited by the availability of consistent local data.

In total, 242 waste collection systems were documented, covering 25 European countries. The numbers of waste collection systems identified for each waste fraction are presented below:

- **Paper and packaging waste**: 135 systems
- **WEEE**: 73 systems
- **Construction and demolition waste**: 33 systems

The documented systems represent local situations: districts, cities, or group of cities forming an intercommunal group.

The result of this data collection is available on the COLLECTORS Webplatform, where the collected data for each waste collection system is presented within individual factsheets.

Case studies

On the basis of the collected data, **12 cases studies** were identified by the consortium to be further analysed. These case studies were identified following several steps:

- For each of the waste fraction, identification of **relevant contextual parameters** for the definition of "**comparable territories**" when it comes to waste management (e.g. density, tourism, etc.), and **performance indicators** allowing the identification of good practices (capture rate, collected quantities, etc.). Regional waste management experts representing different European countries were involved within the definition of most informative parameters;
- For each waste fraction, identification of **well-performing systems in specific contexts**;
- Selection of the **case studies reflecting diverse situations**, taking into consideration the quality of available data and potential contacts allowing further information.

The identified case studies might not be considered as the best performing territories in Europe, but they reflect systems that implemented interesting solutions allowing reaching good performances in diverse contexts.

PPW case studies:
Parma (Italy), Tubbergen (The Netherlands), Gent (Belgium), Berlin (Germany) and Rennes (France)

WEEE case studies:
Pembrokeshire (UK), Genova (Italy), Cyclad (France), Vienna (Austria), and Helsinki (Finland)

CDW case studies:
Odense (Denmark) and Reimerswaal (The Netherlands)

Figure 10: the selected case studies for the 3 targeted waste fractions

In-depths analyses were then conducted in collaboration with the case studies on several aspects: the **environmental performance, cost-benefit analysis, social acceptance,** and **circular economy perspective**.

Policy recommendations

While local waste collection systems are key elements to improve the recycling of waste, other aspects need to be addressed to improve the overall situation. Important aspects include for example the eco-design of products to make them easier to repair or recycle. Besides, waste collection systems are implemented in specific frameworks shaped by the national/regional regulation and economic instruments such as taxes on disposal, that might also need to be addressed. These aspects are not covered in these guidelines, which focus on practical recommendations for local waste collection systems. However, the COLLECTORS project also proposed policy recommendations to address these other challenges.

1. Municipal waste management: guiding principles

While the COLLECTORS project specifically focused on three waste fractions, the researchers also highlighted good practices and recommendations that could be applied to all municipal waste fractions. These elements, that are presented in this part, were completed with recommendations and good practices identified from previous projects.

1.1 A common guiding principle: The Waste Hierarchy

The COLLECTORS project primarily focused on municipal waste collection and recycling, and the documented good practices are centred on this aspect of waste management. However, it is important to highlight that **priority must be given to waste prevention and re-use over recycling**, as presented in the concept of the Waste Hierarchy introduced by the European Directive 2008/98/EC on waste. Therefore, it is of utmost importance to ensure that the waste collection system consider this aspect e.g. by promoting waste prevention as much as separate collection, or by including re-use schemes and organisations within the waste collection system.

The environmental impact assessment of waste collection system performed by COLLECTORS also highlighted the importance of waste prevention and re-use. The production phase (including the extraction of virgin materials) represents the main contributor when it comes to the impact of packaging over their life-cycle, while the impacts linked with their end-of-life are less significant. Similar observations could be made for the electrical and electronic equipment targeted by the project (Lamps, small equipment, and IT and telecommunication equipment).

While closed-loop recycling contributes to reduce the impact of primary production, its potential is less important than strict prevention actions or re-use of EEE e.g. through repair (which prevents the production of a similar product), or re-use of construction materials.

More information on the environmental impact of waste collection can be found in D3.1 and D3.3

1.2 Waste collection system within the circular economy

It is important to recall that **waste collection systems do not operate in isolation**, but are part of a more general system, the "recycling value chain". Waste collection systems serve different purposes: they provide a service for waste producers (in the case of municipal waste, households and generally "assimilated" commercial activities), and they "extract" recyclable fractions and sort them to provide secondary raw materials to recyclers.

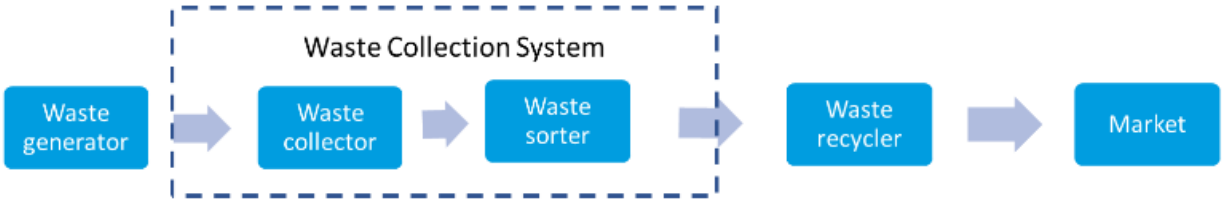


Figure 11: the waste recycling value-chain (source: COLLECTORS, D2.1)

The concept of "circular economy" promotes the shift from "sustainable waste management", where the main objective is to divert waste from disposal to recovery or recycling, to sustainable resource management with the goal of producing high value secondary materials to the end-users, taking more into consideration their demand and quality requirements.

The shift toward a circular economy approach requires a greater integration of all the different players of the whole value-chain, allowing a better understanding of the different perspectives and requirements, as well as a better traceability from waste generation to its end-application.

The following **three factors enable waste collection systems to create more value for the whole recycling value chain**:

- **Traceability of the collected waste**: The more information recyclers can obtain about the origin of products that have become waste, the more they will know about the materials it is composed of, and the higher the chances that these materials can be recycled into high quality products;
- **Supply of collected waste**: in order to be able to operate in a steady way, a minimum amount of waste has to be supplied to the sorter and to the recycler. This means that the collection system must aim at optimising capture rates, while pursuing the efforts of waste prevention.
- **Quality of the sorted waste**: the sorted waste must meet some quality requirements to enhance recycling into marketable secondary materials.

The potential of a waste collection system to contribute to better recycling mainly lies in its capacity to provide significant quantities of sorted waste, complying with the quality requirements for the corresponding secondary materials, i.e. high capture rates and low levels of impurity.

Among these factors, quality seems to be the dominant one for enhancing the performance of the recycling value chain, by unlocking higher quality recycling.

Figure 12: main requirements for the waste recycling value chain to enable the production of more value through the generation of secondary raw materials. The main requirements for waste collection systems are highlighted in red (Source: COLLECTORS, D2.2)

Besides, the new calculation methods for the recycling targets set by the EU Waste Framework Directive will have to be exclude most of the impurities. Therefore, the shift to a circular economy approach with a stronger focus on quality and traceability of sorted materials will be mandatory to comply with these new targets.

Even if the need to shift toward a "circular economy approach" means giving more attention to the recyclers' perspective, waste collection systems cannot work properly without the active participation of waste producers (e.g. citizens), who represent the first step of an efficient waste separation system.

More information can be found in D2.1 and D2.2

1.3 Enhancing participation: securing the contribution of waste producers

COLLECTORS conducted various studies regarding the societal acceptance of waste collection systems, to better understand the perspective of inhabitants. Focus group discussions involving citizens, and analyses of how their perspective is taken into consideration by the 12 case studies were conducted. The main lessons are presented here.

1.3.1 The perspective of waste producers

It is important to understand what makes inhabitant to engage (or not to engage) in waste collection and sorting. It appears that the intention to sort waste is mostly conditioned by four factors: **information, environmental concern, social norms, and convenience**.

Figure 13: the four main factors behind the recycling intentions (source: COLLECTORS, D2.5)

For citizens, **information** means:

- **Sorting guidelines**: what must be sorted, and how?
- Information regarding **what happens to the sorted waste**.

Inhabitants rightly perceive information as the prerequisite for the proper sorting behaviour. The organisations in charge of waste management together with local authorities organising waste collection are regarded as the logical sources of information. Inhabitants expect the information to be **easily accessible** in various places (website, hotline, public places, etc.), **distributed in a proactive manner** (e.g. at schools), **clear, harmonised, and consistent**, and **adapted** to the different target groups. Besides the practical guidelines for sorting, it appears that inhabitants also value the **understanding of the recycling system** as a whole, and its **transparency**. Households

need to be convinced that their sorting behaviour positively contributes to better recycling, and is in-line with more general environmental concerns such as climate change.

Environmental concern might not be a prerequisite for sorting waste for all citizens, but many consulted citizens highlighted it as an essential and overarching factor. This is linked with the general environmental crisis (climate change, biodiversity loss). Several key aspects regarding environmental concern can be highlighted:

- It needs to be stimulated with a proper, local communication;
- It can be regarded as an important factor for citizens to accept the local waste collection system: changes and choices can be justified by a positive impact on the environment
- The sorting behaviour should be linked with positive environmental outcomes.

Social norms were not regarded as essential factors by the inhabitants, yet it seems that the local context does play a role in driving sorting behaviour: when the waste collection system is properly implemented and most inhabitants participate, waste sorting actually becomes a part of local life and thus becomes a social norm that citizens are expected to follow.

Convenience is mostly reported as a key factor when the system is perceived as not convenient. Therefore, it is safe to assume that it is indeed a strong driver, and closely linked with the quality of the information and clarity of the system. Waste sorting is generally perceived as an "**extra effort**", which might be challenging to accommodate to in particular circumstances (e.g. having small children). Using the mixed residuals waste can be seen as an easier way to deal with waste, even more so when residual waste collection is more convenient (more frequent collection, unclear sorting instructions, etc.). The **lack of space** is also mentioned as a concrete challenge when too many sorting fractions are imposed in vertical housing. Other factors affecting the convenience of waste sorting have to be considered too, such as **nuisances** (odours).

More information can be found in D2.5

1.3.2 Getting hindsight on waste producers' perspective and behaviours

Engaging waste producers and citizens requires the implementation of a convenient collection system along with a proper communication that provides the right information, but also the right messages that will motivate the proper behaviours. However, convenience and motivation can be differently perceived depending on the target audience. Besides, the perception and perspectives of inhabitants might vary depending on the type of waste considered: people might consider differently the fact to get rid of one's smartphone possibly storing personal data than other types of waste.

It can be useful to conduct surveys to better understand these elements, and shape communication activities and collection schemes in a more appropriate way.

Highlight: household survey on WEEE in Genoa, Italy

Within the framework of the WEEEMODELS project, a survey was addressed to citizens to better understand their perspective on WEEE. It consisted in 15 questions on the behaviours of consumers on EEE and WEEE, their knowledge of the WEEE system, and their readiness to participate to a new organisation of waste collection. Overall, about 600 respondents were reached, and specific questions on the age, gender, location, etc. allowed the identification of a representative panel.

The questions addressed the following topics:

- Whether the respondents had made the acquisition or disposed of large EEE and small EEE in the past 2 years;
- How did they dispose of it;
- Whether they knew about the "1 for 1" system, which allows the take-back of an old EEE when a similar product is bought;
- Whether they knew about what WEEE means;
- Whether they had already used one of the available collection services for WEEE, and if not, why;
- Whether they would use a proximity collection service for their small WEEE;
- Whether they bought a second-hand product, and the reason behind their choice.

The survey showed that inhabitants had a quite limited knowledge of WEEE and the associated collection service, especially the "1 for 1" system. It also demonstrated their interest for WEEE collection and proximity collection services.

The results of the survey were cross-analysed with existing studies (e.g. conducted at national level) to better understand individual behaviours regarding WEEE disposal, as well as improper/illegal practices.

More information can be found here

1.3.3 Securing the involvement of waste producers

Several recommendations regarding the societal acceptance of waste collection can be formulated:

- Information should be **accessible, widely distributed in a pro-active way, and clear and consistent**. An effective communication system must take advantage of multiple channels to reach the different target audience: website, social media, but also public events, door-to-door explanations. It is also recommended to identify specific target groups that might have different interests or that have to be reached differently, such as:

    - **Newcomers and tourists** that might not have the same consumption or sorting habits than the resident population, and that should be reached upon their arrival (when registering as newcomers, or when checking-in into their accommodation);
    - **Age categories** that might have different interest or perspectives (e.g. family with young children might be reached through social activities, while elderly people might need adapted collection services)
    - **Cultural contexts** including the language barrier, but also different social or religious conventions, different habits, that might require adapting the communication format.
- Information should **not be limited to practical sorting guidelines, but also include information on the waste collection systems.** Many waste producers are interested in knowing the reason behind sorting waste and the positive outcomes of their sorting behaviour.
- **Any changes in the waste collection system should consider the following elements**:
    - space/type of housing,
    - additional efforts required,
    - accessibility of collection points.

  These three main issues are the most commonly reported elements that might prevent inhabitants from sorting their waste.
- The consultation of the inhabitants (via focus groups) and the analysis of the COLLECTORS case studies seem to indicate that **financial incentives** such as pay-as-you-throw or deposit-refund systems are positively perceived by inhabitants.
- **Assessing the perception and success** of new measures is crucial to better understand its social acceptance. However, these assessments should go beyond the general satisfaction of inhabitants; they should also monitor the impact of specific measures to better understand if they secured the citizens' involvement.

More information can be found in D2.5 and in the presentation given during the COLLECTORS conference in Warsaw

1.4 Multi-criteria decision making

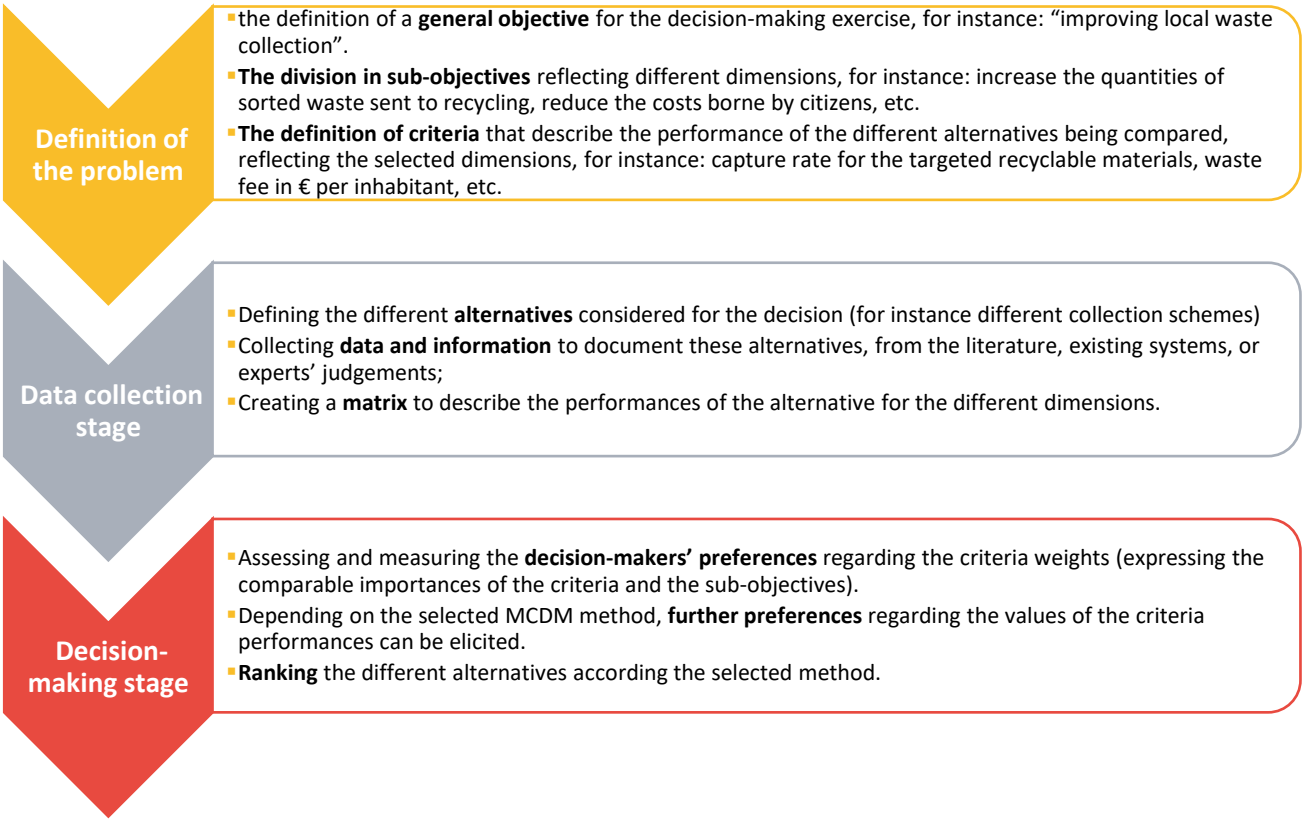
Waste management is a multi-stakeholder topic, and the decisions taken to modify and improve waste collection systems have to include multiple dimensions: technical considerations, regulation, social acceptance, costs, environmental impact, etc. Therefore, using multi-criteria decision-making (MCDM) approaches can contribute to better outcomes while favouring a collaborative approach among the different local stakeholders. The COLLECTORS consortium conducted several working groups to better understand local decision-making and provide some hindsight on how MCDM could be applied to facilitate the improvement of municipal waste collection systems.

1.4.1 The principle of multi-criteria decision-making

Improving waste collection systems generally requires addressing some specific local challenges, or identifying new solutions to be implemented, based on identified good practices or the comparison of possible alternatives. Such process can strongly benefit from participative approaches and the collaboration of many different stakeholders: local authorities, waste companies, producers' organisations, local NGO, etc. The purpose of an MCDM method is to establish a ranking of the alternative options, based on available information on the alternatives themselves and the decision-makers' and stakeholders' preferences.

The principle of MCDM is to break down complex challenges into more comprehensive components. This allows assessing different dimensions of the problem (e.g. environmental impact, costs, social acceptance, and technical considerations) one at a time, through a collaborative approach.

MCDM processes consist in several successive steps:



This approach is quite close to the one used by local decision-makers for waste management and identified by the COLLECTORS project: a given driver (new legal targets, local demand from the population) leads to a new challenge to be documented and prioritised, and for which different solutions are investigated and discussed.

Among these different steps, the definition of the problem and data collection are usually the most resource-consuming ones.

Such collaborative, multi-criteria discussions tend to provide a significant added value, if properly orchestrated. Besides the identification of a solution, it contributes to a better shared understanding of the situation and challenges.

More information can be found in D3.4 and D4.4

1.4.2 Criteria for decision making

Multi-criteria decision-making approaches rely on the selection and documentation of various criteria for different alternatives, allowing their ranking and ultimately the selection of the preferred option.

When it comes to waste collection systems, a list of criteria has been established based on the conclusions from the project and extensive stakeholder consultation. These criteria will be further modified for each of the targeted waste fractions. However, general clusters are presented here, and can be applied to most waste fractions. Even if these different clusters might overlap, it is advised to cover them all to get a complete picture of the different dimensions that are important for building a well-performing a waste collection system:

- **Capture and recycling rates**: it reflects the sorted quantities by the waste collection system, compared with the total generated quantities. While recycling rate measures the performances in a more accurate way (by excluding the impurities in the sorted fraction from the calculation), the lack of data might make its calculation at local level impossible. Capture rate (reflecting the separately collected quantities compared to the total quantities) gives a less precise assessment but is generally possible to assess in a proper way at local level. A simple recording of the total amounts collected and regular sampling to estimate the shares of impurities can be a good option for monitoring results at local level. Data on impurities may come from waste acceptors downstream.
- **Degree of separation and quality:** more source-separation generally leads to higher quality of sorted materials and enables higher quality recycling. Quality can be assessed by documenting the impurity rates of the sorted fractions, or the discarded amounts occurring in the sorting facilities.
- **Convenience & coverage:** as indicated above, a convenient waste collection system, and accessible collection points are necessary to secure the participation of waste producers. Indications on the amount, proximity, and visibility of collection points, coverage of door-to-door collection, etc. can give interesting hindsight on convenience. However, it should be noted that convenience and associated indicators are very much dependent on the local context.
- **Engagement & participation:** information of local engagement can be scarce, which might explain why these aspects are often not visible in decision-making. Different indicators, such as the availability of feedback gathering systems, or how much information and

awareness raising communication activities reach the inhabitants, can approach engagement and participation.

- **Environment, health & safety:** the relevant indicators that can be included mostly depend on the targeted waste fractions, whose impact on environment or health can be very different. Moreover, their choice also depends on the local interest or environmental strategies in place (e.g. local climate change strategy, etc.).
- **Socio-economic impacts:** this cluster covers various aspects, the most obvious one being the cost-benefit impact (including the required investments, running costs, and incomes generated). Other aspects might be relevant to local decision-makers, such as the number of jobs created (especially in the case of re-use activities).

According to COLLECTORS' findings, covering these six clusters should provide a complete picture of the different alternatives and lead to more informed decision making. In addition to MCDM studies, proposed criteria could be applied also in other contexts to support decision-making and monitoring activities related to waste collection. However, this is only a general framework that needs to be adapted according to available data, the exact scope of the decision-making process (e.g. the considered waste fractions), as well as interests of local decision makers. More detailed indications will be provided in the part covering the different waste fractions.

More information can be found in D3.4 and D4.4

1.4.3 The need of consistent data

As shown in the previous parts, well-informed decision-making is heavily dependent on the availability of consistent data, which seems to be one of the main challenges in the context of waste collection. A list of relevant indicators is proposed by the COLLECTORS project and can serve as an inspiration for improving local monitoring[1] activities. The JRC also proposes an extensive list of indicators as well as recommendations for local municipal waste management monitoring[2].

Considering the main data gaps identified by the project, a specific focus should be put on the following information:

- **Waste generation and composition**: conducting frequent composition analysis of mixed residual waste is recommended to allow the calculation of local, consistent performance indicators such as capture rate. Composition analyses are based on sampling of residual waste, and the method used must be carefully selected to ensure representative and replicable results. A list of references for the conduction of composition analysis identified in the aforementioned JRC report can be found in annex 1.

[1] COLLECTORS, 2018, D1.1

[2] Dri M., Canfora P., Antonopoulos I. S., Gaudillat P., Best Environmental Management Practice for the Waste Management Sector, JRC Science for Policy Report, EUR 29136 EN, Publications Office of the European Union, Luxembourg,2018,ISBN 978-92-79-80361-1,doi:10.2760/50247, JRC111059

- **Waste collection:** there is generally missing or limited information on waste streams collected outside of the municipal waste service, e.g. by re-use organisations, retailers, take-back systems, etc.
- **Quality:** little data is available at local level on the quality of the sorted fractions, and on the actual quantities of the targeted waste sent to recycling. This gap limits the comparability of performances of different waste collection systems, as higher capture rates with high contamination can lead to significantly lower recycling rates.

More detailed information about potential indicators for the different waste streams is presented in the following chapters of this report.

More information can be found in D1.1 and D3.4

2. Paper and Packaging Waste

Paper and packaging waste represent a significant share of municipal waste. In 2017, 173 kg of packaging waste was generated per inhabitant in the EU, which represents about one third of the municipal waste. The recycling rate has experienced a steady increase in the past years, reaching 67.5% for packaging waste. However, there are significant differences among Member States and among the different waste fractions (only 42% of plastic packaging waste was recycled in 2017)[3].

2.1 Reaching the new targets

The targets set by the new EU Packaging Waste Directive are ambitious: 80% of packaging waste must be recycled in 2030. The achievement of the new recycling rates will be calculated according to a new method making the targets more challenging to reach. The new targets are summarised in the Table 1 below.

Table 1: New targets and calculation points from the latest EU Packaging Waste Directive

Fraction	Recycling target in 2025[4]	Recycling target in 2030[4]	New calculation points[5]
Glass	70%	75%	Input of a glass furnace, or the production of filtration media, abrasive materials, glass fibre insulation and construction materials.
Ferrous Metal	70%	80%	Input of a metal smelter or furnace.
Aluminium	50%	60%	
Paper and cardboard	75%	85%	Input of a pulping operation
Plastics	50%	55%	Plastic separated by polymers entering pelletisation, extrusion, or moulding operations; or plastic flakes input in their use in a final product.

The new calculation methods will measure sorted fractions devoid of impurities; this means that both increasing the sorted quantities and improving the quality of sorted fractions will be necessary to reach the targets.

By taking into consideration the current average losses occurring between collection and the end-application of the sorted materials, it is possible to "translate" the "recycling targets" into

[3] Eurostat ,2020, Packaging waste statistics (https://ec.europa.eu/eurostat/statistics-explained/index.php/Packaging_waste_statistics#Waste_generation_by_packaging_material)

[4] Directive (EU) 2018/852 of the European Parliament and of the Council of 30 May 2018 amending Directive 94/62/EC on packaging and packaging waste

[5] COMMISSION IMPLEMENTING DECISION (EU) 2019/665 of 17 April 2019 amending Decision 2005/270/EC establishing the formats relating to the database system pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste

"collection targets", which is calculated with the capture rates. The associated collection rates are presented in the table below:

Table 2: Collection targets needed to reach the 2030 recycling targets for packaging waste

Fraction	Recycling target in 2030	Associated collection targets for 2030
Glass	75%	94%
Aluminium	60%	64%
Paper and cardboard	85%	86%
Plastics	55%	76%

These collection targets might not be accurate locally, as they depend on the quality of the collected materials and the subsequent sorting stages that might generate more or less losses. However, it gives an indication of the extra effort needed at local level to reach the targets, both in terms of capture rate and impurity levels.

More information can be found in D3.3

2.2 Assessing and monitoring the situation

Improving local waste collection systems starts from a proper assessment of the initial situation, regarding the level of performances, but also regarding the current organisation of waste collection. Performances should be compared with the current legal targets, yet it can also be interesting to conduct benchmarking with other territories, especially the ones sharing the same types of constraints and contexts.

Relevant data and indicators

A list of relevant indicators for paper and packaging waste was identified by the project through literature search as well as the involvement of representatives from local and regional authorities and producer responsibility organisations. These indicators are regarded as relevant for decision-making, and can be calculated at the local level with the proper information. The full list of indicators is presented in COLLECTORS Deliverable 1.1. More precisions on the economic parameters of waste collection systems will be provided in the part below discussing economic balance (see section 2.5).

The main indicators are summarised in the table below. These indicators are based a selection from the full list identified by the project, for which data were mostly available for the documented systems, and that received most of the attention during the different meetings with local experts.

Table 3: indicators for the assessment and monitoring of PPW collection systems

Indicator	Description	Comment
Waste generation		
Scope of the collected waste	The type of waste included in municipal waste: household waste, commercial waste	Whether commercial waste is included or not is interesting to know when comparing data with other territories, especially for specific fractions (e.g. beverage packaging, paper and cardboard).
Scope of the sorted paper and packaging waste	Which types of packaging are included in the sorting guidelines and which ones are excluded	While collection guidelines are quite homogeneous for certain packaging fractions (e.g. for glass, for which bottles and jars are generally the fractions included), sorting guidelines can be very different for other (e.g. for plastics for which the included packaging can range from bottles and flasks to all types).
Composition of mixed residual waste	Share of paper and packaging waste fractions in residual waste	These figures are essential to assess the capture rates and the potential for improvement. It is very important to make sure that the PPW categories documented in the composition analysis are aligned with the sorting guidelines and targets, e.g. to exclude non-packaging materials, or to distinguish the different types of packaging that are supposed to be sorted or not (e.g. plastic beverage packaging and other types of plastic packaging).
Waste collection		
Separated fractions	Which fractions are source-separated, and which fractions are collected together (co-mingled fractions)	The separation system is important to clearly define for further comparison with other systems. Co-mingling can have an impact on the quality of sorted fractions.
Collection mode	The collection modes (door-to-door, bring banks, civic amenity sites, other) used for the different PPW fractions. Documenting the associated collected quantities for each collection modes gives more information on their relative importance	Clear information on collection modes allows consistent comparisons of waste collection systems. Several collection modes can be used for the same PPW fraction; in this case the associated collected quantities should be identified.
Collection coverage for door-to-door schemes	The share of population covered by a door-to-door collection scheme for each waste fraction	This indicator gives an indication on the importance of door-to-door collection for each waste fraction.
Collection frequency	How many times per week or per month the different waste fractions are collected door-to-door	It is interesting to compare the collection frequency of PPW with residual waste collection frequency.
Number of bring points	Number of bring banks for each waste fraction (possibly per inhabitants or per km²)	The number of bring points gives a first indication on their availability and proximity. It should be noted that the number of bring points per inhabitants also has to be put in parallel with the typology and density of the territory to reflect the actual convenience.
Proximity of containers	Average distance between bring points and housing	This information gives a better indication on the convenience of bring bank system for inhabitants. However, the context also has some importance, as

		bring points are more likely to be reached by foot in urban areas, while they might be accessed by cars in remote areas.
Number of civic amenity sites	The number of civic amenity sites receiving PPW (per inhabitants)	This information gives a better indication on the convenience of the civic amenity sites system for inhabitants.
Performances		
Collected quantities	Total collected quantities for each PPW stream, and in kg per inh.	Collected quantities are the basic information on sorting performances. Expressing it in kg/inh. makes it more comparable with other territories.
Sorted quantities	Total sorted quantities for each PPW waste fraction, i.e. source separated fractions and output of mechanical sorting centres separating co-mingled fractions	Getting figures on sorted quantities for each material fraction (e.g. by breaking down co-mingled fraction into the different fractions composing it) is essential to get a clear information on the performance of the system, and to measure the achievement toward the EU targets.
Capture rates	Separately collected quantities divided by the total generated quantities, for each PPW fraction	Total generated quantities can be assessed as the sum of sorted quantities and the quantities remaining in residual waste (based on data from the composition analysis). Capture rate provides a more precise information on the performances than collected quantities per capita, which can be impacted by the scope of PPW collection and other external factors influencing PPW generation.
Impurity rates	The share of materials that is discarded in the sorting processes before the final use of sorted material	Data on impurities and discarded quantities might be difficult to obtain, especially if the sorted fractions are then aggregated with streams from other origins and no traceability system is implemented. Getting information on the quantities that are rejected by the recyclers for not matching the quality standards (e.g. set by the EPR scheme) could give a first idea on the quality level.
Recycling rates	Quantities actually sent to recycling (e.g. sorted quantities minus the impurities and losses), divided by the generated quantities	Recycling rates give a proper idea on the performance of the collection systems since it includes both information on the quantity and the quality of sorted materials.
Economic features		
Running cost for collection and processing of PPW	Total cost of collection and processing of each PPW fraction, per tonne of material sorted	It is important to detail the exact scope and method used for the calculation of costs, so that consistent comparisons can be performed. Using an existing reporting method (e.g. at national or regional level) with improve the comparability of data.
Waste fee for inhabitants	Average annual waste fee paid by inhabitants, expressed in € per inh. or € per household	This indicator is relevant to monitor the contribution asked from the inhabitants and its evolution.

More information can be found in D1.1

The importance of the local context

The analysis of the data collected by the project allowed identifying some correlations between the local context, and the composition and generation of paper and packaging waste. These contextual elements are relevant to consider when analysing the collected quantities, as specific territories might generate significant quantities of paper and packaging waste compared to the national average, making comparisons more complicated.

The following table presents the main criteria identified by the waste management experts who were interviewed during the stakeholder engagement workshops:

Table 4: Contextual parameters sorted according to their importance (source: COLLECTORS, D4.4)

Importance	Contextual parameters
High	Level of tourism and Commuting, (Overnight stays per inh. per year) Total MSW generation, (Kg / capita / year)
Medium	Type of housing, (Share of detached and semi-detached houses in %) Population, (No. of inhabitants) Population density, (No. of inhabitants per km^2)
Low	Local economy, (GDP per inhabitant) Area size, (km^2) Area characterization, (remote/not remote, coastal/inland/island) Households, (Total no. of households) Household size, (average no. of persons per household)

The analysis of average paper and packaging waste generation per capita according to different contextual parameters was also performed on the COLLECTORS database[6]. The main observations are summarised in the table below:

[6] ACR+, 2019, 135 paper and packaging waste collection system, an analysis by the ACR+ European Observatory on municipal waste performances

Table 5: main parameters and contextual indicators with a correlation with PPW generation

Waste fraction	Main observations	Relevant contextual indicators
Glass packaging	Glass generation is significantly higher in territories with very high tourism activity, and where the non-resident population is significant compared to the resident one. Glass generation tends to be higher in high density areas, and lower in low density areas Glass generation tends to be lower in low-GDP areas Glass generation tends to be lower in places with a parallel deposit-refund system (DRS)	Number of overnight stays per resident population Share of secondary residences Population density GDP per inhabitant Existence of a DRS for glass Share of glass packaging under the DRS
Paper and cardboard	P/C generation tends to be higher in high-GDP areas and lower in low-GDP areas P/C generation tends to be higher in low density areas	GDP per capita Population density
Plastic packaging	Plastic packaging generation tends to be significantly higher in territories with very high tourism activity and where the non-resident population is significant compared to the resident one.	Number of overnight stays per resident population Share of secondary residences

It must be noted that these correlations do not mean that there is a direct link between the contextual parameter and waste generation. While some of them can be easily understood (e.g. a significant amount of non-resident population means more waste producers that are not included in the resident population that is used to calculate the waste generation per capita), others might only reflect other contextual parameters for which no comparable indicator could be found, such as the economic activity and the presence of commercial activities (that might be more likely to be important in densely-populated areas than in remote areas).

More information can be found in D4.4

Comparisons with other territories

Comparisons and benchmarking with other territories is a good method to assess the level of performance of a given territory, and identify solutions to improve the local performances. However, comparisons can be challenging for various reasons:

- **Local data might be calculated in an inconsistent way:** for instance, the capture rate might or might not include sorting residues, and the quality of the data on the composition of mixed residual waste might present different degrees of reliability.
- **The scope of PPW might be very inconsistent:** whether commercial PPW is included, the share of commercial PPW in municipal PPW, or the existence of parallel collection schemes (deposit-refund systems, private collection schemes, scavenging, etc.) can make comparisons less relevant.
- **The contexts can also impact the performances:** as presented above, several contextual parameters can impact PPW generation. Moreover, some specific contextual elements can also impact the sorting performances (e.g. shared bins in vertical housing generally lead to lower capture rates and higher impurity rates) or limit the possibility to transfer good practices (e.g. the lack of available space in very dense areas might prevent local authorities from implementing a dense network of collection points).

When comparing data from different territories, the information on the scope of the data, and applied calculation methods is as important as the actual data, to ensure that the comparisons are done in a consistent way. While it might not be possible to obtain completely comparable data, identifying potential biases linked with different scopes, different calculation methods, or different contexts can help assessing the relevancy of the observations made.

A list of indicators was established by the project, based on the input of various local waste experts from across Europe, sorted by clusters as described in part 1.4.2. The list is summarised below:

Table 6: List of criteria for benchmarking PPW collection systems, identified as relevant by the consulted local waste experts

Cluster	PPW Criteria	Comments
Capture and recycling rates	Capture rates of Plastic, Paper & cardboard, Glass and Metal, (%)	Recycling rates should be preferred to capture rates since they also include information on the quality of sorted fractions. However, the capture rate is a very common indicator and more likely to be available for comparisons. It is important to understand how the capture rates are calculated: what is included in sorted quantities (measurement points, exclusion of streams not complying with quality standards, etc.) and how the generated quantities are assessed (e.g. based on consistent, local waste composition analysis or not). It is also recommended to carefully consider the local waste collection system when analysing the capture rates. A single waste fraction can be source-separated or comingled in a given territory, and thus the separately collected quantities reported might only include the part that is source-separated while the co-mingled quantities can be reported as “mixed recyclables”.
	Shares of Plastic, Glass, Paper & cardboard and	This gives an indication on the unsorted quantities and the potential for improvement. As indicated above, it is relevant to check whether the

	Metal in mixed residual waste, (%)	composition analysis is done on local data and whether the scopes of the categories are consistent (e.g. if there are categories focusing solely on packaging waste for each material fraction).
Engagement & participation	Citizen satisfaction (Existence of feedback gathering system or a system for complaints and conducting regular phone surveys)	Efforts related to citizen engagement, awareness raising and communication are necessary to reach good performance in waste collection. Establishing methods for systematic feedback collection is necessary for understanding the needs of the users, and evaluating their participation and acceptance. Sole existence of feedback gathering mechanisms doesn't increase performance if collected feedback is not systematically monitored and analysed.
Socio-economic impacts	Annual waste fee per capita or per household, (€/capita or €/household)	Considering the evolution of this indicator over time is interesting when comparing waste collection systems. However, comparing the value of the annual waste fee per capita or per household across different territories might be difficult to do in a consistent way. Waste fees might not cover the actual collection costs (which might be partly covered by the municipalities' general budget for instance) and might also reflect different living standards.
	Total operational costs (€/capita)	While the operational costs are regarded as valuable information that can give relevant hindsight on the transferability of a waste collection system to other territories, data on waste management costs have to be considered with care. Data on collection and processing costs are generally calculated in heterogeneous ways (specific scope, inclusion or not of other costs such as cleanliness or administrative costs, specific method to allocate costs to the different waste fractions, inclusion or not of incomes and subsidies or amortisation, different VAT, etc.) or might reflect different costs (technical costs if reported by the operator of the collection, or cost charged by the subcontractor if reported by a local authority not operating the collection). However, comparing technical costs of two alternative scenarios is relevant if the costs are assessed and presented in a consistent manner.
	Collection costs per PPW fraction (Plastic & metals comingled, Paper & cardboard comingled and Glass), (€/tonne)	
	Collection costs of residual waste, (€/tonne)	
	Processing (not including the treatment during recycling) costs (€/capita)	
	Employment impacts (no. of direct jobs)	Employment can be relevant to local elected representatives. However, data is generally limited and it might have trade-offs with cost-efficiency and productivity.
Convenience & coverage	Proximity (no. of bring points, door-to-door coverage and distance to bring points)	Data such as the number of bring points per inhabitant is generally highly valued by decision-makers and might give a first good indication on the convenience of the collection system.

More information can be found in D3.4

Benchmarking elements from the COLLECTORS database

The COLLECTORS consortium documented 135 waste collection systems for paper and packaging waste. Among the data collected by the COLLECTORS consortium, capture rates of PPW could be documented for about 110 waste collection systems. However, the level of available data varies between the individual PPW fractions. To ease comparisons, several categories for contextual parameters were established:

Table 7: classification of waste collection systems according to their context

Name of the category	Density	GDP	Overnight stays per inhabitants
Very low	0 – 100 inh/km²	0 – 10,000 €/cap	0 – 2.5 stays/inh.
Low	100 - 500 inh/km²	10,000 – 20,000 €/cap	2.5 – 5 stays/inh.
Average	500 – 2,500 inh/km²	20,000 – 35,000 €/cap	5 – 10 stays/inh.
High	2,500 – 7,500 inh/km²	35,000 – 50,000 €/cap	10 - 15 stays/inh.
Very high	> 7,500 inh/km²	> 50,000 €/cap	15 - 50 stays/inh.
Extremely high*	/	/	> 50 stays/inh.

** This category was defined for tourism activity only, due to the presence of several territories with significantly higher figures for overnight stays per inhabitant. Such territories were not identified for the other two parameters, or their small number did not allow the definition of a dedicated category.*

To benchmark the documented waste collection system, it was decided to use the capture rate to assess their individual performances. The capture rate gives a good indication on the capacity of the waste collection system to divert recyclable waste from residual waste, even though it does not provide information on the quality of sorted fractions. Due to a general unavailability of local data on the quality of sorted fraction, the recycling rate could not be used.

Correlations between the capture rate and the local context are visible for two parameters: population density, and GDP, as shown on the following graphs, while there is no visible correlation between capture rate and touristic activity.

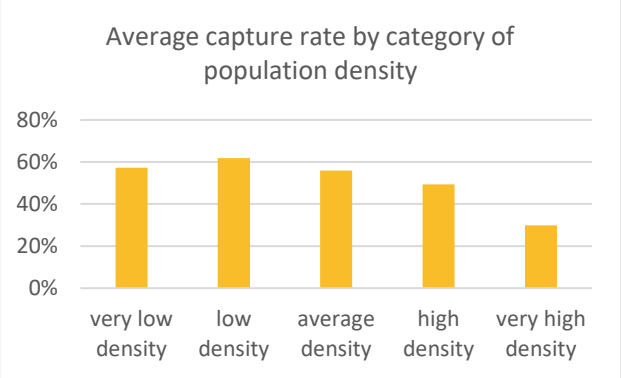


Figure 14: Average capture rate for PPW by category of population density

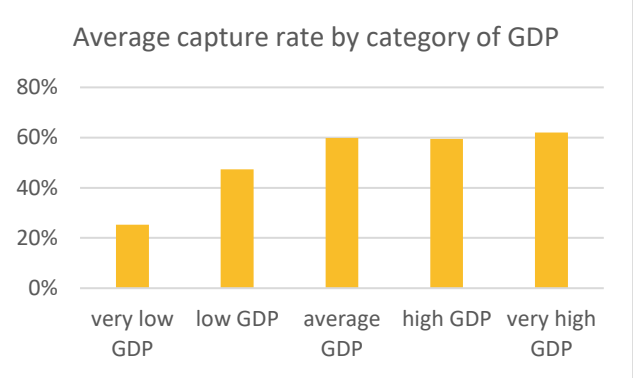


Figure 15: Average capture rate for PPW by category of GDP

Both high density territories and low-GDP areas tend to present lower capture rate. In high density territories, the important share of vertical housing and the lack of space for sorting equipment (at home, in buildings, or on public areas) might explain this trend. When it comes to GDP, it is more challenging to identify the main reasons: it might be the lack of resources to invest in sorting equipment, or the fact that these territories are generally located in newer Member States where the legal framework and local strategies have been introduced at a later stage.

The following table provides average values for the documented waste collection systems, as well as for the ten densest cities (whose population density is above 5,000 inh.km²) and the eight most touristic territories (whose overnight stays per resident population is above 70). The main figures are presented below. It is important to state that all the different values are not available for all territories; therefore, the data is only presented where regarding systems for which sufficient data is available. The average capture rates for the five COLLECTORS case studies are also presented.

Table 8: Average collected quantities and capture rate on the documented WCS

	All WCS		Ten densest cities		Eight most touristic cities		COLLECTORS case studies
	Average collected quantities (kg/cap)	Average capture rate	Average collected quantities (kg/cap)	Average capture rate	Average collected quantities (kg/cap)	Average capture rate	Average capture rate
Glass	22.4	65%	16.7	60%	62.5	74%	89%
Paper and cardboard	37.2	56%	36.3	46%	98.7	55%	75%
P+M+C*	21.0	Insufficient data	11.8	25%	16.4	47%	
PC+P+M+C*	44.9		Insufficient data				
Plastic	11.2	27%					69%
Metal	4.2	Insufficient data					61%
Composite	2.2						
Total PPW	**92.7**	**55%**	**55.4**	**45%**	**193.5**	**62%**	

** These fractions are co-mingled streams mixing different fractions: "P+M+C" stands for streams where plastics packaging, metal packaging, and drinking cartons are mixed together, while "PC+P+M+C" refers to streams mixing together paper and cardboard with "P+M+C"*

The figures confirm the observations made above: dense cities tend to present lower performances and higher production rates of paper and cardboard waste. Touristic cities generate more quantities of PPW per capita. However, their average performances in terms of capture rates are similar or above the average of all the documented WCS.

However, these figures hide discrepancies among these specific categories, as presented on the following graphs (see Figure 7 and Figure 8):

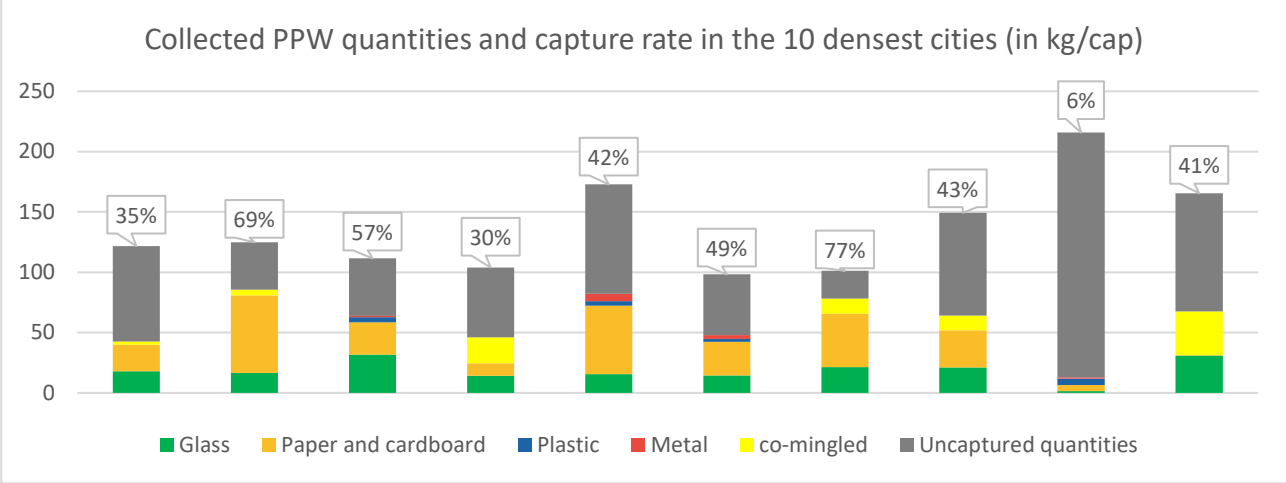


Figure 16: Sorted and unsorted quantities of PPW in the 10 densest cities documented by COLLECTORS, with the capture rate indicated at the top of the bars (ranked by population density)

The data show important differences of generated PPW quantities that might reflect different scopes of collected waste; it also shows that two dense cities achieve good overall capture rates, applying different approaches and strategies for waste collection.

The same observation can be made for touristic territories:

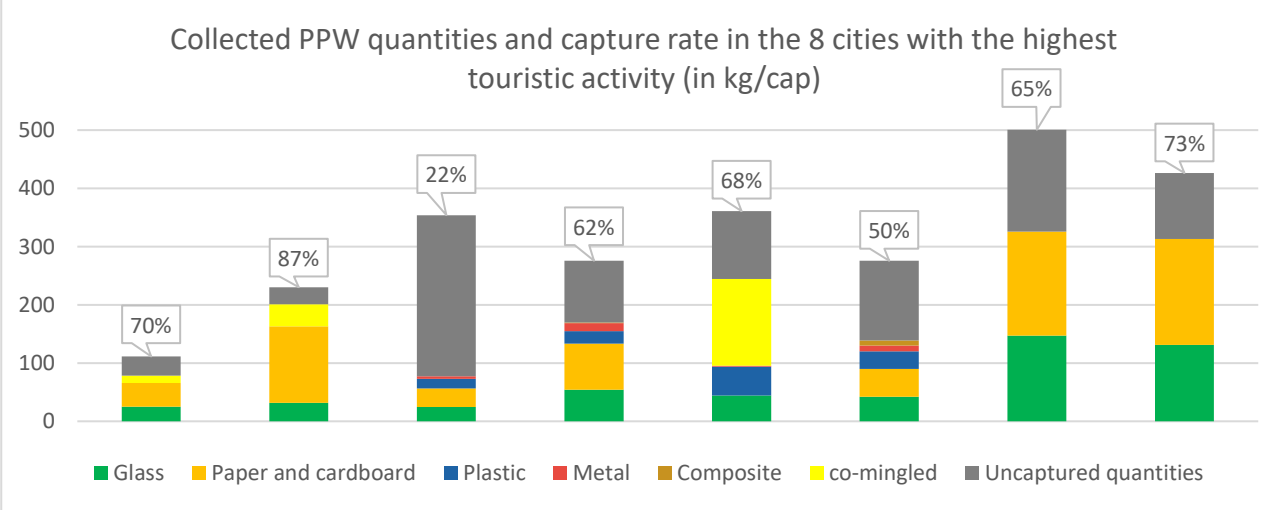


Figure 17: sorted and unsorted quantities in the most touristic territories among the documented systems, with the capture rate indicated at the top of the bars (ranked by overnight stays per resident population)

The information presented below serves as example on how benchmarking can be conducted. For further comparisons, individual factsheets presenting the waste management organisation and performances of all the documented waste collection systems are accessible on the COLLECTORS webplatform.

Figure 18: The COLLECTORS webplatform

More information can be found on the COLLECTORS webplatform

2.3 Where to put priorities and targets?

Implementing and improving selective collection entails investment and possibly higher running costs, and local authorities have limited resources. Therefore, it might be necessary to set priorities and targets considering the local characteristics. As explained above, the priorities are very dependent on the local context and the various interest of local decision-makers.

The new European regulation sets new, ambitious targets that will be challenging to achieve, even for the currently well-performing territories. The change of measurement points will also make it mandatory to improve the quality of sorted paper and packaging waste. It is therefore recommended to assess the current performances following the new calculation methods (introduced in part 2.1), or by gathering information on the current impurity rates of sorted materials sent to recycling. In the absence of data, the following figures were identified by the project as average values:

Table 9: average losses after collection or mechanical sorting of co-mingled fractions (source: Tallentire and Steubing, 2020 - Eunomia, 2019 - Eriksen et al, 2018)

Fraction	Average losses	Influencing factors
Glass	8%	Source separation or commingling with other materials
Metal	3%	No differences between collection methods
Paper and cardboard	1-12%	Source separation or commingling with other materials
Plastics	20%-45%	Quality of the mechanical sorting centre

These data should be regarded as simple indications; actual losses depend on various factors, including the type of collection. For instance, contamination found at the sorting centres is much more significant for paper and cardboard comingled with other materials, compared to when it is source-separated[7].

This first assessment should give indication of the needs for improvement and contribute to set priorities accordingly.

More quantities?

A first possibility to improve the performances of paper and packaging waste collection can be to focus on increasing the total collected quantities, possibly while limiting the increase of costs. In this case, glass packaging waste and paper and cardboard waste represent the largest waste fractions in terms of weight, as they represent more than 50% of the collected PPW in almost 80% of the documented collection systems, and more than 75% for half of the collection systems.

Besides, according to the economic data collected on the five case studies analysed by the project, glass and paper/cardboard consist in the two fractions for which collection and processing costs are the lowest ones from the point of view of waste collection systems. The costs per tonnes reported by the five case studies are presented on the following graph:

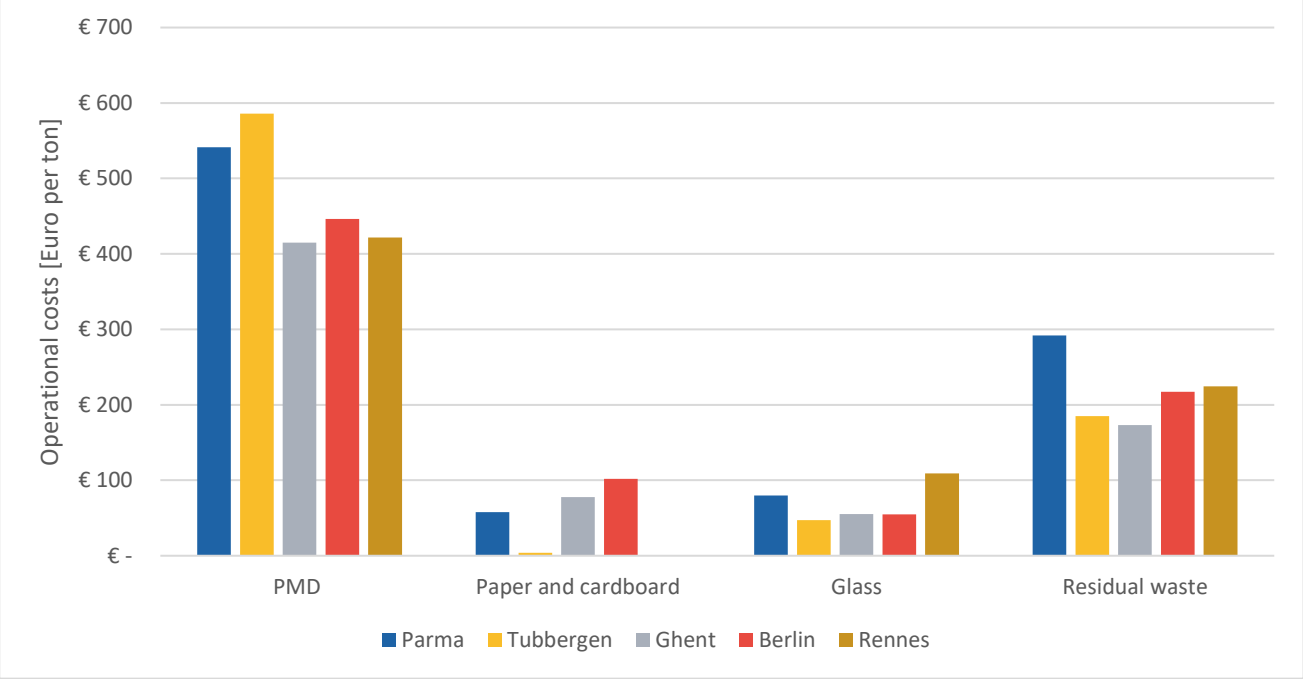


Figure 19: Operational costs per tonnes for each PPW stream, for the documented case studies (source: COLLECTORS, D3.2)

For these case studies, it is also interesting to note that the costs for glass and paper/cardboard are also lower than the ones for residual waste. It should be noted that the costs also reflect the possible optimisation of collection schemes, or the local costs for residual waste treatment.

More information can be found in D3.2

Environmental perspective

With the growing interest in climate change, and the urgency to mitigate carbon emissions within the next years, it can also be relevant to review the local priorities according to their potential for the reduction of environmental impacts, such as greenhouse gas emissions.

Improving selective collection might lead to more "direct" impacts because of more collection routes and longer distances for sending the different fractions to sorting and recycling. However, the "indirect" environmental benefits of ultimately substituting more virgin materials significantly outweigh these direct impacts. Besides, the performances of the waste collection (e.g. how much quantities of waste are selectively collected and the quality of the sorted materials) have a significant influence on the recovery of materials, and thus, environmental benefits.

The climate change and other environmental impacts associated with the production, disposal, and recycling of the different PPW fractions have been studied for the five case studies using Life Cycle Assessment.

When it comes to the different waste fraction, plastic seems to be the material associated with the highest impact on climate change; besides, the impact of disposal of plastic is quite significant,

meaning that diverting plastic waste from disposal to recycling is also relevant. Metal packaging also yield significant benefits, yet the generated quantities are lower than for plastics, making the total environmental benefit associated with metal packaging less important.

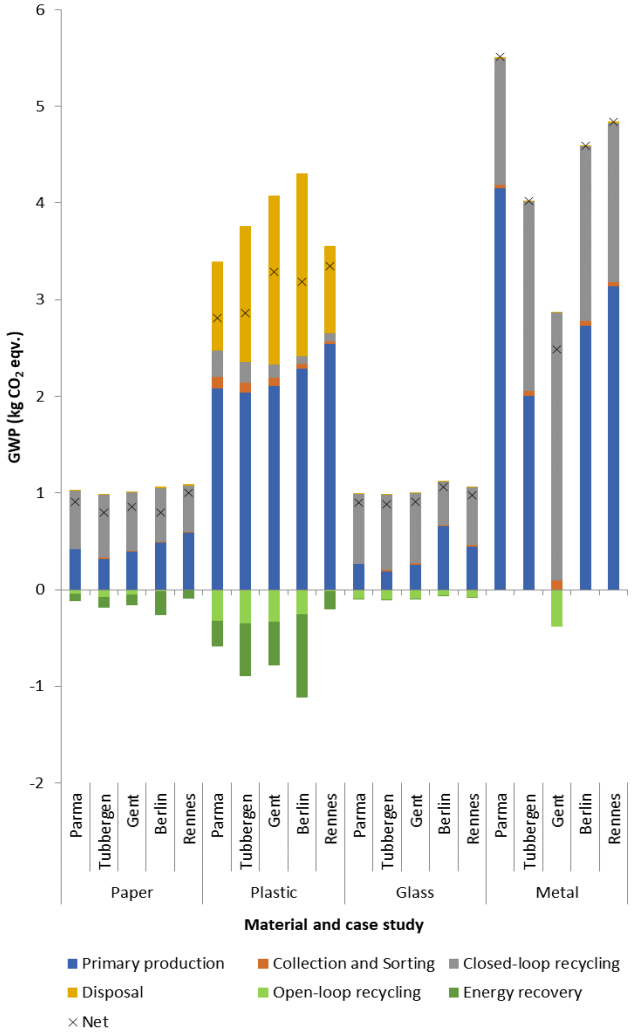


Figure 20: global warming potential for the different PPW fractions and for each step of its life cycle in the five analysed case studies (per kg)

More quantities or higher quality?

Whether priority should be put on increasing the captured quantities or on improving the quality of sorted fractions is a relevant question. Ideally, efforts should focus both on quantities and quality. The potential environmental benefits arising from the improvement of the capture rate (reflecting more the quantitative aspect) or the sorting and recycling rates (reflecting also the quality of collected materials) were analysed for the five case studies, and for each material fraction. It seems that the average potential is different from one material fraction to another:

- For **paper/cardboard** and metal, it seems that the main potential lies in improving the capture rate, as recycling is already very efficient;

- For **glass**, there seems to be an equal interest in improving the capture rate and the quality;
- For **plastics**, improving the quality seems to have much potential, as the main losses occur during recycling due to contamination and low quality.

In general, the environmental analyses tend to show that increasing the capture rate has the most significant benefit; however, the issue of quality is extremely important for plastic packaging waste. There seems to be significant losses post-collection, and low quality does not allow high-quality (e.g. closed-loop) recycling, which has a higher benefit than downcycling or energy recovery, whose environmental benefits might decrease in the future with the decarbonisation of energy.

These considerations have to be regarded as an average situation; the analysis of potential of the five case studies shows different opportunities, even if overall they follow the same direction. This might reflect differences in sorting performances and quality of sorted materials. A case-by-case evaluation of the optimal measures to improve waste collection, sorting, and recycling activities is, therefore, recommended.

More information can be found in D3.3

2.4 Good practices for collection: How to optimise the capture rates and the quality of sorted materials?

The cross-analysis of the collected data and of the case studies led to the identification of effective local strategies to improve paper and packaging waste management. The analysis of case studies and well-performing territories, as well as the discussions with external waste experts from local authorities, producer responsibility organisations, and other local players allowed to identify general good practices and recommendations for boosting the capture rate and the quality of sorted materials.

Separation systems

Source-separation is generally regarded as best practice when it comes to waste collection. The analyses conducted by COLLECTORS highlighted the following recommendations:

- **Source separation is highly recommended for glass packaging and paper/cardboard**: waste collection systems that are source-separating these fractions show higher capture rates than the ones co-mingling it with other materials. It seems that co-mingling also impacts the quality of sorted materials for these two fractions (e.g. contamination of paper and board by wet/fatty substances, damage of other materials by pieces of glass);
- **No notable difference could be identified between systems separating glass by colours and systems collecting all different colours of glass together**. The following sorting processes appear to be able to deliver the same types of outputs.

- **For plastic, metal, and drinking cartons**, no evidence could be found on the advantage of source-separation over co-mingled collection, neither on capture rate nor on the quality of sorted materials. It seems that these fractions can be efficiently sorted in the adequate sorting centres, due to very different characteristics (density, chemical composition, etc).
- **Collecting all types of plastic packaging** (and not only on bottles and flasks) **together**, and possibly with metal and drinking cartons, seems possible if the sorting processes are adapted accordingly. These changes can be done without hindering the quality of the other waste fractions, at the condition of a proper sorting process, which also entails higher costs.

Separation systems are very diverse across the waste collection systems documented by COLLECTORS; the most widespread combination is the source separation of glass and paper/cardboard, and co-mingling of "PMC", which is used in 40% of them. Co-mingling of paper and cardboard with other packaging waste is mostly found in the UK and France, while co-mingling of glass with other packaging fraction (e.g. metal) is mostly found in Italy and the UK.

Collection modes

Various collection modes are available for paper and packaging waste:

- **Door-to-door collection**, where the collector picks up the waste from each different housing;
- **Bring bank collection**, where waste producers have to dispose of their waste in containers located on the public space;
- **Civic amenity sites** are guarded and fenced areas where people can sort many different types of waste, including bulky waste;
- **Other collection modes** might be used: re-use centres, collection on demand…

These different options have advantages and drawbacks. Door-to-door systems are usually perceived as more convenient and associated with higher participation rates, but might also be more expensive and space-consuming for households, which have to store individual or shared bins. Bring bank systems can be seen as more flexible for inhabitants (which can get rid of their waste at any time) and less expensive, but might lead to less participation and higher contamination. Besides, the effectiveness of one mode or the other heavily depends on the way they are implemented:

- **Door-to-door systems** seems to present higher capture rates when the collection frequency of residual waste is similar or lower to the one of recyclable materials. Besides, another issue raised during the expert group discussions is the possible "open access" of bins shared between inhabitants of apartment blocks, and which can generate contamination, which might then "pollute" the good sorting behaviours of the inhabitants. Therefore, storing these bins in closed space or locking their lids can be recommended. Besides, one of the advantages of door-to-door collection is the possibility to check the

content of the bin before collecting it, allowing the collection operators not to collect bins or bags with visible impurities.

- The efficiency of **bring systems** depends on the average proximity to inhabitants, as it seems that there is a correlation between the average density of bring banks and the capture rates. Other factors can play a role, such as the visibility of the bring banks, or their "strategic" location (next to shops, public buildings, schools, or on the way to transport hubs). It is challenging to come up with precise recommendations for the number of bring points to be implemented as an effective network. Figures will depend on the typology of the area, and the density and repartition of the population. In very dense areas, it is likely that the location of bring points will be strongly limited by the available space, and thus the volume of these bring points should be designed according to the population that they are supposed to serve. For rural areas, a minimum number of containers per inhabitant is recommended. The figures of 1 collection point for 250 to 500 inhabitants were found in various sources[7] [8] [9]. In any case, documenting the use of individual bring points to assess their efficiency is recommended to adapt the network of points to the local needs.

In the case of bring points, or when bins are shared among different households in apartment blocks, it is recommended to add a specific opening depending on the collected fraction: 20-cm round opening for glass, slit for paper and cardboard, etc.) which limits the possibilities of misthrows for inhabitants.

Door-to-door collection is often considered as more effective than bring bank systems, as it is perceived as more convenient, however **data comparisons show little differences between the capture rates of systems using mainly door-to-door schemes and systems using mainly bring banks**; door-to-door systems seem to give slightly higher capture rates, yet there are an even distribution of door-to-door and bring systems among the top performers within the documented waste collection systems. However, **this general consideration has to be nuanced** depending on the waste fractions:

- For **glass packaging**, bring bank systems present slightly lower capture rates than door-to-door systems, however the quality is higher in average. This is probably due to the fact that door-to-door collection leads to more crushing of glass shards when bins are emptied in the collection truck, especially when compaction is used. Too fine glass makes it recycling as new bottles impossible. Bring system is the most commonly used collection system for glass within the waste collection systems analysed by COLLECTORS;
- For **plastic packaging,** the average capture rate of door-to-door systems is quite higher than the average capture rate for bring systems, and the average quality seems also higher.

[7] Eco-Emballages, 2010, Guide d'amélioration de l'implantation des points d'apports volontaires :Une approche globale du système
[8] European Commission, 2016, Municipal Waste Compliance Promotion Exercise 2014-5
[9] Bipro, 2014, Capital factsheet on separate collection - Zagreb

Many systems also combine different collection modes depending on the waste fraction or the different areas. Adapting the collection mode to the different local constraints of the different areas (e.g. historical centre with little space for bins in the streets, city centres with smaller housing, and suburbs with more single-family houses) within a single collection system is a common practice according to systems documented by the project, and was highlighted in several case studies as well as during the different stakeholder involvement.

Besides, several dense cities have implemented **temporary or permanent bring bank systems** in parallel with the door-to-door collection to allow separation to inhabitants not having access to a sorting bin (e.g. because of lack of space for individual bins): for instance, Ecostops in Treviso, or Tri'Lib in Paris, which both contributed to increase sorting rates in high density areas.

Highlight: adapting collection modes to different areas in Treviso

The waste collection system implemented in Treviso, Italy, by the public company Contarina S.p.a takes into consideration the different typologies of housing for the choice of collection equipment. While door-to-door system is the main collection mode in use, the containers provided to inhabitants are different depending on their location. Wheelie bins are used in less dense areas, while smaller 40-l bins are used in more urban areas, and collection in bags is made available to users with limited storing space. The urban areas are collected at a higher frequency.

Figure 21: collection equipment used in the Province of Treviso (source: Contarina S.p.a)

The bags have to be disposed in "Ecostop" and "Ecobus", temporary bring sites where inhabitants can bring their waste. The Ecostops and Ecobus are available for about one hour at specific location and times over the week. Bags have to be given to the collection operator or put in the

right container.

Figure 22: Ecostop used in Treviso (credits: Contarina S.p.a)

Despite the fact that high capture rates seem to be achievable through door-to-door collection, bring banks, or combined systems, it is worth mentioning that **several case studies achieved impressive improvement through a complete change of the organisation of waste collection, including a change of collection mode**. Most of the documented cases studies highlight changes from bring to door-to-door systems, such as the recent example of Sarria, a district in the metropolitan area of Barcelona. The case study of Parma also highlights how the change of the collection mode to better address the needs of inhabitants can contribute to the improvement of performances.

Highlight: Parma switching collection mode

Following a strong local opposition against a project for a new incineration plant, the city of Parma decided to set a new waste collection system aimed at optimising separate collection and reducing residual waste generation as much as possible.

The first steps, implemented in 2013, consisted in the introduction of separate collection of biowaste, along with the shift from a collection scheme using road containers to a door-to-door system. Within a year, all parts of the city benefited from a 4-stream kerbside collection (biowaste, paper/cardboard, PMC, and residual waste), while glass packaging is still collected in bottle banks.

Figure 23: demonstration to showcase the end of "road containers" (source: Comune di Parma)

Inhabitants were provided with individual, chipped bins or bags for residual waste (depending on their location), as well as individual bins or bags for the other fractions. Collection frequencies were adjusted depending on the size of the containers (e.g. for residual waste 120-l wheelie bins for less dense areas, 40-l bins in the city centre, and 50-l bags for the historical centre.

The changes were accompanied by the organisation of a “brigade” of municipal employees in charge of controlling the proper sorting behaviours (“*ecovigili*”), with more controls after the implementation to correct the main mistakes (wrong bags used, error on the days of collection). Controls are still on-going regarding the respect of the sorting guidelines and the quality of sorted fractions.

Besides, and to give more flexibility to inhabitants, several eco-stations were implemented. They act as permanent bring points where several waste fractions can be brought. Mobile collection points (“eco-wagons”) were also developed in the historic centre. They stop for a limited time at regular times during the week, and collect only residual waste and PMC, which are the two fractions for which there is no common sorting bins per apartment blocks, and thus are the two

fractions that inhabitants have to keep home between collection rounds.

Figure 24: one of the eco-station in Parma (source: G. Folli, 2016)

These different changes of collection had a very significant effect on the separate collection rates, which increased from 48.5% in 2012 to 73.5% in 2016. The introduction of the PAYT scheme in 2015 has led to a further increase, and the sorting rate increased to 78% in 2017.

Further resources are available for **collection systems in specific contexts***:*

- ***Historical centres****: the INTHERWASTE project listed several good practices for Waste Management in Urban Heritage Sites in a dedicated report.*
- ***Tourism****: the URBAN-WASTE project documented good practices for waste collection in touristic areas. These good practices are available as factsheet here.*

Incentives

While there is a significant diversity of organisation among the well-performing systems documented by COLLECTORS, the main difference with the other systems is the use of incentives, mostly pay-as-you-throw. In average, systems using PAYT or sorting obligations present significantly higher capture rates than other systems, and lower collected quantities of residual waste.

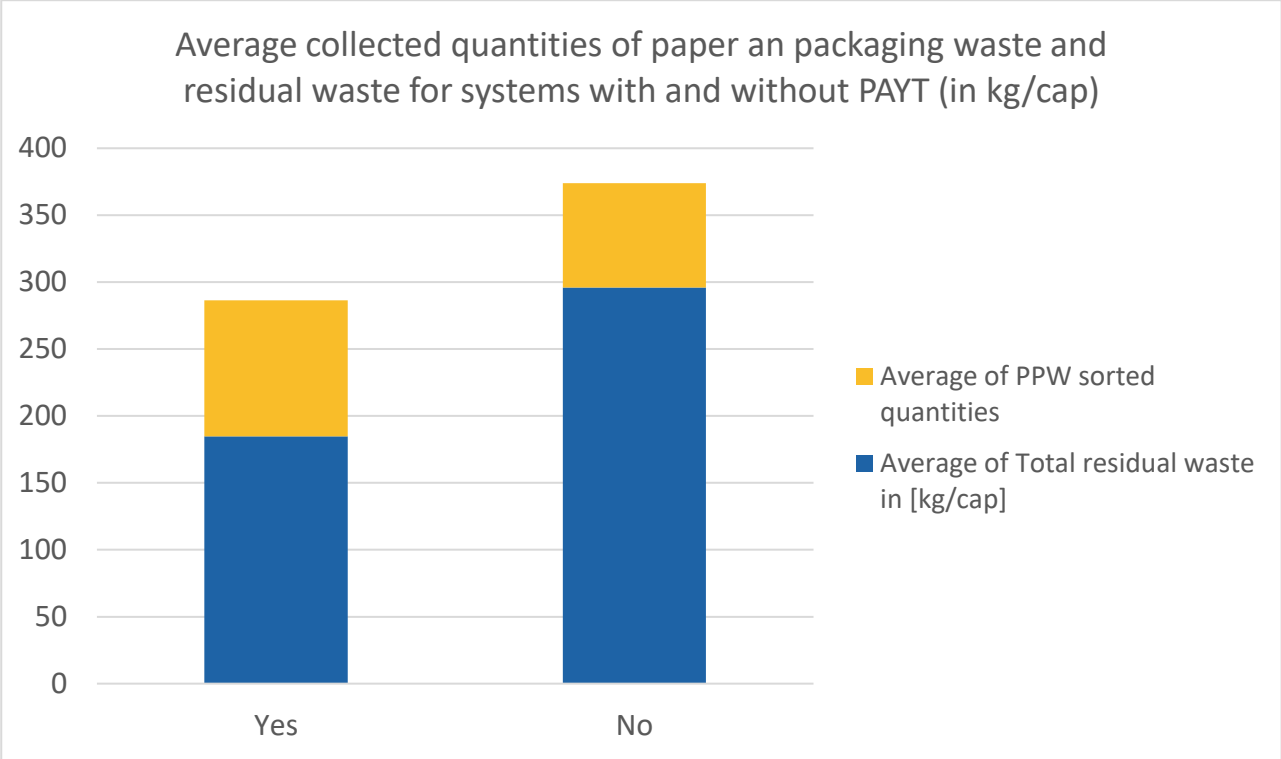


Figure 25: average collected quantities of paper and packaging waste and residual waste for systems with and without PAYT among the 135 waste collection systems

The implementation of PAYT systems is described in several guides[10] [11]. PAYT includes various possible schemes. Most of the systems consist of setting a variable fee according to the collected quantities of residual waste, either by charging residual waste bags, the number of collections, or the weight of the collected waste. These different systems are advantages and drawbacks: weight-based systems are believed to be the most effective ones, but are also more challenging to implement. Volume-based systems (e.g. according to the size of the residual waste bins, the number of residual waste bags used, or the frequency of collection, etc.) are easier to implement, and the most widespread systems among the documented collection systems.

Implementing PAYT systems requires several steps:

- **The identification of waste producers**: establishing the list of paying household (and possibly commercial activity) is the first step, along with the implementation of a system to monitor the use of the system and issue the invoices. Different systems exist to identify the individual bin of the different waste producers: individual stickers (put on the bin or on the bags) with a barcode and the address, or RFID chips on bins or bags. These systems are then recognised by the collection lorry when it is collected. In other territories, inhabitants are given an individual card that will allow them to buy collection bags provided in specific vending machines. The identification system is sometimes used to provide individualised information to the users (e.g. the number of collections provided, or of bags that they have

[10] ENT, 2010, Guide for the implementation of pay-as-you-throw systems for municipal waste (available here)
[11] JRC, 2018, Best environmental management practice for the waste management (available here)

already used). For bring systems, individual cards unlocking the opening of the bring bank, where only a limited volume can be put, is a common system.

- **Participation and involvement of stakeholders**: the introduction of the PAYT system to the user is an important step for its acceptation; a participative process can be implemented to limit concerns or local opposition. Participative activities aiming at explaining the reasons behind the PAYT, the foreseen system, the provision taken against illegal behaviours, or to collect information on the needs from both citizens and commercial activities, can consist in public meetings or workshops involving local elected representatives and waste experts.
- **Communication**: as for any major change in the waste collection system, communication is one of the most crucial points for the implementation of a PAYT scheme. It is recommended to shape communication activities as a dialog, as much as possible. Combining general communication (website, leaflets, etc.) and direct communication (public meetings, information stands, door-to-door campaigns) might also prove more effective. The communication should focus on different points:
  - Explaining the practical implementation and how the system works;
  - Presenting the charging system as transparently as possible. The PAYT fee should not be regarded as "yet another local tax";
  - Explaining why some fractions are charged, while others are "free";
  - Giving advices on how to reduce the production of residual waste through sorting but also waste prevention actions;
  - Explaining the reasons behind the changes, in a transparent and honest way. It can be relevant to show the benefits from the inhabitants' point of view (lower fees, improving the local environment), rather than highlighting the benefits for the local authorities
- **Setting exemptions:** the most common system of an exemption set by local PAYT systems is for diapers, with specific transparent bags distributed to households that use them. Only diapers can be put in these bags, and controls are made during collection. Other local authorities have implemented exemptions for specific activities (schools, homeless shelters, etc.), sometimes with controls of the content of the residual waste and cancelation of the exemption if too much recyclable waste is found. Some systems might exempt low-incomes households as well, however whether social considerations should be included in an environmental tax is debated, as it might reduce its effectiveness;
- **Test phase:** it is possible to run a first "test" year, where the system is actually implemented, but the variable fee is not charged (e.g. the previous fee system is maintained). This allows the citizens to better understand how the system works, as well as to proof test the overall system and identify potential flaws.
- **Monitoring and controls:** a close monitoring and control system should be implemented, especially during the first month of the implementation, to spot mistakes and improper behaviours. Direct communication with the households and commercial activities not complying with the new system can be organised. The intensity of controls can be reduced when non-compliances decrease, and after a few months of implementation. One important point to be monitored is the quality of the sorted fractions, which might

decrease as inhabitants want to reduce their residual waste as much as possible. It is highly recommended to conduct frequent controls, leading to different actions: information of the concerned household, collection of the sorted fraction charged as one collection of residual waste, or fine.

- **Tackling illegal behaviours:** illegal waste disposal is one of the main challenges that can arise after the implementation of a PAYT system, even if these problems tend to decrease over time. Besides information and communication actions, several actions can be identified to limit them:
  - **Controls,** including video surveillance of the most sensitive spots;
  - **Rapid clean-up** of the illegal dumping, as they generally attract more illegal waste disposal;
  - **Implementation of "extra" collection points**, such as the "ecostation" implemented in Parma: punctual or permanent bring points where inhabitants can dispose of their waste in-between collection rounds, for a similar fee.

PAYT in densely-populated areas

Dense areas, especially vertical housing, can be regarded as more challenging for PAYT schemes. Several systems are implemented in vertical housing:

- **Volume-based systems with shared bins**: the costs are charged for the whole building, and then residents split the costs among the different apartments. This system is not recommended as the PAYT effect is usually cancelled by the issue how the fees are split among the different apartment;
- **Bring bank systems that can be opened by residents' cards**
- **Bag-based systems**, combined either with a door-to-door collection in bags, individual or shared bins, or underground containers.

The most commonly-found system in dense cities is the **bag-based system**, which is regarded as a flexible solution that can fit different contexts. It is recommended to consider allocating a limited number of "free bags/collection" (e.g. according to the size of the household) in the fixed fee to prevent illegal behaviours.

PAYT in touristic areas

There are few examples of specific PAYT schemes in touristic areas. Few recommendations can be formulated:

- Specific PAYT system for hotels and restaurants where much waste from tourism is produced, with a fixed fee based on the size of the commercial activities (e.g. the capacity, number of rooms), and a volume- or weight-based variable fee;
- The application of the PAYT scheme to secondary residences (which requires their proper identification).

Alternative to PAYT schemes

Besides PAYT, other incentive methods can be implemented (possibly in parallel).

For instance, "know-as-you-throw" (KAYT) is a concept developed by the Waste4think project, that can be seen as a simpler, more acceptable, or preliminary instruments to PAYT. The idea is to implement a system to identify waste producers and their associated collected quantities, and provide them more individual feedback through both this system and punctual controls. While traditional PAYT systems usually provide feedback only once or twice a year (with the invoice), the KAYT includes more frequent individual feedback, positive and negative. This enables the communication of more adapted sensitisation messages, and the feeling of being monitored seems to improve sorting behaviours[12].

Other systems proved to be effective: for instance, the city of Milan introduced transparent bags for residual waste collection prior to implementing the selective collection of biowaste. This simple change improved the collection of recyclable waste by 2%.

Besides, some cities also implemented sorting obligations for several waste fractions, including paper and packaging waste, for inhabitants and/or commercial activities. These sorting obligations are generally linked with control systems to ensure the compliance of waste producers, associated with information and possibly fines.

Highlight: control of waste sorting in Brussels, Belgium

In 2010, the Brussels Region introduced an obligation for selective collection on paper and packaging waste (glass packaging, PMC, paper and cardboard), among other waste fractions. This was followed with the introduction of a similar obligation for companies.

To enforce this obligation, regular controls are implemented by a team of controllers, which consist in the collection of about 500 residual waste bags before the actual collection, on which the address is noted by the controllers. The bags are then opened and their content is analysed. Fines going from 75 to over 600 euros can be put depending on the content of the bag. Fines are put when the content indicates that the household does not sort waste at all, rather than the presence of few recyclables. Higher fines can be put when specific waste can be found, for instance glass packaging, that can be dangerous for the collection staff.

Residual bags are not individual, meaning that the household has to be identified using different methods: presence of mail with the name and address of the person in the residual waste bags, for instance. Otherwise, further investigation might be required, based on the address where the bag was collected.

This obligation led to the increase of sorted quantities, and the Brussels Region presents overall

[12] More information here : https://www.collectors2020.eu/wp-content/uploads/2018/07/2018_09_26_COLLECTORS_5_Waste4think_Giavini.pdf

good performances, compared to other dense cities: 77% capture rate for paper and packaging waste, low to average impurity rates.

Implementing changes to waste collection

One of the main challenges when implementing some significant changes in the waste collection system is to ensure the social acceptance by the population, so that the right behaviours are adopted.

The analysis of the five case studies highlighted several recommendations to secure the participation of inhabitants in case of modifications:

- Analyse **the impact of these modifications on the following considerations**, possibly for the different areas of the territories:
  - Type of housing and available space in the household or the common areas of buildings (courtyards, etc.);
  - Additional time and efforts induced by the modifications;
  - In case of bring systems, accessibility (distances depending on the expected mode of transportation, opening time according to the targeted population, specific services for inhabitants that cannot reach them).
- Communication must focus on the **practical modifications and implications for inhabitants**, but also on the **reasons behind these changes** and how it will improve the overall situation (the environment, job creation, optimisation of costs/reduction of waste fees, etc.);
- **Direct communication** is highlighted by several case studies as interesting and relevant in case of modifications, when making sure that the information reaches the inhabitants is critical. Addressed letters, or door-to-door campaigns can be implemented to do so. In some territories, waste advisors (possibly partly funded by the EPR systems) can contribute to these direct communication activities.
- **Monitoring of the participation and evaluation of the new measures** are good ways to assess the acceptance of these modifications. Beyond the question of satisfactions, surveys can look at how the modification improved the involvement and the behaviours of citizens. Cross-analysing this information with an analysis of the evolution of performances can contribute to properly assess the efficiency of the current system and identify improvements.
- Establishing a **feedback-gathering mechanism** (e.g. webpage or phone number to address complaints or feedback) can be regarded as a good practice. Some waste collection systems also set online services where citizens can request changes for their collection preferences: size / types of bins, adapted collection frequencies.

Highlight: focus groups to prepare a reduction of collection frequency for residual waste in Ealing, London[13]

Ealing is a borough of London, located in the West part of the city. Following the examples of other boroughs, it decided to modify its collection system in 2015 by modifying the collection equipment and frequencies for residual and packaging waste. Collection of residual waste was done on a weekly-basis in bags, and was modified to a bi-weekly collection in 240-l wheelie bins (with smaller bins available on request); similar modifications were brought to the packaging collection. These changes were brought for several reasons: a better control of collection costs, an increase of food waste collection (whose collection frequency was kept on a weekly-basis, and kept on a voluntary basis), and improvement of cleanliness, since the residual bags were sometimes ripped off by rodents.

To enable these changes and ensure their social acceptance, a series of focus groups involving different types of citizens was organised. The panels were composed of various socio-economic backgrounds and different attitudes toward waste separation. The focus groups highlighted the following elements:

- **The reactions to changes are primarily framed by their existing attitude to waste and to the local council**;
- The reduction of the collection frequency is firstly/instinctively seen as a loss of service, and so as something negative;
- **"Selling" messages are not appreciated**, meaning that the changes should be presented in an honest and transparent way. Likewise, appeals to social norms, presenting the new service as an "improved service" when the reason is mostly to increase recycling rates while reducing costs, or messages assuming an extensive knowledge on how the service works, all proved to be ineffective.
- The **preferred messaging** was mostly focusing on the inhabitants' perspective and interest: explaining how the new system made it easier to recycle (due to co-mingling of packaging and alternate collection between packaging and residual waste), highlight the environmental benefits (increase recycling), explain the end-application of the sorted fractions, highlight the potential savings for the municipalities and how they will benefit the inhabitants.
- The messages should be simple (what practically changes), practical, evidence-based, and it should be made use of everyday terms ("grey bin" instead of "residual waste").

[13] Resource London, 2016, Fortnightly refuse & wheelie bins - West London research summary

2.5 Economic balance of waste collection systems

General observations on costs and incomes

The cost-benefit analysis of the 5 case studies on paper and packaging waste allowed the identification of similar trends when it comes to the economic balance of waste collection system. The size of this panel is too limited to come up with definitive conclusion on the economic performance of the different modes of organisation for waste collection systems; besides, the diversity of economic frameworks (e.g. the local gate fee for waste disposal, the take-back prices for sorted materials, subsidies provided by the EPR system or the national/regional authorities) and of the concrete organisation of waste collection (e.g. the distribution of responsibilities between the producer responsibility organisations, the municipalities or groups of municipalities, public and private waste companies, etc.) makes it challenging to come up with completely comparable figures.

However, similar trends can be observed:

- Waste collection represents the main part of the operational costs;
- Collection and processing of PMC is generally the most expensive fraction per unit of mass, while costs per tonne for glass and paper cardboard are comparably less expensive, and cheaper than the cost per tonne for residual waste collection and treatment;
- For most case studies, the waste fee paid by the inhabitants is the main source of incomes for the waste management of paper and packaging waste, followed by the incomes from material sales and EPR subsidies. However, their respective shares are quite different from one case to another.

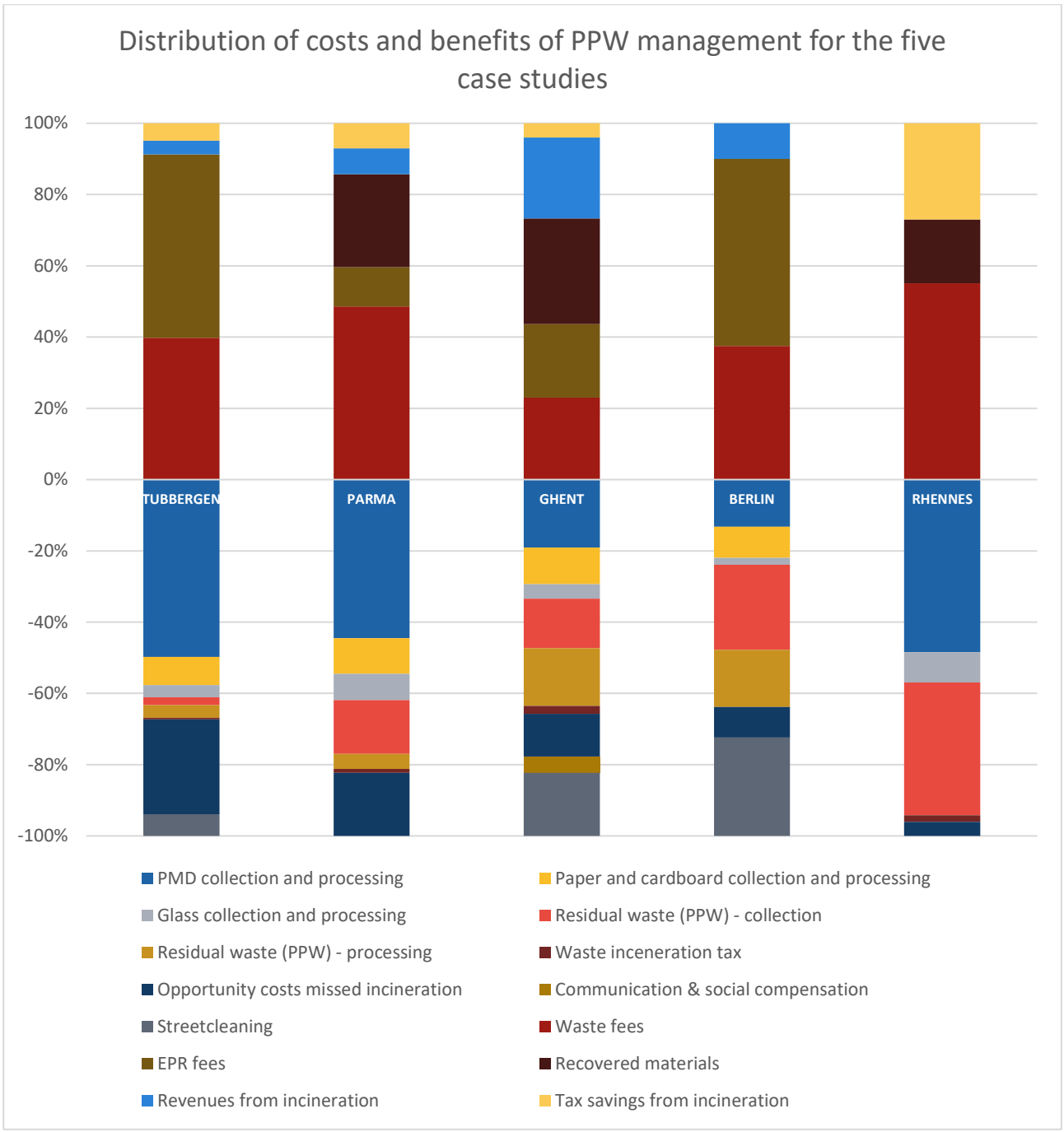


Figure 26: Distribution of costs and benefits of PPW management for the five case studies (source: COLLECTORS, D3.2)

The impact of improving performances on cost balance

The evolution of the cost balance of paper and packaging waste management over the past few years was analysed for all five case studies, during which all case studies experienced increase of performances regarding separate collection.

Table 10: Overview of revenue shifts shown as percentage of total revenue in first year and last year of project period

Case	Waste fee [%]	Recovered materials [%]	EPR fees [%]	Incineration revenues [%]
Parma	56 → 49	18 → 26	8 → 12	16 → 6
Ghent	26 → 21	30 → 24	15 → 30	26 → 21
Berlin	-	-	47 → 52	14 → 10
Tubbergen	60 → 32	-	26 → 53	13 → 3
Rennes	58→ 55	19 → 18	19 → 25	-

It is interesting to note that in all the cases, the contribution of the waste fee decreased, along with the revenues from energy sales from energy recovery, while the contribution of EPR subsidies generally experienced a sharp increase.

There are significant differences regarding the share of EPR subsidies and funding across the five case studies. They reflect differences in the responsibilities of EPR system across Europe: for instance, the EPR system in Germany is directly responsible for organising collection and processing of packaging waste.

For all case studies, the increase of separate collection of paper and packaging waste led to an increase of the operational costs; however, it is interesting to note that these costs were linked with a parallel increase of the revenues as well, while the **waste fee remained stable or even decreased**.

Highlight: the evolution of the cost balance of paper and packaging waste management in Parma

As presented previously, the city of Parma experienced an impressive improvement of waste separation over a rather short period of time, by bringing profound changes to its waste collection system. The changes were introduced between 2012 and 2017, starting with the introduction of kerbside collection for biowaste and PPW (except glass packaging) in 2013, and the introduction of a PAYT system in mid-2015.

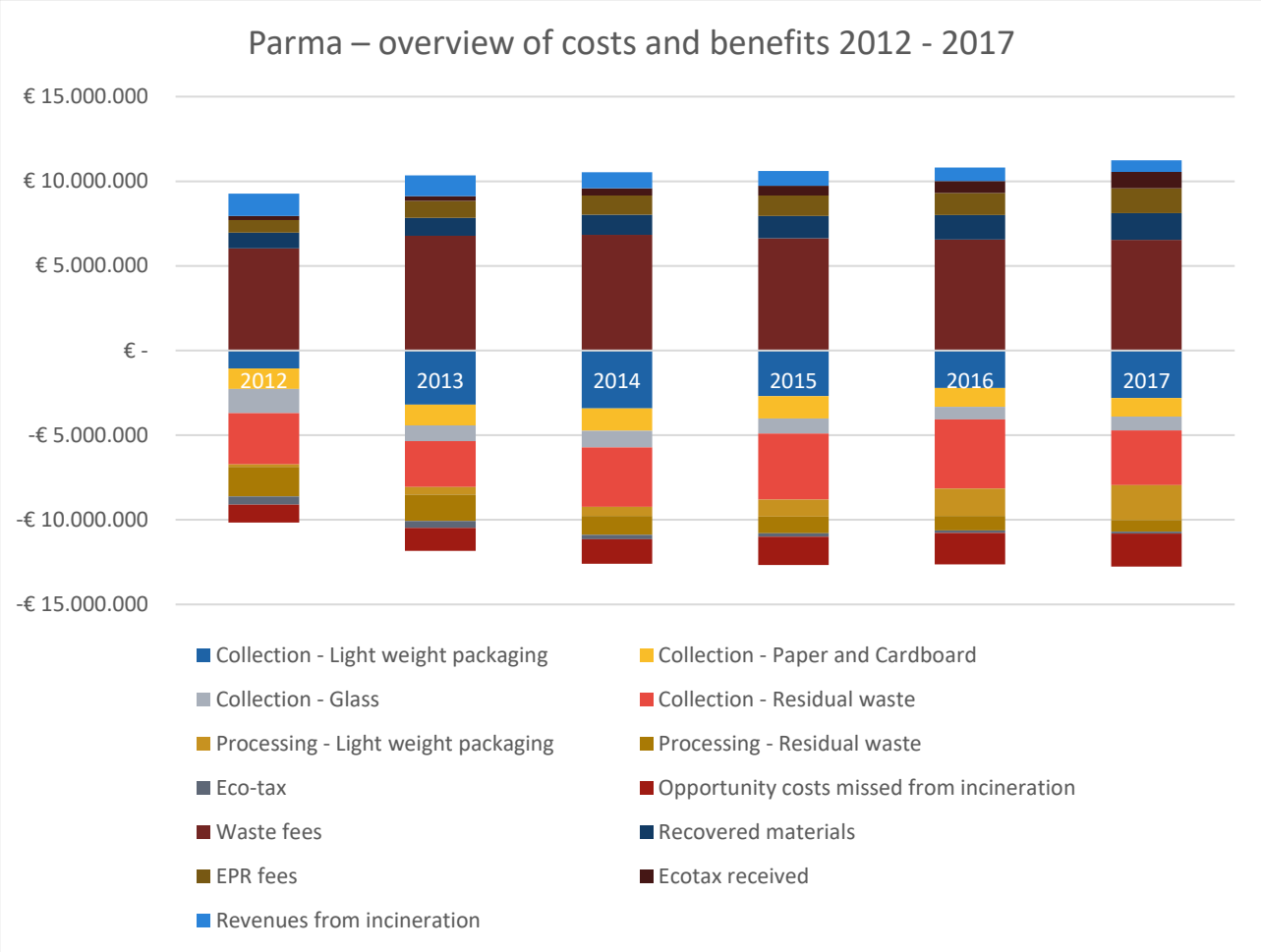


Figure 27: Parma – overview of costs and benefits of paper and packaging waste management (including unsorted PPW)

Over this period, the total operation costs increased, especially the costs for light-weight packaging (PMC), as well as the collection costs for residual waste. However, this overall increase of costs did not entail an increase of the waste fee, due to savings on the cost of treatment of residual waste, along with the increase of revenues from material sales and the EPR subsidies.

The revenues from materials benefited from the new separation system: the previous co-mingled collection of glass, plastic, and metal generated 17 €/t, while one tonne of PMC now generates

106 € and one tonne of glass generates 33 €/t, due to higher quality. Between 2012 and 2015, the revenues from glass and PMC increased by +340%.

Besides, the savings on residual waste treatment by incineration decreased by 3.5 millions €, a reduction of almost 40%.

The waste fee experienced a small increase during the first year (from an average of 245 € in 2010 to 260 € in 2013 for a family of 3 living in 100 m²), but it went back to its initial amount in 2016. It ranges among the lowest fees in the Emilia-Romagna region. Interestingly, the difference between the lowest fee and the highest fee for a family of 3 is rather small: the minimum number of annual collection (24/year) costs 244 €, while the maximum number (52 collections per years) costs 285 €.

More information from COLLECTORS webinar available here.

Benchmarking data on costs

The COLLECTORS project could not produce benchmarking data for cost of paper and packaging waste management. As explained above, benchmarking costs requires a consistent reporting of costs by local authorities, yet local costs data are usually reported in very different ways.

However, some benchmarking of costs is available in several member states, where consistent data are collected and cross-analysed to produce average figures. Below, benchmarking data for costs are presented for the Netherlands and France. It is worth mentioning that it is unsure whether the data from the Netherlands are comparable with the ones from France, considering that the benchmarking method might differ.

Table 11: Overview of collection costs in the Netherlands in Euro per ton for different collection methods[14]

	Residual waste	Paper and cardboard	PMC	Glass
minicontainer	€ 65	€ 103	€ 316	€ 163
Combined duo bin	€ 62	€ 91	€ 468	€ -
Kurbside bags	€ 116	€ 85	€ 453	€ -
Bringbank	€ 144	€ 130	€ 383	€ 64
Average	€ 79	€ 85	€ 370	€ 63

[14] NVRD, 2014, benchmark household waste in NL

Table 12: Overview of collection costs in France in Euro per ton for different collection methods and separation systems for paper/cardboard and PMC[15]

	Residual waste	PC / PMC*	Paper / packaging*	All co-mingled*	Glass
Door-to-door	€ 105	€ 451		€ 462	
Combined systems (DtD + BB)			€ 432	€ 474	€ 111
Bring banks	€ 97	€ 344	€ 349	€ 313	€ 67
Average	€ 108	€ 380	€ 402	€ 449	€ 92

** The figures also include the cost of separation in mechanical sorting centres*

Both tables show similar trends:

- Bring bank systems seem to be cheaper options for glass and PMC. It appears to be more expensive for paper and cardboard in the Netherlands.
- For residual waste, both collection modes are comparable in France, while door-to-door is less expensive in the Netherlands;
- The general observations regarding the costs for each waste fraction made with the case studies are confirmed by both benchmarking data.

More information available in D3.2 and the COLLECTORS webinar on paper and packaging waste

2.6 Toward a circular economy approach

Waste collection systems do not operate in insolation: their purpose is both to provide a service to waste producers while securing their involvement in waste separation, and to produce secondary raw materials with a sufficient quality to meet the requirements of recyclers.

Secondary materials and end-application for paper and packaging waste

The sorted paper and packaging waste fractions undergo various sorting steps before finding their end-applications. The sorting and recycling processes are very different from one material fraction to another, with different recycling options, leading to different end-applications. It is important to note that the composition and quality of the collected waste fractions can have a significant influence on the losses occurring at the consecutive sorting and recycling processes, and might also limit the possibility for high-end applications.

[15] 3

Table 13: sorting and recycling processes, possible end-applications, and quality requirements for the different PPW fractions

PPW fraction	Glass packaging	Paper and cardboard	Plastic packaging	Metal packaging
Sorting and recycling process	Glass is either being separated by colour (green, brown, clear) or collected mixed together and then sorted by optical colour sorting equipment. After collection, glass is sent to recycling facilities that will produce furnace-ready glass cullets. The process includes quality check, contamination removal, processing into glass cullets, and possible colour separation	The sorted paper and cardboard are separated into different grades in a dedicated unit or at the paper mill. When entering the paper mill, a quality check is performed (e.g. by sampling) to verify the compliance with the grade specification. Then the paper undergoes several processes, including pulping with water and removal of contaminants, where most losses will occur, and in some cases de-inking. The obtained product is then used for paper or cardboard production. Sorted grade might also be sent to other processes (such as cellulose insulation production) where different processes occur	The different polymers of plastic packaging are generally collected together (and possibly with other material fractions). In some cases, only PET is collected, while in other a limited number of polymers is included. Sorting by polymers can occur in packaging waste sorting centres, or in dedicated centres, and requires many different automated and/or manual steps. The separated polymers are then baled and traded to recycling facilities (in Europe or outside of EU). Recycling consists in mechanical transformation into intermediate or final shapes such as flakes, agglomerates, granulates, etc. The recycling process includes a pretreatment with shredding and washing, extrusion (where plastic pieces are homogenised through heat) or pelleting. Depending on the produced output, different applications will be possible.	Steel packaging is generally collected together with other fractions and sorted in sorting facilities and baled. Baled steel is then directly sent to steel furnace. There, it is melted in a furnace to produce different grades of steel; the molten steel passes through continuous casters and is formed into various forms, to be then transformed into a wide range of finished products. Aluminium packaging undergoes the same processes before being directly sent as bales to aluminium plants: refiner, or remelter, to be turned into various aluminium products (including packaging). Bales are shredded and contamination removed (e.g. steel, ink, coating).

End-applications	Container glass (flint, brown, green) Insulation mineral wool (short glass fibre) Ceramic sanitary ware Fluxing agent in brick manufacture Sports turf and related applications Water filtration media Abrasive Aggregate in construction materials Reflective highway paint	Newsprint Other graphic papers Case materials Carton board Wrappings and other packaging Sanitary and household Other paper and board Construction materials (insulation, bricks and furniture) Animal beddings or compost Fibre applications in construction and manufacturing (in concrete, asphalt, brake linings)	Mono-colour rPET Mono-colour rLDPE / rLLDPE Mono-colour rHDPE Mono-colour rPP Mixed plastic pellets	3000-series wrought aluminium alloys Low carbon steel Fibres
Quality of sorted fractions	The main factors influencing quality are: - The particle size and size distribution: if too fine, the cullets might not be suitable for high-end application - Contamination: it should be as low as possible. The presence of ceramics (refered as CSP: ceramics, stones, and porcelaine) or other types of glass (flat glass, light bulbs, etc.) is critical if the glass is meant to be remelt as they interfer with the process -	The paper industry manages standardized grade categorizations (EN 643), such as: - Group 1: ordinary grades, such as mixed paper and board; - Group 2: medium grades, such as sorted office paper; - Group 3: high grades, such as white newsprint; - Group 4: kraft grades, such as unused corrugated kraft; - Group 5: special grades, such as used beverage cartons. The possible end-application will depend on the grade obtained. Besides, contamination is an important factor. Contamination with food will affect the physical properties of the end-product. Other contamination might also entail more losses during the pulping and screening processes.	In several member states, specific quality standards were defined for different types of polymers. The most common ones from plastic packaging are PET, LDPE, HDPE, and PP. Plastics Recyclers Europe has released a set of bales quality guidelines. The quality of plastics depends on the content of impurities, the presence of prohibited impurities (e.g. rubber, minerals, wood, hazardous waste, etc.), colour, origin and source, moisture content. The quality criteria will depend on the end-application (e.g. food contact)	Steel is not very sensitive to the presence of impurities because of the temperature of the high furnace that vaporises most impurities. However, the presence of copper should be avoided as it can impact the properties of the steel. There are several European quality standards for aluminium packaging, including one for aluminium beverage packaging. Aluminium recycling is more sensitive to contamination.

Recommendations for paper and packaging waste

As explained in part 1, the main factors that influence the ability of waste collection systems to positively contribute to the recycling value chain are the following:

- **Traceability of the collected waste**: The more information recyclers can obtain about the origin of products that have become waste, the more they will know about the materials it is composed of, and the higher the chances are that these materials can be recycled into high quality products;
- **Supply of collected waste**: in order to be able to operate in a steady way, a minimum amount of waste has to be supplied to the sorter and recycler;
- **Quality of the sorted waste**: the sorted waste must meet some quality requirements to enhance recycling into marketable secondary materials.

For paper and packaging waste, several recommendations and good practices were already provided in the previous parts. As for the alignment of waste collection systems with the rest of the value-chain, the following recommendations can be formulated:

- Easily sortable fractions, such as PMC, can be collected together without hindering the quality of the separated fractions; however, glass and paper/cardboard should be source-separated to secure the quality.
- The number of collected materials for each stream should be limited ("do's and don'ts) to allow more homogeneous fractions.
- Ensure the alignment of the various steps: collection, sorting, and recycling, by:
  - Making clear agreement on the scope of each fraction;
  - Securing the transfer of information between the consecutive steps;
  - Ensuring clarity on the specifications for the outputs of collection, sorting, and recycling;
- Control the quality of the collected fractions, by using transparent equipment, asking collection operators to visually check the quality of the content of the sorted fractions before collection and not collect the contaminated bins, and organising punctual controls of the content of the bins with corrective actions (information on sorting guidelines, or fines).

More information available in D2.2 and D2.4

3. Waste Electrical and Electronic Equipment

This part focuses on some categories of Waste Electrical and Electronic Equipment (WEEE), namely:

- Small household appliances;
- Information technology (IT) equipment;
- Light bulbs.

These specific fractions were targeted considering that significant quantities are still improperly disposed in residual waste, and show low collection rates.

The practical organisation of WEEE collection is very different from the collection of paper and packaging waste, considering that it is mostly organised by Producer Responsibility Organisations (PRO), and that local authorities only partly contribute to the collection by facilitating municipal collection points and communication with citizens. Besides, collection methods are quite different from the traditional door-to-door and bring bank systems. Finally, WEEE is not generated on a regular basis compared to packaging waste, which makes the sorting behaviour different.

In addition, only part of the WEEE generated end up in the "legal" WEEE system. The European project CWIT(« Countering WEEE Illegal Trade ») determined that only 35% of the 9.5 million tonnes of WEEE generated in Europe in 2012 ended up in the legal collection and treatment routes, while the rest was illegally exported (15%), treated in unlicensed units (33%), illegally collected to extract valuable materials (8%), or thrown away in the residual waste (8%)[16]. The ProSUM project provided an overview of the gaps in the different Member States.

3.1 Assessing the situation

Improving the local waste collection system starts from a proper assessment of the current system and its performances. The level of performance is usually compared with legal targets or the average performance at regional or national level, yet it can also be interesting to compare it with other territories sharing similar characteristics.

Relevant data and indicators

A list of relevant indicators on WEEE for decision-making and the assessment of local performances was identified by the project, with the help of representatives from producer responsibility organisations and public authorities. The list includes indicators that were considered both relevant and possible to assess at local level. The full list of indicators is presented in COLLECTORS Deliverable 1.1.

[16] [16] CWIT, 2015, *Deliverable 6.4 - Recommendations for the electronics industry*

The main indicators are summarised in the table below. These indicators are based a selection from the full list identified by the project, for which data were mostly available for the documented systems, and that received most of the attention during the different meetings with local experts.

Table 14: Useful indicators for the assessment and monitoring of a local WEEE collection system (Source: COLLECTORS, D1.1)

Indicator	Description	Comments
Waste generation		
Estimated WEEE generation	Estimated WEEE generation in the area in scope (municipality, city...) based on estimate of WEEE generation per capita available at national level.	The generated quantities at sub-national level are usually not available. Even if local consumption patterns might be different, using national data is generally the best way to assess the generated quantities. A specific method has been established for its calculation[17]. Additional information on local / regional data might be available to better assess the local generation, thanks to local surveys or studies (e.g. number and types of products in household stocks)
Mixed residual waste composition	Share of small WEEE included in mixed residual municipal waste.	Monitoring the quantities of waste in residual waste with composition analyses is a relevant way to assess the potential for improvement. To obtain consistent results, it is recommended to use a standardised method with a representative number of samples. Additionally, surveys exploring citizen's habits of disposal may provide good inputs on this issue.
Waste collection		
Scope of WEEE collected	What is included: WEEE from households only, WEEE from households and WEEE from similar sources	Even if the scope of collection might be limited to household waste, it might not be possible to control that the collection system is only used by households.
Separate collection of waste fractions	Applied options for separate collection of different WEEE and collected amounts in t and kg/capita	There are generally several different collection options for WEEE. Having the collected quantities per WEEE fraction and type of collection mode is useful for comparison and to assess the potential for improvement. The classification and identification of WEEE into categories should follow as much as possible standard ones (e.g. the WEEE Directive categories), to allow consistent comparisons with legal targets and other territories. Aligning this classification among the different players for reporting is a relevant process.

[17] UNU, 2014, Study On Collection Rates Of Waste Electrical And Electronic Equipment (available here)

Types and number of collection modes used	Types and number of the following collection modes: civic amenity sites, retail bring points, mobile collection, other	Identifying the different collection modes, along with the number of collection points, is a way to assess the convenience of the collection system. Several indicators can be used for assessment and benchmarking, such as the number of collection points per inhabitants, the density of collection points, etc.
Waste treatment		
Quality of collected WEEE	Amount of WEEE rejected/complaint by treatment operators per container (%-estimation for categories Large Appliances, IT monitors and screens, Cooling Appliances)	The rejected quantities might give an indication on the quality of the collected WEEE and identify room for improvement Rejected/complaints of quantities may refer to WEEE missing valuable parts (also known as scavenged WEEE), damaged WEEE (unable to follow proper depollution and/or treatment) or the presence of impurities (non-WEEE materials).
Output from first sorting / treatment	Output fractions from first sorting / treatment of WEEE categories /types and destination	The share of materials going to recycling and to disposal is a good indicator to understand how effective the waste collection system is in terms of captures quantities and quality.
Waste prevention		
Key measures to promote re-use/repair	Specific measures to promote re-use/repair of WEEE taken at local level	Re-use is an important part of WEEE management and yield significant environmental benefits. Identifying the main measure to improve repair and re-use is therefore relevant.
Economic features		
Costs / organisation	Description of - (shared) responsibilities and benefits - funding sources (PRO, regional tax; regional budget; special waste budget; waste fee, including shares)	While it might be difficult to identify the amounts related to the different funding sources, it is interesting to identify them, as well as how they are calculated.
Annual running costs	Annual running costs to operate current WEEE collection. If possible, breakdown of costs in: waste collection, waste transportation, waste treatment, staff, infrastructure, compliance.	Due to competition, information on costs might not be easily available. However, most PROs produce annual figures of the management of their activities which are usually submitted to the corresponding relevant authorities. Some further elements on costs will be presented below.
Fee system	Municipal waste fees to consumer based on: fixed fee, no PAYT elements (flat rate); pay-as-you-throw elements; no clear information; other	How inhabitants are charged with waste collection might have an impact on WEEE collection. PAYT schemes on residual waste might limit the amount of small WEEE discarded in residual waste bins. PAYT on bulky waste might also limit the presence of WEEE in mixed bulky waste. Other strategies offering a reduction of waste fees when using official collection points for disposing of WEEE may work towards

		increasing collection rates.
Social aspects		
Feedback gathering mechanisms	Existence of citizen feedback gathering mechanisms (surveys, questionnaires) and information on behavioural insights	Feedback gathering mechanisms are important to better understand the perspective and needs of the inhabitants.
Capacity building and training addressing authorities	Existence of capacity building activities and training programmes addressing authorities.	Part of WEEE is collected by local authorities. To ensure a proper collection preserving the quality, capacity building is important. Appropriate training for raising awareness and increase knowledge on the different channels followed by WEEE is relevant to enforcement bodies.
Influencing policy and challenges		
Penalties, sanctions, fines	Are penalties, sanctions, fines for non-compliant management of WEEE types / categories in place	As explained above, illegal practices might significantly impact the collection performances. Identifying mechanisms used to limit their impact is relevant for understanding the collection figures.
WEEE escaping from formal collection route/system	Is information available on: a) WEEE littering or vandalism b) informal WEEE collection (theft, scavenging) c) informal WEEE treatment? If yes, short description of problem and potential measures	There might be significant gaps in local data due to the illegal practices or WEEE mislabelled as other fractions (e.g. scrap metals). Having some information or local assessment of such practices can contribute to better understand this gap.

More information can be found in D1.1

The importance of the local context

As explained previously, local context might play a role on the generation of WEEE or the capture rates, e.g. by making it more challenging to set an adequate waste collection system. The expert discussions organised during the course of the project led to the identification of several contextual parameters with high, medium, or low impact on WEEE collection.

Table 15: contextual parameters sorted according to their importance of WEEE waste collection systems (source: COLLECTORS, D4.4)

Importance	Contextual parameters
High	Population density, (No. of inhabitants per km^2) Local economy, (GDP per inhabitant)
Medium	Estimated WEEE generation per capita, (Kg / capita / year) Area size, (km^2) Area characterization, (remote/not remote, coastal/inland/island) Type of housing, (Share of detached and semi-detached houses in %)
Low	Population, (No. of inhabitants) Households, (Total no. of households) Household size, (average no. of persons per household) Estimated WEEE generation, (Total in tonnes)

When comparing local waste collection systems, it is therefore recommended to focus on territories sharing similar contexts when it comes to **population density**, which reflects the space available for collection points and the capacity for inhabitants to store WEEE to be discarded, and the **GDP per inhabitants,** which might reflect the availability of resources to invest in waste collection system. The GDP might also have an impact on the WEEE generated quantities.

More information can be found in D4.4

Comparisons with other territories

Comparing and benchmarking local data with other territories can be an interesting way to identify solutions for improvement. However, it is important to be aware of the possible inconsistencies of data:

- **Local data might not be reported in a consistent way:** the exact scope of data might be very heterogeneous among local territories. For instance:
  - The share of non-household WEEE collected with municipal WEEE might be different depending on the rules of collection;
  - The scope of collection modes included in the data might only cover part of the streams (e.g. only municipal collection points), which will only give a partial view of the actual collected quantities;
  - The codification of the WEEE used for reporting may vary depending on the source of the information, which leads to non-comparable data sources (e.g. use of European Waste Codes vs WEEE Directive categories vs national WEEE categories)

- **Significant data gaps** linked with illegal practices or mislabelling of WEEE streams can also lead to discrepancies;
- **The context can also impact the performances:**
  - Local consumption patterns might impact the WEEE generation and make the potential for collected quantities different;
  - The collected quantities in retailers' points might not match the administrative borders, which means that some of the collected quantities might be "imported" from neighbouring territories.

It is therefore recommended to collect information on the actual scope and calculation methods of data when conducting comparison of performances. While it might not be possible to obtain completely comparable data, identifying potential biases linked with different scopes, different calculation methods, or different contexts can help assessing the relevancy of the observations made.

A list of indicators was established by the project, based on the input of various local waste experts from across Europe, sorted by clusters as described in part 1.4.2. It is summarised below:

Table 16: list of criteria for benchmarking WEEE collection systems, identified as relevant by consulted WEEE experts (source: COLLECTORS, D4.4)

Cluster	WEEE Criteria	Comments
Capture and recycling rates	WEEE capture rate, (%) WEEE collection rate, (maximising collection, tonnes/year or tonnes/capita).	Capture rate is regarded as one of the most relevant indicators, yet it is generally uncertain as what is put on the market on local level is an estimation and more monitoring of the WEEE flows is needed. Lifetimes of small WEEE also vary, which complicates the estimation of capture rates from what is put onto the market. Monitoring the share of large WEEE received non-intact can also help to identify scavenging. Besides, WEEE ending up in scrap dealers can be considered as another relevant criterion.
	Share of WEEE in mixed residual waste, (%)	WEEE in mixed residual waste can be unreliable because of lack of data. WEEE may not be included as a category in the sorting analyses, and they cover only small WEEE. However, it gives a hindsight on the potential for improvement.
Engagement & participation	Existence of feedback gathering system	Identifying efforts to establish a communication with the inhabitants can give good indications of a waste collection system performing well in terms of social acceptance and general communication.
Environment, Health & safety	Climate impact	Climate impact is a relevant criterion for early phase prioritisation of improvement actions regarding WEEE collection on a case region with developing collection system.

	Getting the hazardous substances out of the loop and critical materials recycled	It is regarded as relevant for early phase prioritisation of improvement actions regarding WEEE collection on a case region with mature collection system
Socio-economic impacts	Increase in local employment, (Number of direct jobs) Increase in local employment and GDP, (as total value for the local economy)	This criterion is especially relevant for re-use activities that are job-intensive and can play a relevant role for the social economy. It can also be interesting for sorting activities and disassembly (e.g. of IT and small equipment), which also include many manual steps, and are also job-intensive
	Total costs of WEEE collection, (€/tonne)	The cost of collection is an important parameter, especially when considering the waste collection system in a low-GDP area.
Degree of separation & quality	Number of WEEE categories collected in CAS	This parameter can give an interesting hindsight on the quality of the separation system.
	Share of WEEE collected in CAS in relation to total WEEE collected	The quality of WEEE received through retail bring-points is in general of better quality when compared to other sources. Therefore, it is useful to know the ratio between retail and CAS collection.
Convenience & coverage	Number of inhabitants / 1 retailer bring point and non-retail bring points	In parallel with the number of bring points per inhabitants, information on their proximity (such as bring-points / km^2) could be also considered for benchmarking of accessibility to WEEE collection.
	Easy access to collection (for consumers)	Other indicators for assessing the proximity (such as the average distance to bring points), opening hours, visibility, availability of different collection modes, etc. can give an overview of the convenience of collection.

The European Commission made available the WEEE calculation tool and associated data, that allow Member States produce estimates of the WEEE Generated at national level. This tool requires regular the input and update of (sometimes not available) data from national experts on WEEE statistics. The tool was created to help Member States to calculate collection targets based on the WEEE Generated methodology as defined in the WEEE Directive.

More information can be found in D3.4

Benchmarking elements from the COLLECTORS database

During the project, 74 WEEE collection systems were documented across Europe, which allowed presenting some benchmarking elements. The same categories as presented in Table 7 have been used; however, due to less data available, both “high” and “very high” categories were merged in

one “high” category, so that sufficient number of waste collection systems are available for each category. The categories are presented in the table below:

Table 17: classification of waste collection system according to their context

Name of the category	Density	GDP
Very low	0 – 100 inh/km²	0 – 10,000 €/cap
Low	100 - 500 inh/km²	10,000 – 20,000 €/cap
Average	500 – 2,500 inh/km²	20,000 – 35,000 €/cap
High	> 2,500 inh/km²	> 35,000 €/cap

When it comes to correlations between collected quantities for the 3 fractions targeted by COLLECTORS with population density and GDP per capita, the lack of available data limits the analyses. Some correlations could be identified for small equipment, for which more data are available, as shown on the following graphs:

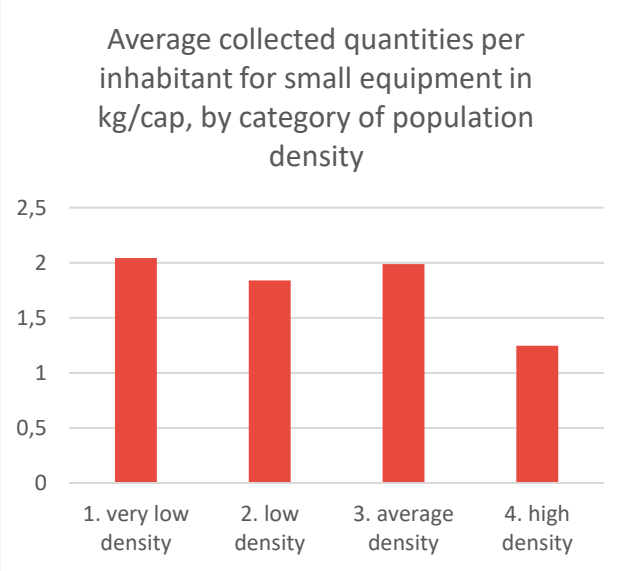


Figure 28: Average collected quantities per inhabitant for small equipment in kg/cap, by category of population density

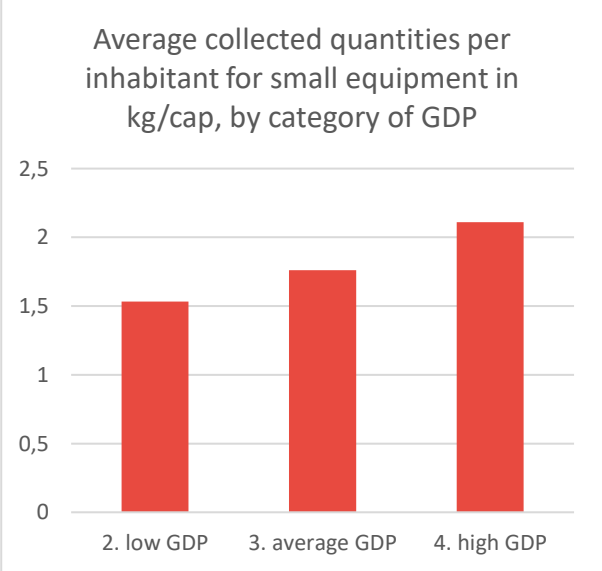


Figure 29: Average collected quantities per inhabitant for small equipment in kg/cap, by category of GDP (no sufficient data available for very-low GDP territories)

Collection rates seem lower in high density area, and higher in territories with higher GDP. Adjusting the number of collection points in high-density areas is more challenging due to less space to do so, and reaching inhabitants in vertical housing might prove more challenging. Regarding low-GDP areas, these differences might reflect different elements, such as a possibly lower total generation of WEEE, the lack of resources to invest in sorting equipment, or the fact

that these territories are generally located in newer Member States where the legal framework and local strategies have been introduced at a later stage.

The high diversity of local organisation and the heterogeneity of the data makes it challenging to cross-analyse local strategies with local performances. However, individual factsheets presenting the waste management organisation and performances of the documented waste collection systems are accessible on the COLLECTORS webplatform.

More information can be found on the COLLECTORS webplatform

3.2 Where to put priorities and targets?

European targets

The European WEEE Directive (2012/19/EU) indicates that, as of 2019, the following collection targets should be reached for WEEE collection rate:

- 65% of EEE put on the market, calculated on the basis of either the total weight of WEEE collected, or the average weight of EEE put on the market in the three preceding years; or
- 85% of WEEE generated on the territory of that Member State;

Besides, specific recycling and recovery targets apply for the different categories of EEE. The recycling and recovery targets for the categories targeted by the project are presented below:

Table 18: targets for the WEEE categories targeted by COLLECTORS in the WEEE directive, from 15/08/2018

WEEE category	Target
Lamps	85% recovered* 80% prepared for re-use and recycled
Small equipment	75% recovered
Small IT and telecommunication equipment	55% prepared for re-use or recycled

**Recovery means any of the operations presented in Annex IIB to Directive 75/442/EEC, and includes recycling and energy recovery*

The unreported fractions

As explained above, the fate of a large share of WEEE is unknown. This is also the case for the five case studies analysed by COLLECTORS, for which the streams were mapped. As an illustration, the figure below presents the flow of small WEEE, small IT equipment, and lamps in Helsinki, one of the five case studies:

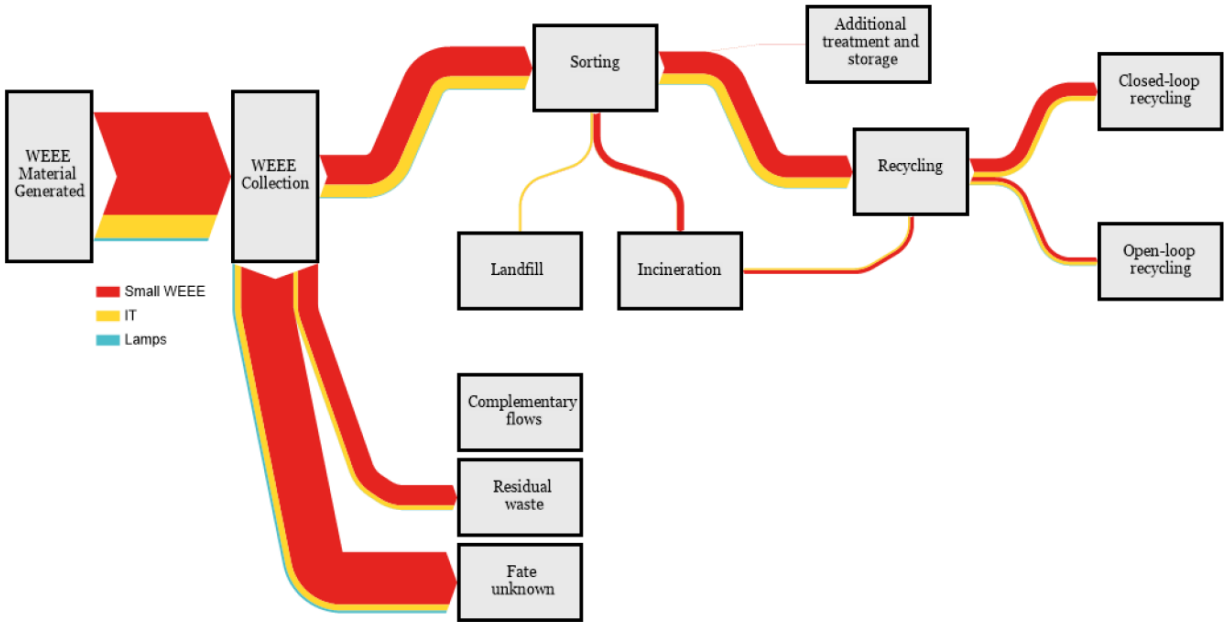


Figure 30: flows of small WEEE, IT equipment, and lamps in Helsinki

While the unsorted waste that is collected with residual waste seem to be significant, the quantities for which the destination is unknown is even more important. The fate of these unreported quantities is supposed to be:

- **WEEE hoarded or passed on**: some electrical and electronic appliances are known to be kept at home even when unused. Several surveys[18] [19] suggests that inhabitants are likely to hoard some types of products when buying a new one (e.g. laptops and smartphones) for various reasons: back-up solution if the new product fails, old appliance passed on to relatives, concerns about the security of the data stored in them.
- **Illegal management**: WEEE might be scavenged for the recovery of valuable materials, or collected as scrap metal and thus not being reported as WEEE.
- **Illegal exports**: part of WEEE might be exported illegally for further re-use or recovery of valuable materials.

These different behaviours have different negative consequences: besides making the targets more difficult to reach, they represent a loss of resources for the WEEE management system by diverting valuable resources. They also benefit the informal economy, and might lead to negative environmental impacts linked with improper treatment and depollution, especially when it comes to the disposal of the non-valuable parts. For instance, fridge compressors that are removed before collection entail significant impact on climate change by generating the uncontrolled emission of significant quantities of greenhouse gases.

[18] CRM Raw Material Recovery, 2018, Trials evaluation report
[19] CWIT project, 2015, Recommendations for the electronics industry

Environmental considerations

The environmental analyses of the case studies highlighted common trends when it comes to the impact of the 3 categories of EEE over their life-cycle:

- Among these 3 categories, **IT equipment** is the one associated with the most significant environmental impact for most of the impact categories;
- For the 3 categories, the most impactful step is the **production of the constituent materials** of electrical and electronic equipment, although the disposal (by incineration or disposal) can have an important impact;
- Collection and sorting of WEEE have comparably low impact.

The analyses conducted by the COLLECTORS projects also identified the limitations for the improvement of WEEE environmental impact linked with the fact that many materials in WEEE cannot be recycled due to the complexity of their components, especially for IT equipment. Therefore, better product design and innovative recycling technologies are required to unlock this potential, by bringing together EEE producers and recyclers. When it comes to waste collection systems, **it also means that there is a significant potential in increasing the quantities sent to re-use.** Re-use operations have a rather small environmental impact, while it results in avoided impacts associated with the production of new materials, which represent the most impactful step of EEE lifecycle. This is especially true for IT equipment. On the other hand, the environmental balance of re-use might be more nuanced with equipment with different range of energy efficiency. It might be more environmental beneficial to replace an old appliance with a low energy efficiency, by a new one with a better energy efficiency, especially if the "consumption phase" of the product has a significant contribution.

More information can be found in D3.3

More quantities, or higher quality?

The project analysed the benefits from improving captured quantities and from reducing the sorting losses (e.g. through improving the quality of sorted fractions by avoiding the presence of non-WEEE in sorted fraction, or not mixing different types of WEEE). Collection seems to be a key bottleneck when it comes to improving the environmental impact of the WEEE recycling value-chain; however, the reduction of sorting losses yields benefits that are even more significant.

From a waste collection point of view, it seems that there is as much benefit from the improvement of collection than with the improvement of its quality in order to limit further losses over the value chain, and to divert WEEE from disposal. The importance of preserving the quality of sorted equipment should not be overlooked, and adequate measures should be taken to do so.

Good practices to improve both aspects are presented in the next section.

3.3 Good practices for collection: how to optimise both the capture rates and the quality?

The COLLECTORS project collected various good practices and recommendations based on its analysis and the experts' consultation over the course of the project.

Developing collection points

The success of a WEEE collection system heavily depends on the design of the collection system, and the complementary character of the different collection options. Due to the different nature of WEEE fractions (e.g. in terms of size and weight), and to specific constraints of inhabitants (mobility, location…), complementary collection modes/options have to be implemented to ensure a proper capture rate of total WEEE. This is especially a challenge for densely-populated areas where available space might limit the implementation of permanent collection points, and where inhabitants might have limited space for storage, and might not be motorised to bring their bulky waste in larger collection points such as civic amenity sites.

Several guiding principles can be listed when it comes to the design and implementation of collection systems:

- **Proximity and accessibility**: proximity is especially important in densely-populated areas, as explained above. Accessibility should include different criteria, such as opening hours fitting the constraints of inhabitants. Defining specific services to people that might experience difficulties in carrying their waste (e.g. elderly people) can also be recommended.
- **Visibility:** collection points should be visible, e.g. following a proper, possibly consistent visual identity, designed with clear instructions (e.g. with pictograms) so that inhabitants can clearly identify and use them. Visibility is also a matter of information on the location of collection points, which should be easily available and centralised, despite the diversity of players involved in collection (municipality, retailers, re-use organisation, etc.). However, collection points should also be located in secured locations to preserve the value of the collected WEEE.
- **Simplicity:** using the collection schemes should be as simple as possible: conditions to use them (opening hours, accepted fractions, possible fees) should be easily available information. For collection points, having trained employees able to help the users with WEEE sorting greatly contributes to their user-friendliness and also helps to improve the quality of the collected WEEE (as this will lead to better sorting).
- **Motivation:** inhabitants should be given "good reasons" to sort their waste. The motivations behind the sorting behaviours can be different from one person to another: environmental concern, social aspects (such as donation to charity organisations benefiting from re-use and recycling), etc. A better understanding of their perspectives and motivations, as well as their possible misconception on WEEE management, will contribute to more adapted messages to promote sorting behaviours.

- **Cleanliness:** dirty collection points will deter inhabitants from using them. Collection points should be associated with "resources" more than with "waste", as much as possible.

Assessing the convenience of the waste collection system through feedback-gathering mechanisms can be regarded as a good practice. As an illustration, the public waste company AMIU that manages municipal waste in the Italian city of Genoa commissions an external audit of how the system works and is perceived by its users, on an annual basis. Besides, stakeholder meetings, including citizens, are regularly performed to identify possibilities for improvement.

The **number and density of collection points** is a relevant indicator for monitoring the implementation of the collection scheme at local level, yet it does not seem possible to provide reference figures that can fit all contexts. As an illustration, the table below presents figures on municipal and retail collection points in several European countries, along with the collected quantities[20]:

Table 19: number, density, and collected quantities of municipal and retail points in several European countries (Eunomia, 2019)

Country	Country population 2019	Population density (inh./km²)	Municipal collection points per 100,000 inhabitants	Municipal collection points per 1,000 km²	WEEE collected via municipal collection points in kg/cap	Retail collection points per 100,000 inhabitants	Retail collection points per 1,000 km²	WEEE collected via retail in kg/cap
Belgium	11,467,923	374	4.94	18.5	6.12	62.26	232.8	2.67
France	67,028,048	122	7.01	8.6	6.14	8.65	10.6	1.83
Germany	83,019,214	232	9.03	20.9	7.82	9.03	20.9	0.94
Ireland	4,904,226	69	1.84	1.3	3.03	8.16	5.7	5.86
Netherlands	17,282,163	457	2.89	13.2	3.85	54.97	251.2	3.13
Switzerland	8,542,323	207	7.02	14.5	11.61	58.53	121.1	2.51
UK	66,647,112	269	1.7	4.6	9.47	0.75	2	1.39

These figures show the significant differences across European countries, and that there is little correlation between the number and the density of collection points and the associated collected quantities.

As explained above, many different collection options are available for organising collection of WEEE. These different options are summarised in the table below, along with their advantages and limits.

[20] Eunomia, 2019, Assessment of WEEE collection systems and their effectiveness in other European countries

Table 20: description of different collection systems available

Collection system	Description	Example	Advantages	Limits and requirements
Civic amenity sites	Civic amenity sites (CAS) are (preferably guarded, fenced-off) areas where inhabitants can dispose of and sort out their household waste into receptacles in order to be recycled or otherwise treated.	 Figure 31: closed WEEE container in the CAS of CYCLAD, France (source: CYCLAD)	In many territories, civic amenity sites are closely associated with waste sorting for inhabitants, thus enabling the collection of significant quantities. If properly organised, it can contribute to the collection of large quantities of WEEE.	Collection in CAS can lead to lower quality (both for recycling or re-use), due to improper storage, improper sorting behaviours or instructions leading to mixture of WEEE from different categories, and possibly theft.
Retail points	In-store take-back systems are implemented differently depending on the Member State and the legal obligations. According to the WEEE Directive, applicable in all MS, citizens can bring their old appliances when buying a new one ("1 for 1"), and bring small WEEE without a purchase ("1 for 0"), the latter is applicable to big retailers exceeding 400sqm. Different obligations might apply depending on the way the Directive was transposed in the MS, obligations may depend on the size of the retailers, or set limits on the number of items that can be discarded. Other systems, such as take-	 Figure 32: collection container in front of a supermarket in Italy (source: Ecodom)	This is convenient for small WEEE and might be a good solution for developing a dense network of collection points close to the inhabitants. WEEE collected in retail points generally has a better quality, due to better informed staff, better storage, less misthrows, and limited theft.	It might require the existence of national obligations to allow the implementation of a dense network of collection points. Inhabitants might not associate waste collection with retailers. Therefore, it requires proper communication to make households aware of such possibility and the conditions for bringing back their WEEE.

Collection system	Description	Example	Advantages	Limits and requirements
	back of e.g. smartphone and laptops in stores, can be promoted through incentives, such as free data wiping, or discount for a new equipment.			
Collection on demand	Municipalities or re-use organisations can provide an "on-demand" collection service: inhabitants can request the collection of specific (usually bulky) waste, usually under specific conditions, e.g. the item is reusable, or the number of annual collections is either limited or not free.		Convenient for inhabitants. Adequate solution for people that cannot come to the CAS (disabled, elderly people, no access to vehicles…). Possibility to charge the user for the collection. When used for re-use: enable to check the quality of the items.	Expensive. Collection on demand where inhabitants are asked to put their waste on the kerbside prior to collection might lead to scavenging. It should be limited as much as possible. Focusing collection on demand on reusable fractions might be relevant.
Take-back on delivery	This system allows households to get their old appliance taken back when getting the new one delivered, usually free of charge.		Very convenient for the inhabitant, especially for large equipment. In some countries or with some retail chains, it is also proposed to take back small WEEE along. Improves Improves the preservation of the item's integrity. The use of reverse logistics allows to expand logistics possibilities in the collection system.	Inhabitants must be aware of this service and the applicable/corresponding conditions. Retailers should ensure traceability of the waste collected. In some countries waste collection is only allowed to officially licensed waste transport companies thus preventing the use of reverse logistics.

Collection system	Description	Example	Advantages	Limits and requirements
Mobile civic amenity sites	Temporary installations located in a public area where residents can sort their household waste in order to be recycled or otherwise treated. Unlike a regular civic amenity site, the mobile civic amenity site is only open during limited periods and is generally smaller. Mobile civic amenity sites can be composed of containers, crates, or collection areas materialised by fences.	 Figure 33: the "E-tram", a mobile collection point using several tram stops in Zürich (source: city of Zürich)	Good solution for remote or dense areas where no CAS is available or for inhabitants for whom CAS are not accessible. Convenient, proximity service for inhabitants. Good for raising awareness.	More expensive than CAS. Requires sufficient communication to inform inhabitants. Limited storage capacity, so only for small items or limited number of large items. Should be limited to items brought by foot or by bike.
Kerbside bulky waste collection	This consists in the collection at a regular frequency (generally of various types of bulky waste), where inhabitants can dispose of their waste on the kerbside.		Convenient for citizens.	Such collection does not allow a proper source separation, as WEEE collected with bulky waste might be damaged. Besides, it might lead to scavenging for the most valuable components and materials.

Collection system	Description	Example	Advantages	Limits and requirements
Kerbside collection in bags	Several local authorities experimented kerbside collection in bags, where small WEEE is mixed with textiles	 Figure 34: bags used for textiles/WEEE collection in Herford (Germany) by RecyclingBörse (Source: Sven Grieger, 2018)	Convenient for inhabitants.	Limited information on efficiency and associated costs. Possibility of theft or scavenging.
Collection at re-use centre	Re-use centres can also accept products or waste brought by inhabitants. This allows a visual pre-selection of goods and ensure a proper quality (of potentially sellable goods) or its reparability. The status of the items brought (whether it is regarded as a product or waste) depends on the national regulation and the status of the organisation running the re-use centre.	 Figure 35: repair of washing machine in a re-use centre (source: Rreuse)	Allow a quality check of the items to ensure that they are reusable, repairable, and sellable. Possibility to raise awareness of the users on waste prevention. Extend the lifespan of the product, thus the amount of waste to be collected. Positive social impact	Might be less convenient for inhabitants due to less proximity. Only relevant for re-usable products. Requires much space.

Collection system	Description	Example	Advantages	Limits and requirements
Mini civic amenity sites / collection points	Several dense cities have developed smaller collection points in urban centres, where several waste fractions can be sorted, including small WEEE. Such collection centres can take various forms: smaller versions of CAS, open areas with various containers, or closed buildings.	 Figure 36: minirecyclingstation in Oslo (source: Olso Kommune)	Proximity, convenience. Good solution to promote re-use.	Only for small WEEE. It is recommended to set a secured access or to have permanent staff. Expensive. Finding sufficient space in urban centres is challenging.
Collection in common areas of apartment blocks	Several cities have developed collection systems using available space in common areas of apartment blocks to store and sort more waste fractions, including small WEEE. Specific collection routes are then implemented to collect wastes from the different participating buildings.	 Figure 37: storage space in an apartment block in the city of Luxembourg (source: SDK)	Convenient for inhabitants.	Expensive, even if cost-savings can be achieved through synergies for the collection rounds. Long implementation that requires the involvement of different players, and individual diagnosis. Risk of theft or scavenging
Collection in schools or B2B in specific campaigns	Several PRO and municipalities have developed collection systems at schools or other semi-public places using available space and connecting the collection to awareness campaigns	 Figure: Ceremony of prizes at school in Portugal (source: Electrão)	Convenient at local level Collection and awareness campaign at the same time	Requires dedicated space for storage Could be expensive depending on the locations and quantity collected

Collection system	Description	Example	Advantages	Limits and requirements
Collection in other premises (workplace, etc.)	Several producer organisations developed systems with which companies can implement a collection spot (crate, box, pallets, etc.) on their premises, while following several rules on the storage and collection. Several experience of collection of WEEE in schools were also organised	 Figure 38: collection boxes provided by Ecologic for WEEE collection on workplace in France (source: EcoLogic)	Convenient for small WEEE. Good for communication.	Requires the proper involvement of the organisation for ensuring the observation of sorting guidelines, the absence of contamination, and compliance with collection rules. Requires sufficient storage space.
Special events	Special collection events can be organised to promote WEEE collection, and make inhabitants sort the items that are hoarded in their home. These events can be organised close to specific apartment blocks (targeting very specific areas), or on public spaces. Inhabitants must be informed prior to the collection event e.g. by leaflets put in their mailboxes.	 Figure 39: punctual WEEE collection point in Paris (source: ecosystem)	Convenient for inhabitants. Good solution for dense areas with limited collection points. Interesting solution for collection WEEE hoarded at home.	Needs a good collaboration between the PRO and the local authority. Requires training of staff and proper information of inhabitants beforehand if possible, using a variety of communication channels.

As shown in the table, there is no "perfect", one-size-fits-all collection system, and each of them has advantages and drawbacks. It is recommended to avoid collection options with which WEEE are handled with other items, get damaged or that can lead to scavenging. For instance, collecting WEEE with regular kerbside collection of mixed bulky waste might not enable qualitative recycling.

The different collection modes must be selected by taking into account different parameters, such as its convenience for inhabitants, taking into account their available space for storing waste, the efforts required to sort their waste, and the accessibility of collection points. These parameters are heavily dependent on the local context. The cost of collection is also a very important parameter; collection in civic amenity sites or in large retail establishments can be regarded as less expensive options compared to mobile collection points, collection in apartment blocks or collection upon request. These more expensive options should be reserved e.g. to areas where inhabitants have little access to CAS. A good balance should be reached between the number of collection points to ensure a proper proximity service for inhabitants, and the associated collection costs.

Besides, the efficiency of individual collection systems also depends on how they are implemented in practice. More specific examples and recommendations will be presented in the following parts.

Highlight: punctual collection in a very dense city - Paris

To address the issue of low performances in dense urban areas such as Paris, where only 1.7 kg/cap of WEEE is collected (compared to the French average of 10.2 kg/cap), the producer responsibility organisation ecosystem developed a "ready-to-use" system for municipalities. It consists in the punctual implementation of WEEE collection points on the public space where inhabitants can bring several types of WEEE (small and IT equipment, large appliances, screens).

These so-called "*collectes solidaires*" ("solidarity collection'') aims at delivering the re-usable items to charity organisations performing re-use activities. Their implementation follows a specific process:

- Fixing a location and date for the collection
- Authorisation for using the public space
- Training of sorting operators
- Information to inhabitants (through leaflets, website)
- Monitoring of the results and satisfaction.

The cost of the operation is entirely covered by the PRO (including the operational costs, communication, and staff). The system is now implemented in several big cities in the Paris Region, the city of Lyon and Toulouse, and received very positive feedback from both local authorities and users. The "re-use" aspect of collection seemed to be a source of motivation for many of the users.

More information (in French): https://proximite.ecosystem.eco/

Source: ecosystem, 2018, presentation given during the COLLECTORS kick-off event

Highlight: developing complementary collection schemes in an urban area - Genoa

Figure 40: one of the Eco-van collecting small WEEE

To improve WEEE collection performances, AMIU, the public waste company in charge of managing the municipal waste in Genoa, launched the WEENMODELS project. This European project brought together local stakeholders and players of WEEE management to identify new solutions for WEEE collection and communication.

The main outcome of the project was the revision of the collection system, especially the implementation of 47 new mobile collection points and four permanent collection centres. The mobile collection system operates daily in different parts of the city, at different stations at scheduled times and locations and where citizens can confer their small WEEE, including lamps. Small household equipment and IT equipment can be brought to the ecological islands and to the ECOVAN +.

Before being rolled out, the mobile collection system was tested in six locations during five months, and these different locations received very different feedback, which allowed to better identify the final location of the collection points.

Besides, a common online logistics platform was implemented, accessible for all collection points partaking the project (e.g. retailers having to implement 1 for 1 or 1 for 0 collection, etc.). This platform allows them to plan WEEE collection and perform all the reporting activities required by the regulation. The retailers also benefited from an inexpensive collection service and the possibility to take WEEE to the collection centres operated by AMIU.

The success of the new system also benefited from a significant effort on communication, to which about 1,500 retailers and other participating organisations contributed. This allowed the dissemination of the information on the new collection system, and the fact that it is free for inhabitants.

Over the course of the project, the collected quantities has increased of +38% for lamps and +67% for small WEEE and IT equipment.

More information on: http://www.weeenmodels.eu/EN/index.html

Highlight: bringing collection points closer to citizens in Milan, Italy

Within the scope of the European project CRM recovery[21], the Italian PRO Ecodom developed a pilot test by implementing WEEE bring points in grocery stores, which are part of the daily life for many citizens. These containers have been designed for the collection of small WEEE and are placed indoors for security concerns. The design of the container prevents from accessing the WEEE through the opening; WEEE is collected in a 240-l bin that makes its unloading simple.

Figure 41: a WEEE bring point implemented by Ecodom in a grocery store, Italy (source: Ecodom)

This experiment led to an increase of collected quantities, which can also be attributed to the special communication efforts promoting this system. This also allowed the collection of WEEE that is not commonly collected in municipal collection points, such as small IT equipment.

More information on: http://www.ecodom-consorzio.it/it/iniziativa/crm-recovery

Survey and communication

As with other waste fractions, communication is a key element for a successful local waste collection system. Communication activities focus on several aspects:

- Provide practical information on WEEE collection to waste producers;
- Disseminate the right messages that promote proper sorting behaviours;
- Collect feedback from waste producers on their behaviour, perspective, and motivations.

Understanding waste producers' perspective

A better understanding of the behaviour of inhabitants is equally important; WEEE is "occasional" waste, meaning that collection and sorting behaviours might not be as well integrated as for more "frequent" waste fractions such as packaging waste. Thus, it might prove useful to investigate the perception of the population regarding WEEE and its collection, to better understand their knowledge of the system, their motivation behind sorting behaviours, or their concerns.

[21] http://www.criticalrawmaterialrecovery.eu/

Highlight: overall observations from several surveys on WEEE

Both the CWIT and CRM Recovery projects summarised the results of several surveys conducted toward citizens, in Italy (by the PRO ECODOM in 2011), Romania (by the PRO ECOTIC in 2014), and in the UK (by the consultancy Axion in 2017)[22]. The main observations are summarised below:

- In the UK, consumers confirmed that they rarely disposed of WEEE, as few of them disposed of more than two items in the past year;
- The survey in the UK also confirmed the tendency to hoard specific "personal" EEE items such as smartphones, tablets, and laptops. Several reasons are invoked:
  - Their small size makes them easy to store "out of sight" and do not make their disposal urgent;
  - These items are more likely to be resold or given to family or friends;
  - Data security was also presented as a reason for hoarding. Consumers seem to trust more "high street retail brands" to handle their data securely when taking the items back.
- Both surveys conducted in Italy and Romania highlight the lack of general knowledge on WEEE management from the general public: this lack of knowledge concerns the collection points and systems, especially when it comes to small and IT equipment. It also concerns the purpose of the recovery of WEEE, such as the presence of hazardous components or the environmental benefits linked with WEEE recycling.
- The surveys showed a growing interest in environmental considerations, which needs to be linked with WEEE collection.

These different surveys provided relevant hindsight on the level of knowledge of the inhabitants, as well as their motivations, which can be used to better develop communication activities.

Delivering practical information

The first step toward a proper sorting behaviour is the knowledge on the practical organisation of waste collection. One of the issues with WEEE collection might be that the diversity of collection options and of players involved in the actual collection (municipality, retailer, charity organisation, etc.) makes the system more complicated to understand for the inhabitants, and possibly leads to scattered information. **Ensuring a consistent information** covering all the different possibilities is necessary to help inhabitants with the identification of the different collection possibilities. The use of a consistent visual identity for the collection points and the different separated fractions can also contribute to clarify the sorting guidelines to citizens.

Inhabitants are likely to associate waste with the municipal collection system, therefore integrating all the practical information in a single place (municipal website, separation guidelines

[22] CRM Raw Material Recovery, 2018, Trials evaluation report
[22] CWIT project, 2015, Recommendations for the electronics industry

delivered to every household, smartphone application with geo-positioning, for instance) might make it easier for inhabitants to quickly find it.

The relevant practical information can be listed as follows:

- Location of collection points;
- Description of other non-bring schemes (e.g. collection on-demand);
- Conditions for using these different schemes:
  - Opening hours;
  - Accepted fractions (preferably referring to the names of products rather than technical, waste-related terminology);
  - Conditions for delivering WEEE (fee, resident card, 1 for 1 or 1 for 0, reusable items or not, etc.)

The knowledge of citizens regarding the different options for WEEE collection might be very variable. Setting a specific application highlighting these different collection options (e.g. by type of product, material fractions, etc.) and presenting the most favourable option (e.g. re-use for items in good working conditions, then recycling) can also help citizens to make the right choice. Such application was designed by the Flemish intercommunal group IMOG for the collection of bulky waste[23], with which the user can identify the different options for re-use and recycling of various types of waste, the location of collection centres, and the tariffs for collection. In most countries, PROs have designed similar tools on their websites and free Apps for citizens.

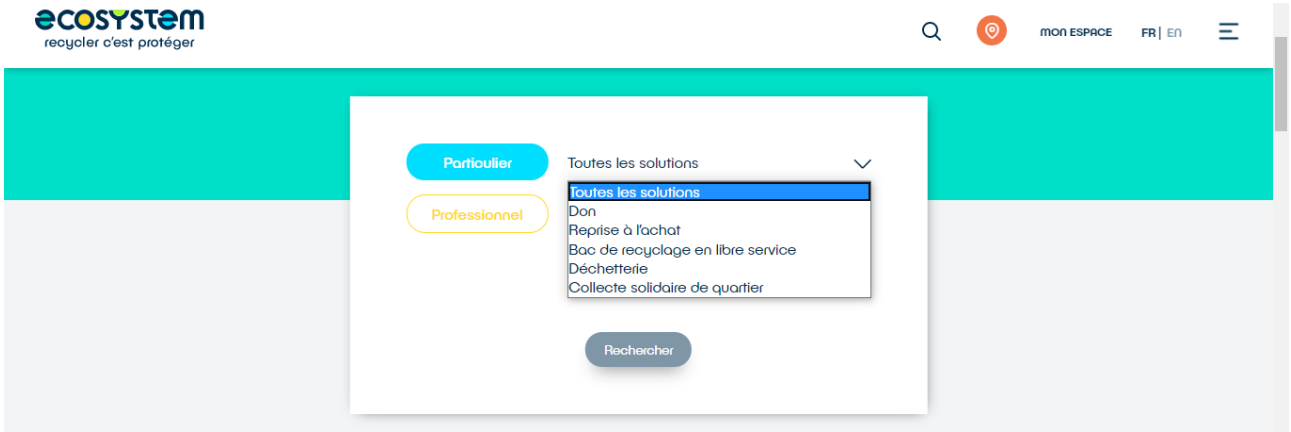


Figure 42: webpage providing indications to the citizens regarding the different collection options for various types of WEEE (Source: ecosystem)

At the collection points, the availability of staff to inform and help the users with the sorting guidelines can prevent from misbehaviour and reduce the level of contamination and damaging of the sorted fractions.

[23] https://urbanrec-project.eu/descarga_web.php?id_pub=378

Promoting the right sorting behaviour

Communication activities should also provide reasons for citizens to adopt proper sorting behaviours. Getting hindsight on their motivations and perspectives can help with the selection of key messages. Such messages can include:

- **Environmental considerations**: explaining the environmental benefits of WEEE re-use and recycling, or the environmental impact of improper WEEE management can contribute to promote sorting behaviours. There is a growing concern in environmental issues, especially on more general issues such as climate change or marine litter. In specific areas, citizens can be more aware of specific environmental topics (water pollution, biodiversity loss, etc.). Linking their sorting behaviours with these environmental concerns can make separate collection more meaningful;
- **Lifting mistrust and doubts on WEEE management:** citizens might have misconception on how WEEE management works, for instance on the fate of sorted WEEE. Explaining how WEEE ends up in illegal routes is also important, as citizens might believe that it also concerns WEEE that is properly sorted.
- **Social aspects:** citizens might be interested in the positive social impact of WEEE collection when the collected items are sent to re-use activities, organised by charity organisations. The fact that their sorting behaviour is beneficial to social economy can also be a driver for citizens.

Highlight: "My Recycling Wales", more transparency on the fate of sorted waste

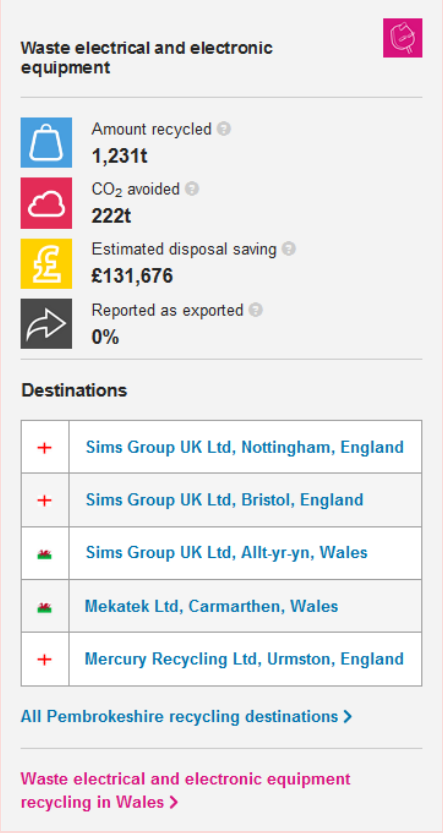


Figure 43: screencap of the summary information on WEEE for Pembrokeshire in 2018 (source: https://myrecyclingwales.org.uk/local_authorities/pembrokeshire)

The online platform "My Recycling Wales" (https://myrecyclingwales.org.uk/) has been implemented by the Welsh Government to provide transparent information and data to any interested party, including citizens. The data are extracted from the WasteDataFlow, an online reporting system used by local authorities across the UK to report their waste-related data.

Different sections are available, displaying key information on collected quantities, associated environmental and economic benefits, and the destination of sorted fractions. Data are available for each local authority and several waste fractions including WEEE.

Some sections cover the overall data for Wales, along with explanations on the outcomes of sorted fractions and end-application of the sorted materials, including graphs, infographics, and videos explaining the different processes at stake.

Besides, users can access specific data for each local authority for several years, allowing them to consult the collected quantities as well as the destination of their sorted waste (treatment unit, and countries to which it might be exported).

Preserving the quality of collected WEEE

Ensuring a good quality for the sorted WEEE is very important to guarantee its proper re-use, recycling, and recovery of materials. Through a questionnaire addressed to producer responsibility organisations in six different countries, focusing on different contexts, specific solutions were identified to improve the quality of sorted WEEE.

The main factors influencing the quality of sorted fractions include:

- The level of scavenging, i.e. the removal of valuable parts from EEE products (fridge compressors, hard drives, etc.);
- The conditions in which waste is collected and stored may damage appliances and hinder subsequent treatment or preparing for re-use;
- The presence of non-WEEE in the collected streams (e.g. in case of mixed bulky waste collection, or due to improper sorting by users in collection points).

Based on the feedback from PROs, the following recommendations can be formulated:

- Quality is generally **higher in retail collection points** compared to civic amenity sites, because in retail points as theft or scavenging is more limited, storage conditions are better, and the staff is usually better trained on product identification, and handling of collected WEEE. Besides, door-to-door/ on-demand collection also allows to check the collected equipment and adapt the transportation mode.
- **Adapted collection equipment and proper segregation**, such as specific containers for lamps (e.g. metallic cages and cardboard boxes), small WEEE and small IT equipment (in plexiglass and/or cardboard boxes) and collected separately from bigger appliances, can contribute to reduce damages and make further transportation more convenient;
- An important aspect is the **training of staff at municipal collection points,** in identifying the different products, informing the users, and properly storing and handling the different fractions so that they reach the right treatment plant or re-use centre in good conditions. Some PROs organise regular visits to the different municipal collection points for such training, and to co-define action plans to improve sorting and collection.
- **Better communication** on collection points, with clear indications on the different banks and containers (with pictures and texts describing the products) to limit the misthrows from users and allowing for raising awareness at the same time;
- **Securing collection points** has a significant impact on both capture rates and quality. More information is provided in the following section.
- **Better monitoring of contamination** in the different fractions: while quantified monitoring of contamination is usually not implemented, except in WEEE treatment plants where contamination is reported to the PRO, quality checks can be performed, e.g. during on-site visits organised by PROs on collection points or joint initiatives involving the staff working at collection points. This can contribute to bring the attention of the managers of collection points on current sorting mistakes and help them to identify corrective actions.
- **Standards for collection:** applying existing standards (e.g. EN 50625-4 on Collection and Logistics), or corresponding internal standards for the transportation of WEEE. Some good practices were also established by the project Infocycle[24].

Promote re-use

While re-use was not the core focus of the COLLECTORS project, its significant environmental and social benefits make it the priority of WEEE collection systems. A German study identified that, if properly collected, around **one third of WEEE, furniture, and leisure goods disposed at civic amenity sites could be prepared for re-use[25].**

[24] http://www.infocycle.gr/

[25] Messmann, L., Boldoczki, S., Thorenz, A. and Tuma, A., 2019, Potentials of preparation for reuse: A case study at collection points in the German state of Bavaria. Journal of Cleaner Production. 1534–1546. DOI:10.1016/J.JCLEPRO.2018.11.264. (available here)

Integrating re-use into WEEE collection systems is necessary to increase the quantities made available for re-use organisations. Collaboration with the local re-use organisations is a key aspect so that the collection practices are aligned with their requirements. Besides, citizens' behaviours might be positively impacted if they see that social economy organisations will benefit from them.

As with collection for recycling, quality is an essential parameter when implementing collection for re-use. Several recommendations can be listed[26]:

- **Civic amenity sites** represent a great potential in terms of collected quantities, but generally collect products of lesser quality, compared to other, more secured collection points. To overcome this shortcoming, it is recommended to:
  - **Train the staff** to better identify re-usable products and direct them to the re-use section of the CAS;
  - **Better inform the users** of the possibility of re-use. For instance, the Alelyckan civic amenity site in Goteborg, Sweden, includes several re-use areas along with the traditional "collection for recycling" space. When entering, the users are directly offered the possibility to identify the re-usable items and directed to the right section[27].
  - **The handling and storing** should be done with care: items should be stored in closed areas protected from rain and scavenging.
- **Other collection schemes** can be adapted to improve collection for re-use:
  - Specific collection on-demand for re-usable items;
  - Mini recycling stations (such as the minirecyclingstations in Oslo[28]) can be used as proximity collection points for re-usable items;
  - Punctual collection events (as presented above) focusing on donation to charity organisations, where the staff can identify re-usable goods;
  - Collection in store, where incentives can be used (free data wiping, coupons for buying a new product, etc.).

[26] Rreuse, 2020, The potential for re-use: how to improve the involvement of the re-use sector within municipal WCS, presentation given during a COLLECTORS webinar (available here)
[27] https://www.urbanwins.eu/alelyckan-recycling-park-in-gothenburg/
[28] Presented here: *Urban Resource Centres, 2019, A classification of local approaches to waste prevention, re-use, repair and recycling in a circular economy*

Highlight: Cyclab'ox, a re-use showroom on civic amenity sites

The Cyclab'ox is a visible and attractive space dedicated to re-use on the eight civic amenity sites of CYCLAD, a French intercommunal organisation managing waste in the north-east of the Charente-Maritime department. It is organised as a living room, and items selected by the staff are displayed and made available for inhabitants, who can take them home.

The project also includes the implementation of "temporary repair cafés", where inhabitants can get assistance to have their products repaired, thanks to available pieces in the stock of WEEE or the use of a 3D printer. If the product is not reparable, users are provided information on where to find a second-hand equipment as a replacement[29].

Figure 44: the CyclaB'ox implemented in Cyclad (source: Cyclad)

More information on re-use of WEEE can be found on the Life ReWEEE project website

3.4 Good practices to prevent illegal activities

Illegal practices such as scavenging and theft have a significant impact on both the capture rate and the quality of sorted fractions, which seriously hinder the further possibilities for re-use or recycling[30]. Among the parts that are subject to scavenging, PROs reported the following ones:

[29] Ecosystem, 2020, The experience of CYCLAD: cooperation between a municipality and PRO for reaching higher performances, presentation given during the COLLECTORS webinar on WEEE (available here)
[30] SOFIES, 2019, Scavenging of WEEE: environmental and economic consequences for society (available here)

refrigerator compressors, TV deflection yokes, printed circuit boards, washing machine motors and cables. Tackling illegal practices is therefore as important as boosting capture rates. Moreover, setting a convenient collection system so that citizens are adopting the proper behaviour and bring their waste to the right place is an important element for limiting the quantities oriented toward illegal treatment or exports. Any action mentioned above to improve the convenience of the collection system is a good step toward the reduction of illegal activities.

Illegal practices are mostly due to vulnerability of collection modes or collection points, to which municipal collection points are especially subject. Thefts can occur if no control of access is implemented, if WEEE is easily accessible to users, or if selling of stolen parts is easily allowed. Besides, any collection schemes making WEEE available for anyone on the public space (e.g. kerbside collection) is to be avoided.

Several local actions can be recommended to limit these illegal activities on municipal collection points:

- **Improve the security of collection points**: this can be achieved by several actions:
  - Proper fencing of the site;
  - Use of locked and secured shipping containers for WEEE, where WEEE are put either on the containers' floor or in metal boxes;
  - Video surveillance with internal monitoring, and launching on motion detection;
  - Marking of WEEE received on the CAS to allow traceability;
  - Optimisation of the collection frequency of WEEE, e.g. to once or twice a day, and eventually during the weekend.
- **Cooperation with local police,** that can perform regular checks to monitor the presence of illegal activities;
- **Local monitoring and benchmarking** of collection points, along with inspections. By establishing a closer monitoring of the individual performances of each individual municipal collection point, irregularities can be spotted, e.g. a sudden drop of collected quantities, or under-performance compared to other points. A specific monitoring can also be performed on the input of WEEE treatment units, where specific products are investigated for missing parts (e.g. motors or compressors missing on fridges, washing machines, or air-conditioning appliances, or missing parts on CRT screens). Such check can also be performed when auditing the collection points.

Figure 45: marking of WEEE on CYCLAD's civic amenity site (source: Cyclad)

Highlight: a success story for tackling illegal practices - Cyclad

CYCLAD is an intercommunal group managing municipal waste for 234 municipalities covering a total population of about 230,000 inhabitants in the west of France. One of the main challenges faced by CYCLAD was thefts of valuable WEEE components; to address this issue, CYCLAD collaborated with the PRO Ecosystem, and implemented a series of measures on its civic amenity sites, including the use of locked containers for storing WEEE with special locks, financed by the PRO, and the implementation of video surveillance. The WEEE brought by users of the civic amenity sites are also marked with a bright orange paint, and scrap dealers within a radius of 50 km of the CAS were informed on this to make sure that they can identify stolen WEEE when brought by scavengers. A special contract was established with the police, who regularly checks the collection sites.

The action was linked with a communication campaign aiming at raising awareness on the small WEEE hoarded at home, and to tackle misconception on WEEE managements (such as claims that all WEEE is shipped to India for treatment).

The national framework for WEEE management was also improved: a legal ban on cash transaction for WEEE was introduced in 2011, and from September 2015, operators cannot collect and treat WEEE without a contract with one of the producer responsibility organisations.

All these different actions led to an increase of the collected quantities of +26% for small WEEE and IT equipment, and 50% for lamps, between 2014 and 2017. In 2019, collection of all WEEE reached 12.9 kg/cap, which is over the average collection rate in France (11.5 kg/cap).

Additionally, other flows of unreported WEEE are associated to WEEE that is collected together with scrap. This is a common practice in many MS, often considered illegal, and in most cases the WEEE is usually reported and treated as scrap, hence not following proper treatment and not contributing to statistics of WEEE collected. Specific measures have been set in place in some MS, like for example the ban on cash transactions in France or the requirement to scrap facilities for reporting the WEEE received separately. Enforcement is key for ensuring these measures are implemented.

3.5 Economic balance

Cost-benefit analyses were performed for the five case studies identified by the project. While the panel is too limited to draw definitive conclusions on the cost balance of WEEE collection systems, several common trends could be observed. The case studies were analysed focusing on 3 main WEEE categories: lamps, small equipment, and small IT equipment, from the perspective of PRO, which are generally coordinating the waste collection systems. The analyses covered the activities of PRO, i.e. collection, transport, and treatment.

General considerations on cost of WEEE management

The management of WEEE involves several players, along with various material and monetary flows. An overview is presented on the following graph:

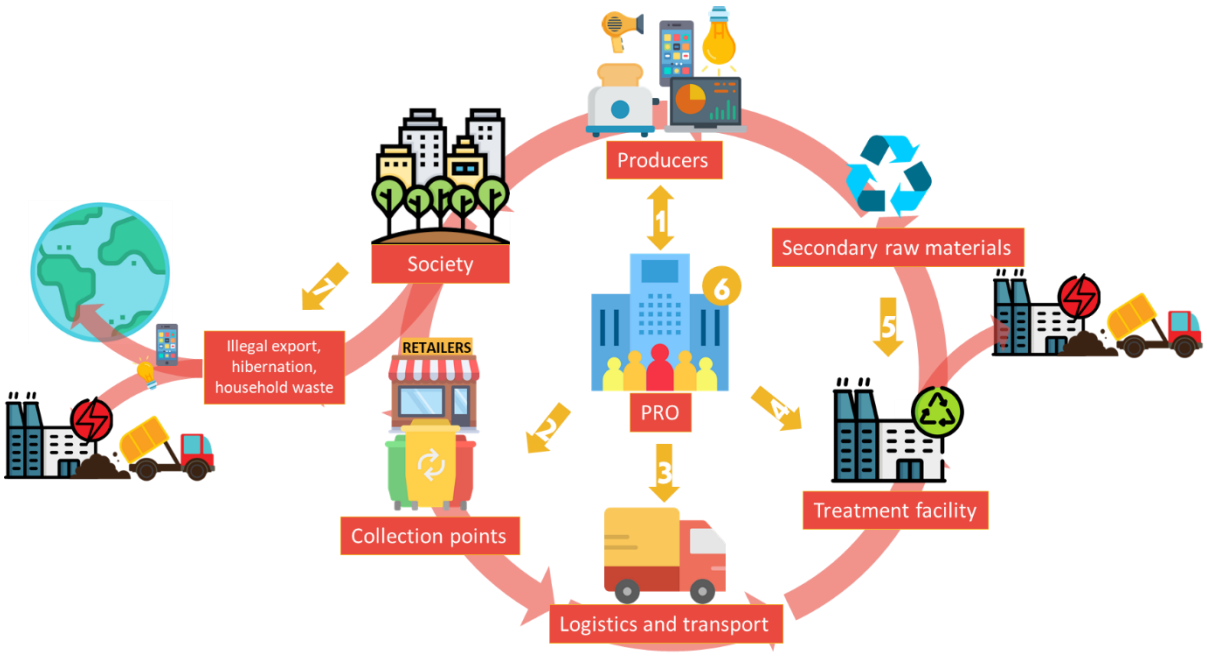


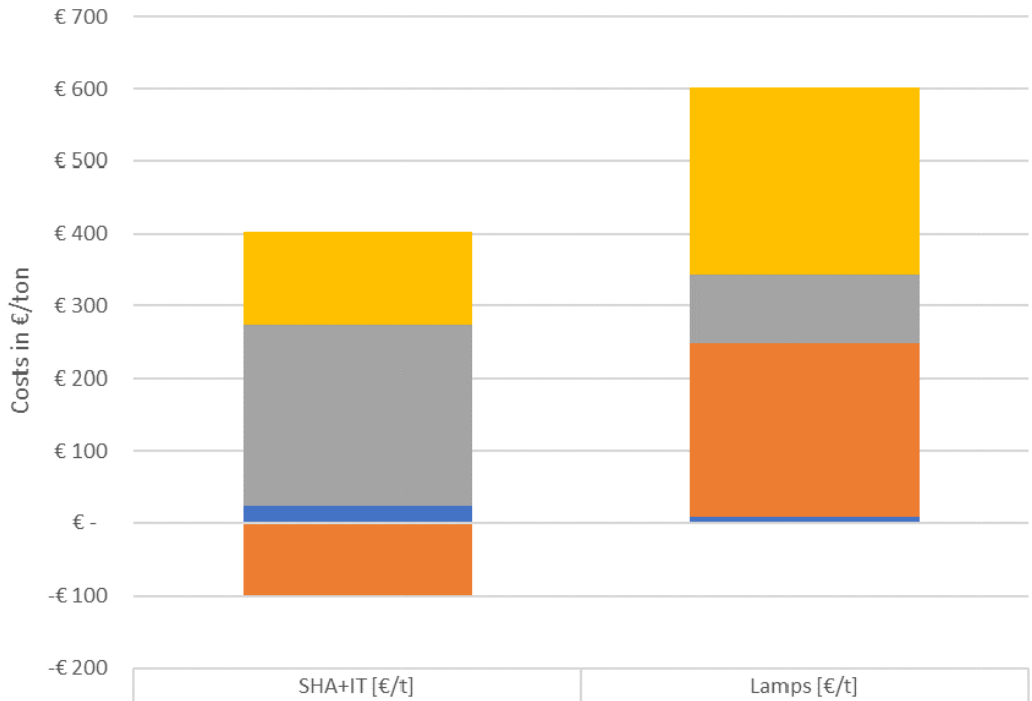
Figure 46: Overview of material (red) and financial flows (orange) in the WEEE value chain (source: COLLECTORS, D3.2)

The different monetary flows are described below:

1. **PRO fee**: producers pay the PRO according to a fee system defined by each PRO. This fee is usually indirectly paid by the consumer, and is sometimes made visible on the price tag. The duration of the contract is variable, and is an important parameter; short-term contracts might prevent PRO from engaging long-term commitments and investments;
2. **Contribution to collection points**: when financially responsible of collection, PRO will fund e.g. containers and pay collection points (retailers, municipal collection points, etc.) according to the collected quantities. How it is done is very variable, and goes from flat fees, to bonuses according to the number of separated fractions. PRO generally also funds communication activities for the promotion of collection.
3. **Logistic costs**: WEEE will be collected from collection points to transfer station, or treatment units. These operations are also financed by the PRO.
4. **Treatment costs**: a fee is often paid to the operator of the treatment units, where WEEE are dismantled, shredded, depolluted, and where the different extracted fractions are either sent to recycling or to disposal.
5. **Revenues from sorted materials**: these revenues largely vary depending on the types of WEEE category.
6. **Compliance costs**: PRO conduct monitoring, controls, to limit illegal activities, whose costs are also covered by PRO.

7. **Costs of improper / illegal behaviours**: illegal activities generate costs for the society (e.g. treatment of unsorted WEEE, unfair competition of illegal operators, losses of resources for the legal WEEE system, costs on the environment, etc.).

The average cost-benefit balance for the management of small WEEE and lamps are very different, as shown on the following graph:



	SHA+IT [€/t]	Lamps [€/t]
Transport and collection	€ 129	€ 259
Shredding, sorting, dismantling and pretreatment	€ 249	€ 95
Recycling and recovery	-€ 98	€ 240
Incineration and landfill	€ 24	€ 8

Figure 47: average European technical costs for WEEE management, 2008 (source: COLLECTORS, D3.2)

For small WEEE, treatment costs outweigh collection and transport costs, while the revenues from sorted materials only cover a small part of these total costs. For lamps, collection costs are much more significant, and the fact that they contain hazardous content makes their treatment more expensive, while producing no revenues.

Observations from the case studies

Data on costs of WEEE management are challenging to identify, due to competition. Obtaining comparable data for the different case studies proved to be not feasible. The analyses focused on specific periods when new practices were implemented, in order to assess the impact of these new practices on the cost balance of the different systems.

The case studies implemented various types of activities, which all led to increase collected quantities, as shown in the following table:

Table 21: summary of the WEEE case studies (source: COLLECTORS, D3.2)

Case study	Implemented activities	Additional collected WEEE (in kg/cap)	Cost effectiveness (in €/tonne)
Pembrokeshire	Awareness raising campaigns	0,98	€ 846
Vienna	Promoting reuse in cooperation with a network of local re-use organisation	0,73	-
Genova	Implementation of mobile and permanent collection points	0,40	€ 183
Cyclad	Actions against scavenging in civic amenity sites	1,38	€ 525
Helsinki	Specific actions targeting low population density	0,89	€ 117

These limitations make it challenging to draw definitive conclusions. However, it seems that all case studies managed to increase the collected quantities with a cost per tonne ranging between €117 and €850 per tonne of collected WEEE, which is below the cost of WEEEE lost due to improper collection and scavenging (€1,480 per tonne[31]). It is also important to note that there is no direct relation between the collection rate and the height of the PRO fee (which varies largely between countries).

The impact of the improvement on PRO fees differs from one case study to another; for small WEEE, PRO fees decreased for 3 case studies, while the collection rates increased. For lamps, the situations are much more diverse. The decrease of PRO fees might be associated with increased efficiencies of collection, transport, and treatment processes.

The analyses tend to show proper and sustainable recycling of lamps, and small and IT equipment cannot be financed by the benefits from recycling. Therefore, it requires additional financial compensation from the PROs or the society.

The improvement of source separation of WEEE leading to less contamination, less damages, and higher quality can contribute to increase the benefits from recycling, which should contribute to balance the cost of collection.

More information can be found in D3.2

3.6 Toward a circular economy approach

Waste collection systems do not operate in insolation: their purpose is both to provide a service to waste producers while securing their involvement in waste separation, and to produce secondary raw materials with a sufficient quality to meet the requirements of recyclers.

[31] United Nations University, 2018, WEEE Recycling Economics – the shortcomings of the current business model

Secondary materials and end-application from WEEE

WEEE encompasses very diverse products containing a wide range of materials and substances, as well as valuable and critical raw secondary materials such as gold, silver, lithium, indium, or rare earths. The most common materials composing WEEE are:

- Ferrous metals (e.g. iron, steel);
- Non-ferrous metals (e.g. copper and aluminium);
- Plastic;
- Glass;
- And other material fractions (e.g. concrete blocks in washing machine, fluids, rubber, etc.).

Besides, the composition of EEE products and their content might quickly evolve over time. A good illustration is the transition from cathode ray tube screens (CRT) to Liquid Cristal Displays (LCD) and then to Light Emitting Diode displays (LED).

To extract materials from WEEE, different steps are necessary to sort them, then dismantle and depollute them:

- **Collection and sorting**: WEEE is commonly sorted according to the specific depollution and treatment processes, with the following grouping being the most common:
  - Cooling and freezing appliances;
  - Other large household appliances;
  - Small household appliances and IT equipment;
  - Screens (often flat and cathode ray tube separated);
  - Lamps.
- Pre-treatment includes **depollution**, where the following substances or components are commonly removed:
  - Appliances containing ozone depleting substances (e.g. CFCs);
  - PCB/PCT containing capacitators or other components;
  - Chlorofluorocarbons (CFCs and HCFCs) or fluorocarbons (HFCs), or other hydrocarbons (HCs, isobutene, etc.);
  - Plastics containing bromide fire retardants;
  - Lamps from Liquid Cristal Display, switches, contact thermometers and relays containing mercury;
  - Batteries;
  - Toner cartridges, ink-containing receptacles and ink ribbons;
  - Asbestos-containing components;
  - Gas discharge lamps;
  - Components containing refractory ceramic fibres;
  - Appliances containing radioactive materials;
- **Manual and mechanical dismantling and recycling:** after the removal of hazardous substances, the remaining fractions can be further separated then subject to recycling, or disposal. WEEE is usually shredded and different materials are sorted for material recovery.

The main sorted fractions are metal, plastic, and glass. The quality of the sorted fractions depends mainly on the quality of the input, and the treatment processes involved.

The following table presents the main characteristics and end-application of the three main sorted material fractions:

Table 22: description, sorting and quality specifications, and end-application of the main material fractions extracted from WEEE

	Metal	Plastic	Glass
Description	Steel and stainless-steel alloys, aluminium, copper and precious metals	Very diverse polymers, with all kinds of additives (e.g. flame retardants). The different WEEE categories have very different content in terms of quality and quantity: - Cooling appliances contain mostly polystyrene - Large household appliances mostly include polypropylene The main polymers are ABS (Acrylonitrile-Butadiene-Styrene), HIPS (High impact Polystyrene) and PC (Polycarbonate).	Glass is found in monitors, screens, and large household appliances. It includes different types of glass, e.g. CRT glass contains lead and fluorescent coating.
Further sorting, quality considerations	For international trading, the US Institute of Scrap Recycling Industries (ISRI) classification is often used, with specification for different fractions: aluminium scrap, circuit boards, ferrous scrap, copper scrap. Specifications focus on the density, the content of specific metal, and the level of impurities	The mixed fraction of plastics extracted from WEEE treatment is grinded and sorted through different processes, where the contaminated fraction is extracted for disposal, and the recoverable fractions are washed and further sorted. Current sorting of polymers is economically and technically challenging, even though new technologies appear to be promising.	CRT glass requires appropriate treatment. The diversity of glass makes sorting and closed-loop recycling not practicable.
End applications	Used by steel producers and non-ferrous metal refiners in their processes to produce intermediate or final metal products or alloys.	For the most part, WEEE plastics is exported for recycling (e.g. in Asia) or incinerated. A very minor share is used in new products. Most of it is downcycled, e.g. outdoor furniture.	Reprocessed in construction materials (tiles, ceramics, concrete blocks) Lead-free glass (e.g. Photovoltaic panels) can be used for the production of foam glass and glass beads.

More information in D2.2

Main recommendations for WEEE

The analysis of case studies and the involvement of WEEE experts over the course of the project allowed to identify key recommendations to ensure that waste collection systems positively contribute to the success of the whole WEEE recycling value-chain. The main factors that influence the ability of waste collection systems to positively contribute to the recycling value chain are:

- **The traceability of the collected waste**: there are many unreported flows for WEEE. Traceability of the WEEE generated is crucial to ensure that WEEE is following the correct paths and reaching official destinations ensuring proper treatment.
- **The supply of collected waste**: in order to be able to operate in a steady way, a minimum amount of waste has to be supplied to the sorter and recycler;
- **The quality of the sorted waste**: the sorted waste must meet some quality requirements to enhance recycling into marketable secondary materials or preparing for re-use.

When it comes to WEEE, the key recommendations are to:

- **Improve collection rates** through better-performing collection points;
- **Improve quality** of the sorted fractions through a proper storing and handling of WEEE and adequate training of the staff of collection points;
- **Tackle illegal behaviours** through the securing of collection points and ensuring traceability.

These three recommendations are very much interlinked, as the reduction of illegal practices such as scavenging or informal collection positively impact the quality and the capture rates. Finally, the circular economy analysis conducted by the project listed the following specific propositions to improve the contribution of WEEE collection systems to the recycling value chain:

- **Improve surveillance and training of collection staff** in municipal collection points to reduce the level of scavenging, aligning with the practices in retail points;
- **Improve "collection for sorting"** of municipal collection points, by allocating more space, making sorting instructions clearer, and training the staff for the identification of products;
- **Monitor the contamination of WEEE fractions** by non-WEEE fractions;
- **Better monitor the level of scavenging** by identifying missing parts in key fractions and monitoring the individual performances of collection points;
- **Better harmonisation of collection points;**
- **Ensure that logistic operations are carried out by trained professionals;**
- **Implement information and awareness raising campaigns,** possibly with incentives or rewarding competitions, and designed upon studies on citizens' behaviour;
- **Increase the number of collection points** and develop proximity of collection points;
- Promote local actions against illegal practices and in favour of more separation and better collection infrastructure through **economic compensations** by PRO to collection points.

More information in D2.4

4. Construction and Demolition Waste

Construction and Demolition Waste (CDW) arises from construction and total or partial demolition activities, and accounts for nearly 30% of EU waste. CDW is a large source of secondary raw materials, consisting roughly out of wood, masonry (inert materials such as brick, concrete and rock), drywall, roofing, plastics (such as PVC, insulation) and metals. It has a strong potential for recycling and re-use because of the high value of the materials (mostly metals), the large market for re-use (such as the use of waste aggregates in roads) but also because the technology for recycling is well established.

Local management of municipal CDW is very heterogeneous; it ranges from a "limited service" allowing inhabitants to dispose of small quantities of rubbles, to a commercial service open to local construction companies, which can bring different categories of CDW against a fee.

The report will focus on the information and data collected by the project, the analyses of the two case studies, and the information provided by experts' consultations. For further information on CDW management practices and performances across Europe, it is recommended to consult the following report on management of construction and demolition waste[32].

4.1 Municipal management of construction and demolition waste

Overview of local practices

The data collected by COLLECTORS from 34 municipal waste collection systems for CDW highlighted significant differences when it comes to the handling of construction and demolition waste by local authorities. Among the diversity of organisations, several trends can be highlighted:

- Many local authorities only collect CDW through their civic amenity sites;
- Most of them limit the CDW handled by the municipal service: only household waste is accepted, with limited quantities, and only certain fractions (e.g. rubble or asbestos);
- Some do accept non-household waste, but with limits on volumes or weight, or as a paying service. In some cases, quantities beyond a certain limit are charged;
- In many cases, larger quantities (even generated by households) have to be collected by an authorised private company.

This heterogeneity is reflected by the very different collected quantities across the panel documented by the project, with collected quantities per inhabitants ranging from a few kg to over 500 kg/cap, with an average of 100 kg/cap.

[32] Deloitte, 2017, Resource Efficient Use of Mixed Wastes - Improving management of construction and demolition waste

The most commonly collected fractions are mixed inert waste and rubbles, which might be the only CDW fraction handled by municipalities. The most commonly sorted fractions reported by municipalities are:

- **Inert waste,** either collected as a mixed fraction, or separated in different fraction such as concrete, bricks, stones, etc. Among these sorted fractions, gypsum is one of the most commonly source-separated.
- **Hazardous waste,** mainly consisting of asbestos and waste containing asbestos;
- **Wood**, either treated or not
- **Other recyclable materials** such as flat glass, metal, and plastics

It is challenging to clearly identify the exact waste quantities originating from construction and demolition activities, as fractions are usually sorted by types of materials (e.g. metal containers also include furniture and products mostly made out of metal).

The vast majority of the reported quantities of CDW are collected in civic amenity sites. In very few local authorities, specific collection points can be used, or collection on request.

Relevant CDW indicators to assess, compare, and monitor

The project identified a list of indicators that can be relevant to assess a CDW system and conduct differences. Information on the organisation of the system, the scope of activities, and the context, are as important as the quantitative data to properly compare the performances of different systems. This list has been established and discussed with representatives of local authorities, to identify information that is both relevant to local decision-makers and that can be collected at local level.

Table 23: relevant indicators for the analysis and comparison of CDW systems (source: COLLECTORS, D1.1)

Indicator	Description	Comments
Waste generation		
Mixed waste composition	Based on mixed waste composition analysis: % of CDW (or relevant fractions e.g. such as asbestos cement) in mixed waste	Construction and demolition waste might not be much present in residual waste, so it is also relevant to analyse the content of CDW in mixed bulky waste (collected on the kerbside or in a mixed container in a civic amenity site)
Waste collection		
Scope of municipal CDW	What is included: from households only, or from households and from similar sources	Similar waste quantities might be much more significant than purely household waste. While it might be difficult to ensure that commercial activities do not use the municipal services, indications on the limits for using the municipal service might give some indications on the scope.

Responsibility of collection	Responsibility for collection of different CDW fractions. Specification who is leading operations: public authority or private scheme.	This is a useful information to compare the data and local practices. It might be difficult to compare two territories where the responsibilities are very different.
Separate collection of waste fractions	Applied options for separate collection of different CDW fractions and collected amounts in t and kg/capita	The number and types of separated fractions give a good indication on the degree of quality of source separation and the development of the local CDW system
Types and number of collection modes used	What collection modes are used and how developed they are (number of bring points, etc.): civic amenity sites, specific bring points, on-demand collection	Identifying the different collection modes, along with the number of collection points, is a way to assess the convenience of the collection system. Several indicators can be used for assessment and benchmarking, such as the number of collection points per inhabitants, the density of collection points, etc.
Waste treatment		
Type of first treatment	First sorting / treatment: destination of different CDW fractions after collection	Knowing about the destination of the different CDW is a first step to assess the effective recycling
Output from first sorting / treatment	Output fractions from first sorting / treatment and destination	In case of pre-treatment or sorting, it is useful to collect information on the final destination to clearly identify contamination and the actual performances
Economic feature		
Costs – organisation and fees	How the system is funded and by whom, especially the waste producer	Understanding how waste producers financially contribute to the system is important; how this fee system encourages source-separation while avoiding illegal practices is a relevant information
Annual running costs	Annual running costs to operate current collection system for different CDW fractions.	The breakdown by waste management steps (e.g. collection, transport, treatment, etc.) provides relevant information for the analysis of the system
Influencing policy		
Relevant additional national/regional/local legislation and instruments for CDW	Targets / legal provisions on treatment of CDW influencing local / regional waste management in place	Taxes or bans on disposal, or specific recycling targets are relevant drivers for promoting source-separation of CDW
Control and sanctions	Control mechanisms in place to ensure there is compliant	

	CDW management	
Challenges and drivers		
CDW escaping from formal collection route/system	Information on CDW littering, treatment, and associated quantities	Illegal practices might occur, especially when there is a lack of collection infrastructure.

Comparisons with other territories should primarily take into consideration the scope of the municipal CDW system: it makes little sense to compare a system whose objective is to offer a minimum service to inhabitants for small quantities of inert waste, with a system developing an extensive collection and recycling strategy for CDW produced by inhabitants and local companies.

More information can be found in D1.1

One of the goals of a CDW system can also be to provide an accessible and safe solution for the collection of hazardous substances, such as asbestos, in which case the performance of the system might not be the level of recycling, but rather how safety is ensured, or how pro-active the system is to identify and help to safely remove it from old buildings.

The relevant contextual parameters and waste-related indicators discussed with representatives from local waste organisations are summarised in the following table:

Table 24: relevant contextual parameters and waste-related indicators for CDW systems (source: COLLECTORS, D4.4)

Relevant contextual indicators for CDW	Relevant waste-related indicators
Local economy, (GDP per inhabitant) Type of housing, (Share of detached and semi-detached houses in %) Population density, (No. of inhabitants per km^2)	Capture rate and share of CDW in mixed fractions Accessibility and coverage of collection points Capture and removal of hazardous fractions Collection costs and fee for inhabitants

More information can be found in D4.4

Documented CDW systems

While it is difficult to present meaningful benchmarking elements for CDW systems, considering that the purpose and scope of each system is very different from one another, it can be interesting to consult information on the organisation and performances of individual systems. Individual

factsheets presenting the waste management organisation and performances of the documented waste collection systems are accessible on the COLLECTORS webplatform.

The project further analysed two case studies, focused on two municipalities that developed specific action to promote the re-use and recycling of specific CDW fractions. These two case studies will be presented in the following part, as interesting illustrations on how to improve local management of CDW.

More information can be found on the COLLECTORS webplatform

4.2 Gypsum recycling in Reimerswaal

General presentation

Reimerswaal is a municipality in the province of Zeeland in the south-western Netherlands on Zuid-Beveland. The municipality had a population of 22,432 in 2017, and has a surface area of 242 km2 of which 140 km2 is water.

The municipality of Reimerswaal is responsible for the collection and management of household waste and outsourced the operation to private scheme the Zeeuwse Reinigingsdienst (ZRD). ZRD also manages all the CAS in Zeeland, including the one located in Reimerswall.

ZRD collects about 25 separate waste streams at the civic amenity site, amongst which are gypsum, wood, bricks and concrete, glass, plate glass, hard plastics, metals. Gypsum waste is collected on every CAS in Zeeland but one. ZRD focusses on collecting clean gypsum waste, free from contamination, such as tiles and wood, and instructs the citizens and other users of the CAS to separate gypsum accordingly.

After collection in a separate container, all gypsum waste from ZRD is transported to their civic amenity site in Middelburg from where it is transported to New West Gypsum Recycling in Kallo, near Antwerp. It is essential that the recycled gypsum achieves a pre-determined quality suitable for the manufacturing of new gypsum products. Presently there is no standard pre-determining the recycled gypsum's quality and the criteria vary from plant to plant. By choosing closed-loop recycling the need for manufacturers to acquire virgin gypsum is reduced. The most advanced plants have substituted up to 30% of virgin gypsum raw materials with recycled gypsum.

The initial reason for source-separation of gypsum was the introduction of a ban on landfilling for waste fraction with a potential for recovery, which is the case for gypsum (except for some part of it, which is too contaminated to be recycled at a reasonable price).

Results

The collection of gypsum is considered as very good, as ZRD received a gold certificate in 2011 and 2012 for the large amount of clean gypsum waste collected; collected quantities have been increasing since then, reaching almost 6 kg/cap in 2017.

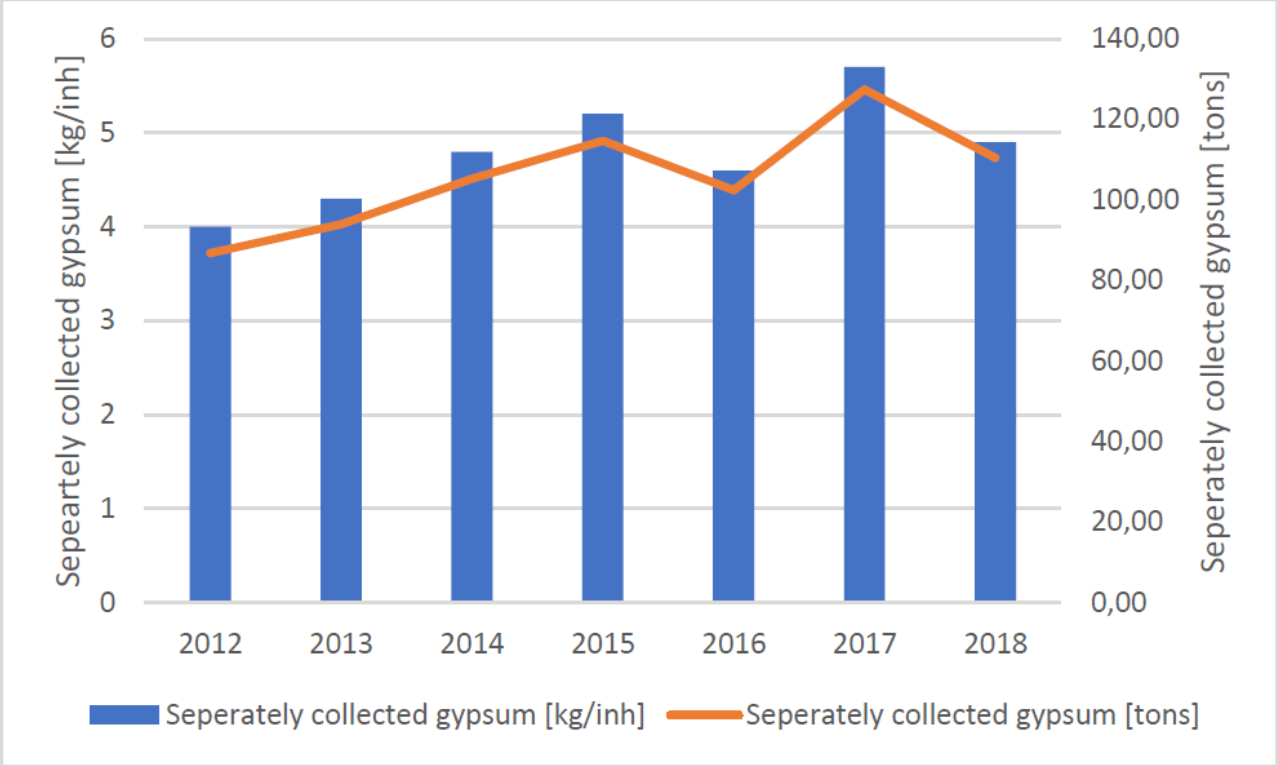


Figure 48: Gypsum collection in Reimerswaal 2012 – 2018 (source: COLLECTORS, D3.2)

Besides, recycling gypsum yields considerable environmental benefits compared to production with virgin materials, while its collection and transport has a very limited impact.

More information can be found in D3.3

Cost-benefit analysis

The good practice implemented in Reimerswaal has a rather low investment costs (which consists of the additional container in the civic amenity site). Regarding running costs, it appears that the additional transport costs for recycling and gate fee for recycling of gypsum (50 €/t) are compensated by the avoided costs of landfilling, whose gate fee and tax amounts to about 108 €/t.

Overall, the low investment costs and transport costs, but mostly the high costs for landfilling, makes the practice economically viable. It is unclear whether this good practice would be economically relevant in another context with a lower landfill tax for CDW.

More information can be found in D3.2

4.3 Recovery of bricks, insulation and sanitary waste in Odense

General presentation

Odense is the 3rd largest city in Denmark with a population of 204,200 inhabitants. Municipal waste is managed by a public waste company, Odense Renovation A/S. Odense has 8 recycling stations (CAS), with over 40 containers for collecting different waste materials. The vast majority of containers will be found at all the recycling stations in Odense. However, the smallest recycling stations do not have space for all 40 containers. Five of the eight stations facilitate the separate collection of all these categories.

The civic amenity sites of Odense collect a high diversity of CDW fractions:

- Window glass with frames
- Window glass without frames
- Double glazing with PCB
- Asbestos and Ethernite
- Roofing board
- Gypsum
- Concrete and Bricks
- Mineral wool
- White toilets and washbasins
- Building waste with PCB
- Bricks.

Figure 49: container for toilets and washbasins in one of the civic amenity site in Odense, Danemark (source: Odense Renovation)

Odense is a good example of a municipality involved in innovative CDW management schemes, leading the way in the reuse of old bricks which are being refurbished in Odense Renovation A/S's recycling centres. Previously, when bricks were delivered to Odense Renovation A/S, they were crushed and reused in construction projects, just like concrete and slate, but discarded bricks now have their own dedicated containers at the recycling centres. When a container is full, it is driven to the Gamle Mursten factory in Svendborg on Funen, where they are cleaned and sorted before being stacked on pallets ready for reuse in new constructions.

Odense also collects both waste mineral wool insulation and waste ceramic sanitary ware separately in order to repurpose this material. In 2016 Odense started working with the company Noreco and KI Hansen for the recycling of both these materials streams.

Results

Thanks to its extensive and well-developed system of civic amenity sites, Odense has reached one of the country's highest recycling rate for bulky waste, with about 87% of bulky waste/CDW being recycled.

The collected quantities for the three waste fractions analysed within the COLLECTORS case study have been stable for the past few years. They are presented on the graph below:

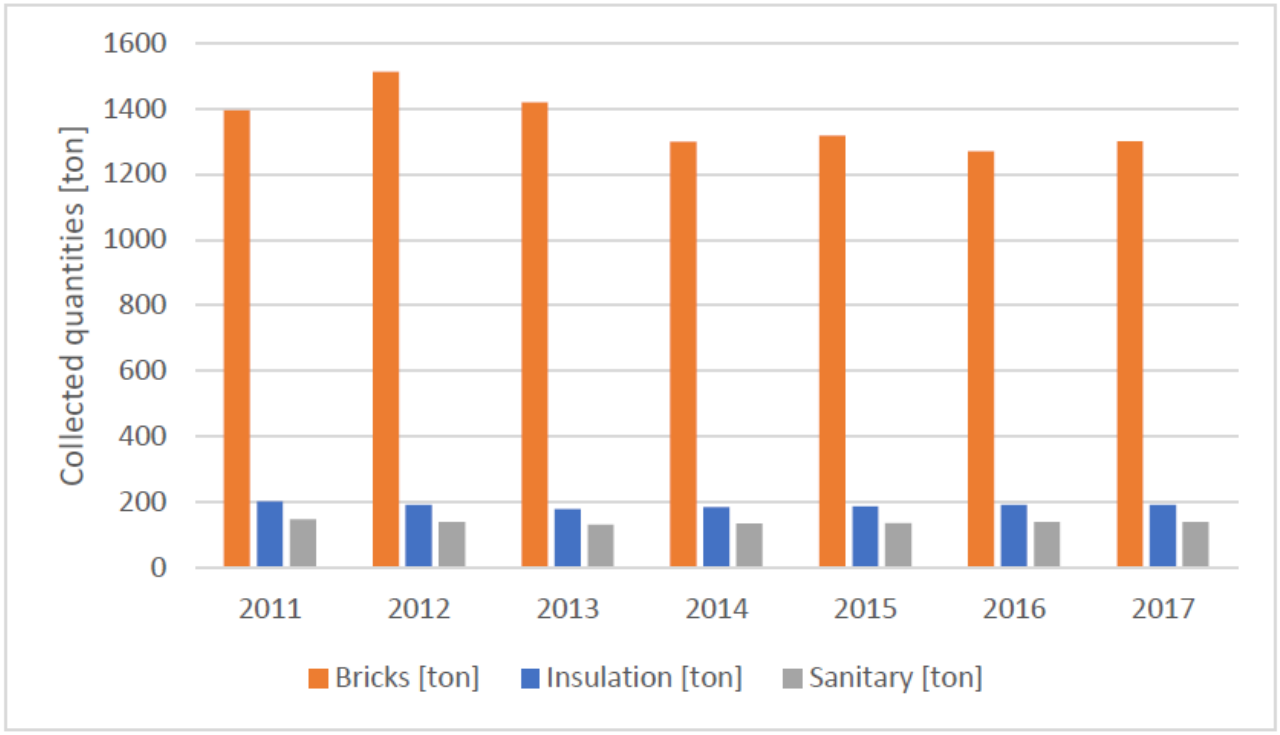


Figure 50: Brick, insulation and sanitary waste collection in Odense 2011 – 2017. Insulation and sanitary materials were collected before 2016, but they were not sent to recycling. (source: COLLECTORS, D3.2)

Then environmental analysis shows that the avoided impacts linked with the re-use of bricks (and thus the avoided primary production of new bricks), and of insulation materials are extremely significant. For both fractions, the impact of additional transport is negligible. The impact of the recycling process of insulation material is noticeable, but small compared to the avoided impact thanks to the displacement of primary production.

The environmental benefit from the use of sanitary ceramics in concrete, on the other hand, is rather limited. This is due to the fact that it does not allow the displacement of primary sanitary ceramics, and that it is used as a substitute for sand and gravel, which is associated with low environmental impact in comparison. The benefits from avoided transport and disposal are also limited. For this fraction, it seems that a system enabling their re-use would yield considerably higher environmental benefits.

More information can be found in D3.3

Cost-benefit analysis

This good practice required limited investments, with five additional containers being implemented for bricks, five for sanitary ceramics, and one for insulation materials, in total.

The overall economic balance is positive:

- The re-use of brick entails additional costs for transport (the landfill site being closer than the company re-using the bricks), and the savings from landfilling are limited, due to the low cost of sending bricks to landfills (10 €/t).
- The recycling of insulation waste allows savings, thanks to the proximity of the recycling plant, and the fact that the fee for recycling is lower than the landfill cost for insulation materials (90 €/t vs. 100 €/t for landfilling)
- The recycling of sanitary ceramics has a positive economic balance, thanks to low transportation distances to the recycling plant, and a lower gate fee compared to landfilling (55 €/t vs. 100 €/t for landfilling)

This cost-benefit analysis shows the importance of transport and landfill costs for the economic balance of CDW recycling. The viability of this good practice might not be transferable to another territory with low landfill costs and remote recycling facilities.

More information can be found in D3.2

4.4 Recommendations for CDW management

An interesting similarity between both case studies is the starting point for the separate collection, which is the availability of a clear market for the final end-application and a clear business-case. It is interesting to note that both waste collection systems were defined according to these end-applications and their associated requirements, that determined the sorting and collection process.

The approach developed by Odense, were separated fractions are determined according to the new potential routes for valorisation and end-application, seems extremely relevant when it comes to the design of the CDW collection service. Another interesting driver is the existence of a landfill ban on specific recyclable CDW fractions and/or taxes on CDW, which both seem to have an impact on the case studies.

It is also worth mentioning other good practices focusing on specific aspects:

- **Waste management for asbestos**: due to its extremely hazardous nature, asbestos requires very specific recommendations. Some good practices and recommendations are provided in the report on best environmental management practices for the waste management sector by the JRC[33]. Local authorities are recommended to:
  - Provide clear instructions on the conditions for asbestos-containing material to be safely removed;
  - Give guidance on how to ensure the safety of nearby residents during removal;
  - Make available a list of certified companies and collection points;
  - Provide sealable double-coated bags for collection and transport;
  - Set proper collection points (e.g. civic amenity sites with proper containers) or free on-demand collection services.
- **Re-use of construction products and materials**: promoting re-use can be recommended, considering its environmental benefits, and the fact that some CDW fractions might not have relevant recycling options. The Alelyckan civic amenity site in Goteborg, Sweden, a re-use section dedicated to construction and demolition waste, where e.g. doors, windows, or bathroom ware is collected from inhabitants and local construction and demolition companies, and sold at a lower price to inhabitants[34].
- **Sustainable construction**: while improving the management of CDW to promote re-use and recycling of construction materials is important, it is necessary to consider sustainable construction as a whole. ACR+ drafted guidelines for public authorities[35], highlighting various recommendations and good practices.
- **Pre-demolition audits**: as such audits become mandatory, they can also contribute in identifying hazardous substances from materials and promote source-separation, and allow more high-quality recycling. To help with their proper implementation, VTT published guidelines for pre-demolition audits[36].

More information in D2.4

[33] Dri M., Canfora P., Antonopoulos I. S., Gaudillat P., Best Environmental Management Practice for the Waste Management Sector, JRC Science for Policy Report, EUR 29136 EN, Publications Office of the European Union, Luxembourg,2018,ISBN 978-92-79-80361-1,doi:10.2760/50247, JRC111059

[34] https://www.urbanwins.eu/alelyckan-recycling-park-in-gothenburg/

[35] ACR+, 2019, Sustainable Construction Guidelines for Public Authorities, a Circular Economy perspective

[36] VTT, 2019, Pre-demolition audit - overall guidance document

5. The impact of COVID-19 and measures to maintain waste collection and separation

5.1 Introduction

The COVID-19 pandemic hit Europe in early 2020, a few months before the end of the COLLECTORS project. This pandemic and the corresponding (lockdown) measures are expected to impact waste generators (change in population, business hours, tourism activities), the composition of waste (change in consumption, new type of hazardous COVID-19 waste) and on waste management (shortage on staff, restrictions of movement). Therefore, the COLLECTORS consortium decided to conduct a survey and complementary researches on how the pandemic impacted municipal waste management, in order to identify good practices that can contribute to keep a proper waste collection service and not disrupt separate collection.

This section is based on various sources of information:

- A collection of information that was organised by ACR+ during the 1st lockdown periods (March-May 2020), focusing on the actions set at national and local level to overcome the challenges and changes linked with the pandemic and the lockdown measures;
- A dedicated COVID-19 survey organised within the framework of the COLLECTORS project, which collected data from 16 different cities and regions, and allowed to get in touch with other territories and studies;
- An on-going collection of information and reports from other organisations that conducted similar studies.

This section will focus on providing information on the observed impact of the pandemic on local waste collection system, and list already-identified good practices.

The point of this section is to present both the results from the survey (especially when it comes to reported quantities in early 2020) and list the main measures and recommendations regarding waste management during pandemic.

5.1.1 The COVID-19 pandemic in Europe

The COVID-19 outbreak started in late 2019 in China, and the first cases appeared in Europe in early 2020. In February 2020, a significant increase of cases was registered in Northern Italy, and by mid-March 2020, Europe was the centre of the epidemic, with all European countries being affected. This situation led most European countries to define various measures at national level such as lockdowns to limit the spreading of the virus.

It is difficult to compare these measures, considering that they generally were taken and lifted over time and sometimes applied differently at sub-national level. Most countries opted for the closure of schools, and non-essential retails and services (including HORECA sector), and many declared "state of emergencies" enforcing various constraining measures on travels, public events, and closure of businesses. Some countries implemented even stricter "lockdown" measures restricting the movement of population for non-essential purpose (e.g., Italy, France, Spain). In other countries such as Sweden, very few measures were taken, and government mostly relied on social distancing and ban of public events. An overview of the measures taken by different European countries is available in annex 2.

The pandemic and the associated restrictions led to changes in the number of private waste producers, including both the resident population with people deciding to go to their secondary home and the tourists that would have normally been here. For instance, it is assessed that the Paris Region lost about 20% of the population (including the tourists), with about 11% of the inhabitants of the Paris Region staying outside of their primary residence (e.g., students going back to their parents' place), of which 5% is outside the region[37].

These different situations potentially led to different impacts on waste generation and management; the closure of businesses and HORECA is likely to reduce the generation of commercial waste and the restrictions of movement is also likely to increase waste generated by households. Considering that the measures taken in the different regions and their duration were different, it is likely that regions were impacted in very different ways when it comes to waste generation and composition.

Therefore, the COLLECTORS project decided to launch a survey to get more detailed data and information from local authorities to better understand how the pandemic impacted waste collection, and the measures implemented along with their impact. Moreover, other sources of information were also considered, to cross-analyse the results and list key recommendations for local waste authorities to cope with the current and potential upcoming pandemic.

[37] Institut Paris Region, *Note rapide n°867,* available here: https://www.institutparisregion.fr/fileadmin/NewEtudes/000pack2/Etude_2434/NR_867_web.pdf

5.1.2 COLLECTORS survey

Figure 51: countries of the survey's respondents

Between June and October 2020, the COLLECTORS consortium conducted a survey – available online – for cities and regions to share their data and experience on the impact of the COVID-19 on their waste management systems. The survey was addressed to ACR+ member as well as waste collection systems documented by the COLLECTORS project. It was finally filled by 16 national or local authorities in charge of waste management, representing about 19,400,000 inhabitants, and located in 10 different countries. It is worth mentioning that about 20 more territories attempted to fill the survey but could not complete it for various reasons (lack of time, lack of monthly data, etc.).

Table 25: list of the respondents, with location and population

Territorial category	Country	Population
Municipality	Portugal	212,474
Municipality	Netherlands	25,068
Municipality	Denmark	205,000
National Authority	Luxembourg	626,108
Municipality	Croatia	806,341
Group of municipalities	Spain	316,798
Group of municipalities	Portugal	143,564
Municipality	Spain	37,456
Municipality	Spain	18,590
Municipality	Portugal	120,391
National Authority	Malta	514,564
Group of municipalities	Portugal	959,569
Group of municipalities	Romania	14,488,488
Municipality	Greece	55,525
Group of municipalities	Italy	535,000
Group of municipalities	Italy	314,200

They represent very different types of territories, from large cities to more rural areas, as well as touristic cities. The core focus was municipal waste management, in-line with the scope of COLLECTORS. The panel also encompass various collection modes, as presented in the following graph:

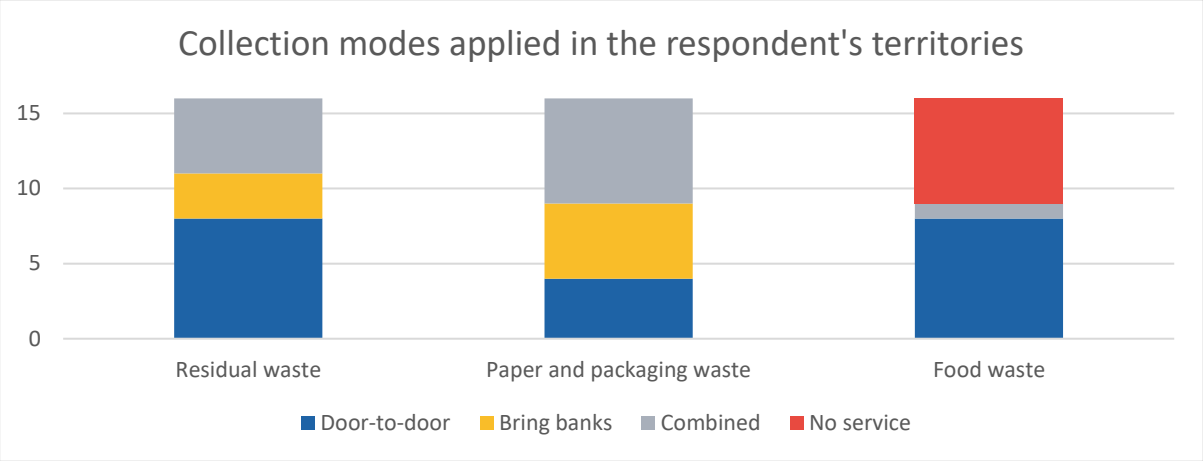


Figure 52: collection modes for residual waste, paper and packaging waste, and food waste in the respondents' territories

Besides, three of the waste collection systems include a pay-as-you-throw system.

The different results obtained from the survey will be presented in the following parts, and completed with information taken from other sources and studies. In particular, the survey allowed to better highlight the following points:

- How the local changes (e.g., to collection frequencies or closure of civic amenity sites) impacted the capture rates;
- How the collected quantities changed between the first months of 2019 and 2020 in the different territories;
- How the different organisations of waste collection were impacted by the pandemic.

5.2 Impact on waste quantities and management

The first hours of the pandemic of the novel coronavirus, COVID-19, forced public authorities and municipal waste operators to rapidly adapt their waste management systems and procedures to take into consideration elements such as safety and health measures for employees, waste treatment requirements, general procedures due to coronavirus for waste sector, staff availability, etc. As mentioned above, the COVID-19 pandemic has several impacts on municipal waste management. These different impacts were reported by the survey's respondents, but also by several territories from which information was collected by ACR+ during the first wave of the pandemic (c.f. annex 3).

- Impact on waste generators:
  - Change in resident population, leading to fluctuation of waste quantities;
  - Slowdowns or closure of business, retail, and services, leading to the reduction of commercial waste generation;

- Stop of tourism activities;
- Impact on the composition of waste generated:
  - The changes of consumption patterns or habits linked with the lockdown measures;
  - The generation of new types of waste, such as face masks and other personal protection equipment. Since this type of waste is collected with residual waste, no quantitative data is available.
- Impact on waste services:
  - Shortage of staff, impacting the running of collection routes and sorting/treatment units;
  - Impossibility for inhabitants to reach civic amenity sites due to restriction of movement.

5.2.1 Impact on waste generation

The impact of COVID-19 on waste generation is really different from one territory to another; it mainly depends on the scope of municipal waste (e.g. whether and to what extend commercial activities are included), or the context of the territory (e.g. touristic intensity, etc.). The data reported by cities and regions reached within the framework of the COLLECTORS survey highlight this diversity, as shown on the following graph. The following bars refer to the different respondents for which complete data were available for the lockdown periods.

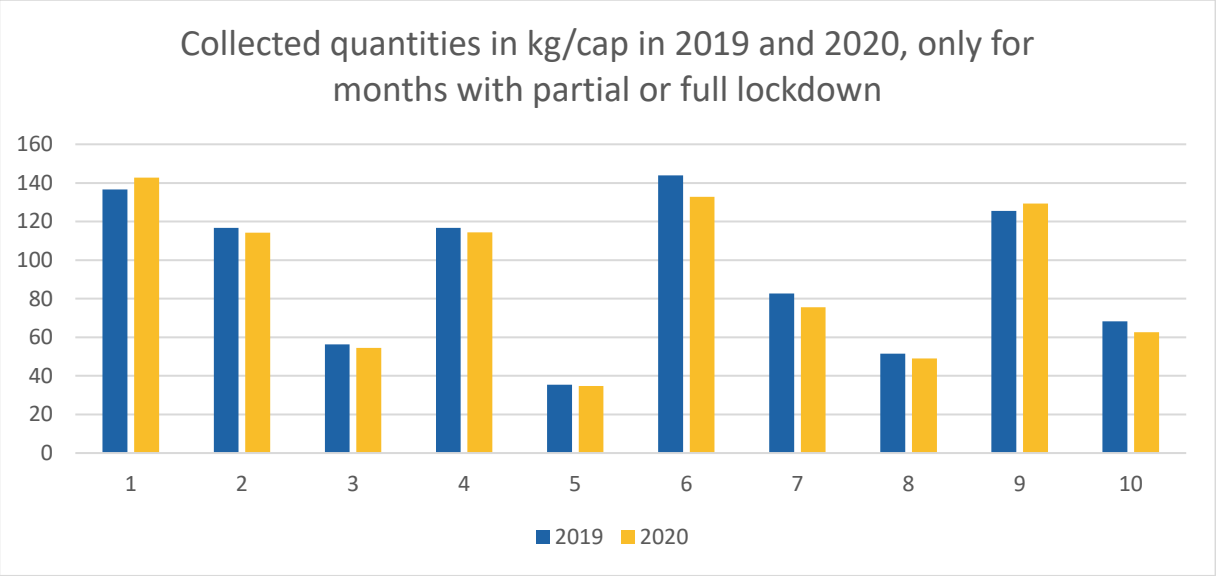


Figure 53: collected quantities in 2019 and 2020, for the months during which restriction measures were introduced in 10 cities covered by the survey

Most of the cities experienced a slight decrease, and some even experienced a small increase. The decrease is mostly noticeable for several cities that are usually characterised by a high touristic activity, or where commercial waste is included in municipal waste collection.

Detailed data on the evolution of the collected quantities for different fractions were also collected for several territories, such as the Region of Catalonia, or the city of Milan. These figures are presented below:

Catalonia (7,600,065 inhabitants)

In tonnes	Normal 1 month	COVID-19 1 month	Variation rate
Bio-waste	34,008.28	30,267.37	-11%
Paper-cardboard	26,193.38	15,715.03	-40%
Glass	15,890.81	11,123.57	-30%
Packaging	13,210.04	15,059.44	-14%
Total selective waste	**89,302.51**	**72,166.41**	**-19.19%**
Mixed waste	**193,000**	**170,000**	**-12%**

Figure 54: evolution of collected quantities in Catalonia (source: ARC, 16/04/2020)

Milan (1,390,434 inhabitants)

	Weeks 10-14 2020 vs 2019
Residual waste	-24.4%
Paper-cardboard	-20.0%
Glass	-16.7%
Plastic and metals	-16.3%
Food waste (households)	-14.4%
Food waste (commercial activities at night)	-80.5%
Total waste	**-27.5%**
Street bins	-38.2%

Figure 55: evolution of collected quantities in Milan (source: AMSA[38])

In both territories, overall quantities declined for both the mixed and sorted fraction. The most significant decreases can be noticed for paper and cardboard and glass in Catalonia, and for commercial food waste in Milan. It is likely that these decreases are connected with the closure of commercial activities and services such as HORECA establishment. Milan published a summary of the impact and measures taken online[39].

The three Irish regional authorities on waste published a report summarising the impact of the first lockdown on waste management[40], which reports the same trend: an increase of household waste by 21% (with comparable increase for residual waste and sorted waste), and a sharp decrease of commercial waste, and construction and demolition waste by 50%.

Some local authorities, such as the Irish regional authorities, also reported specific increase of occasional waste (bulky waste, garden waste, construction and demolition waste, etc.), possibly linked with the lockdown measures and the fact that many people took this opportunity for small renovation works, gardening, or tidying up their housing. It resulted in difficulties to access civic amenity sites, even leading to traffic jams[41].

Many articles also reported increasing littering of gloves and masks. This particular aspect was not necessarily reported by local authorities within the survey or collection of information as the impact on the waste service was limited. However, some measures were adopted to tackle this issue and will be presented below.

In conclusion, it is difficult to give one single trend regarding waste generation at local level, and it seems that many different situations could be experienced, possibly depending on the local specificities, but also the scope of waste management by the respondents. It is also possible that some changes of consumption could not be observed when it comes to waste management, or that more changes occurred for each individual waste fractions. Analysing 2020 reports from

[38] https://www.acrplus.org/images/project/Covid-19/AMSA_Waste_management_during_COVID-19.pdf
[39] https://www.acrplus.org/images/project/Covid-19/AMSA_Waste_management_during_COVID-19.pdf
[40] Regional Waste Management Offices, 2020, Performance of the Waste Sector in Ireland - Covid 19 – Initial Restrictions Phase
[41] https://www.gelderlander.nl/nijmegen-e-o/nijmegen-ruimt-massaal-op-file-bij-milieustraat~ad9a9ea0/

waste authorities when they are available will probably contribute to better understand these trends.

5.2.2 Impact on waste collection and sorting

The COVID-19 and the associated restrictive measures had different impacts that could lead to changes in the organisation of waste collection. Among the most frequent changes of collection services identified from the survey and other sources, the following ones were identified:

- **Closure of civic amenity sites**: in many territories, the restriction of movements and closure of non-essential services led to the closure of civic amenity sites. 30% of the respondents reported a closure in March, and more than half reported changes going from minor disruptions to full closure in April. In general, collection points limiting interaction between the inhabitants and with the collection staff, such as door-to-door and bring systems were given priority.
- **Reduction or stop of collection services**: in many places, on-demand or kerbside collection of garden waste and bulky waste were suspended. In some territories, the frequency of selective collection (e.g., of dry recyclable waste) was reduced over a short period of time. Several respondents of the survey reported such reductions of collection frequencies for sorted fractions such as paper and packaging waste, with negative impact on sorted quantities.

The association of French local authorities AMORCE conducted different surveys[42] during the lockdown periods, which monitored the closure of civic amenity sites (CAS) and of sorting centres, as well as the suspension of selective collection routes. These figures tend to show that most CAS were closed in March (some being only open to business or communal waste), but they progressively re-opened in April and May (sometimes with restrictions on the waste that could be brought). When it comes to separate collection, a large share of local authorities suspended bulky waste collection in March and April, while paper and packaging waste collection could be maintained by most local authorities during the lockdown (the suspension rate ranging from 30% in late March to 15% in late April).

These observations were also made by the London Waste and Recycling Board[43] whose survey reported that the changes of collection mostly concerned bulky waste and garden waste. However, it shows that almost all boroughs could not maintain business as usual services during the lockdown.

Otherwise, several territories had to interrupt community composting, and some had to adapt street cleaning operations, either by increasing or decreasing the frequency of the operations.

These trends are visible among the 16 waste collection systems surveyed within the framework of COLLECTORS:

[42] https://amorce.asso.fr/boite-a-outils-dechets-gestion-des-dechets-et-coronavirus
[43] LWARB, 2020, *How local authority waste services responded during the COVID-19 pandemic*

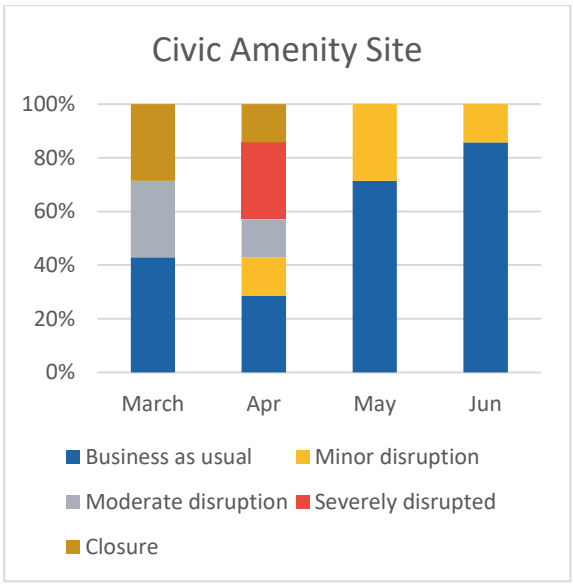


Figure 56: status of the CAS during the first wave of COVID-19

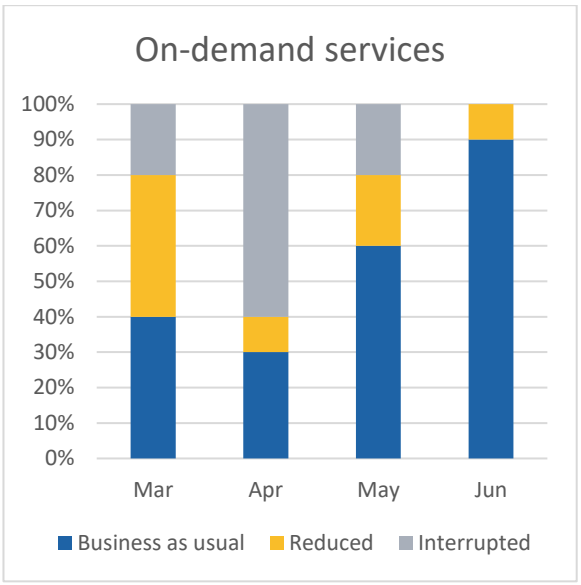


Figure 57: status of on-demand systems during the first wave of COVID-19

In parallel, fly-tipping has been increasing in several territories, with one-third of the respondents reporting moderate to severe increases. This observation was also made by LWARB, with 42% of waste authorities experiencing increases of fly-tipping. Regarding the COLLECTORS survey, it is worth mentioning that there is an unsurprising correlation between occurrence of fly-tipping, and the closure of CAS and interruption of on-demand services.

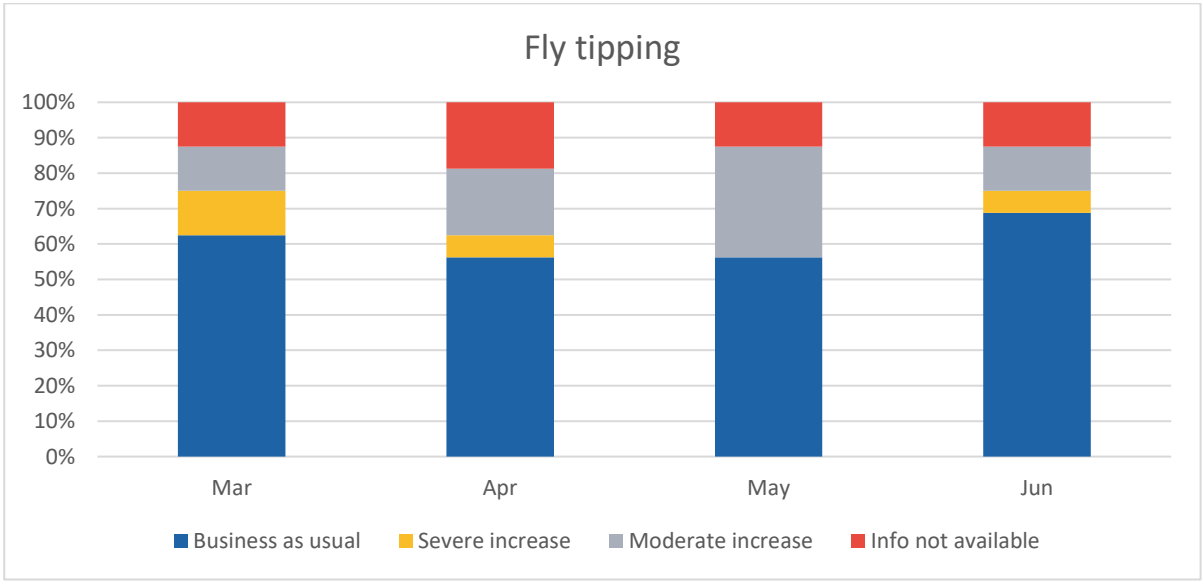


Figure 58: status of fly-tipping in the respondents' territories during the first wave of COVID-19

Regarding sorted quantities, the collected data tend to show different local trends. The different collected quantities for several waste fractions (residual waste, paper and packaging waste, food waste) for several of the respondents are presented on the following graph:

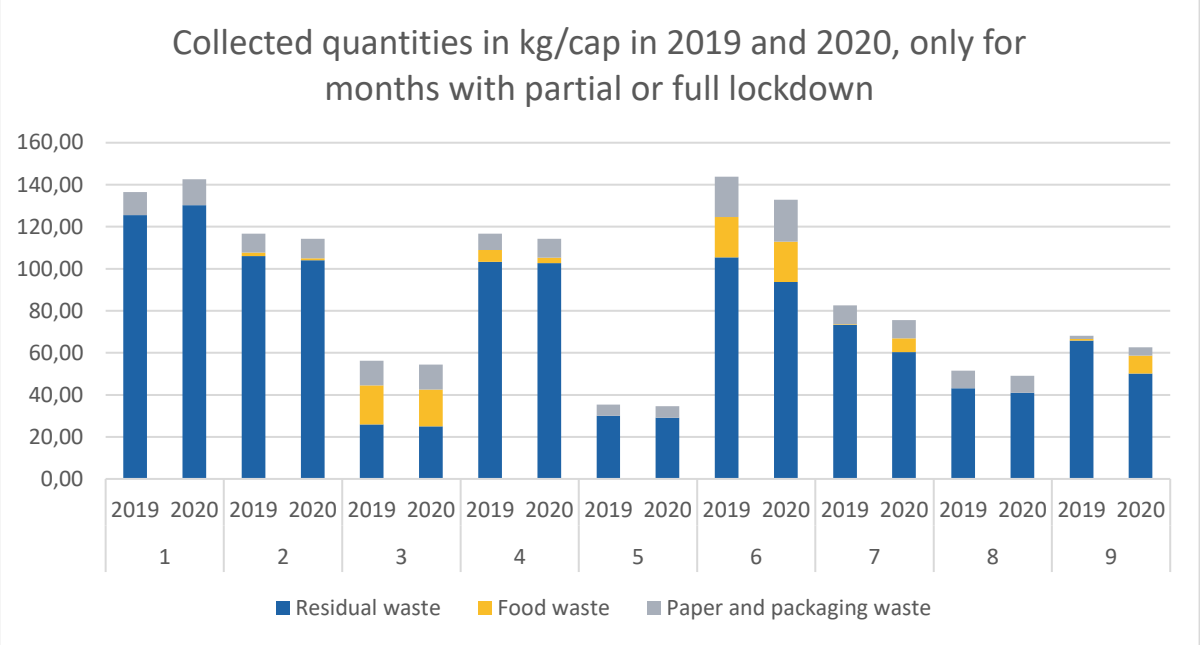


Figure 59: collected quantities in kg/cap for 9 different waste collection systems, for the month where restriction measures where implemented

The data tend to show that the capture rates were not really impacted by the pandemic, and it seems that for these nine territories all managed to either maintain their sorting performances, or even increase them. Some of them even managed to increase their capture rate (e.g., WCS 6 and 9), due to the recent implementation of food waste collection. The data presented in Figure 55 for the city of Milan also tend to show that the sorting system could be kept operational during the lockdown.

This trend is confirmed by a survey launched by CITEO, the French EPR organisation for paper and packaging[44], which reports that 78% kept their recycling habits during the lockdown, and 63% of the respondents even reported that they are more aware of their daily waste production and wish to reduce it. WRAP also reported a similar positive impact on behaviours toward food waste[45].

Impact on recycling

The pandemic also impacted the recycling sector, with the lack of demand and low prices of virgin plastic leading to temporary closure of converting plants[46]. The European recycling industry was quite impacted by the epidemic, with a lack of material and a very low demand compared to last year[47].

This impact moving along the recycling value-chain was also reported by AMORCE's members, with different sorting centres facing difficulties to get bills of sorted materials to be collected in April.

[44] https://www.citeo.com/le-mag/malgre-la-crise-sanitaire-le-geste-de-tri-resiste/
[45] https://wrap.org.uk/content/food-waste-and-covid-19-survey-3-life-flux
[46] *Plastics Recyclers Europe*
[47] *BIR*

5.2.3 Measures implemented

The COVID-19 pandemic led to various adaptations from local and regional authorities, either dictated by the measures taken to contain the spread of the virus, or by the impact on their organisations (e.g., shortage of staff). Local waste authorities faced different challenges with several key objectives, among which:

- Ensuring the safety of the collection staff
- Properly managing the allocation of staff and staffing levels
- Keeping an adequate level of service and waste collection running
- Reaching the inhabitants and other waste producers with the right information on possible changes

ACR+ collected information from various sources and territories during the first wave, regarding some first insights on the impact of the pandemic and the measures taken by the different regional and local authorities. A summary of these elements is presented in the annex 3.

The figure below summarised the main trends observed during the first wave:

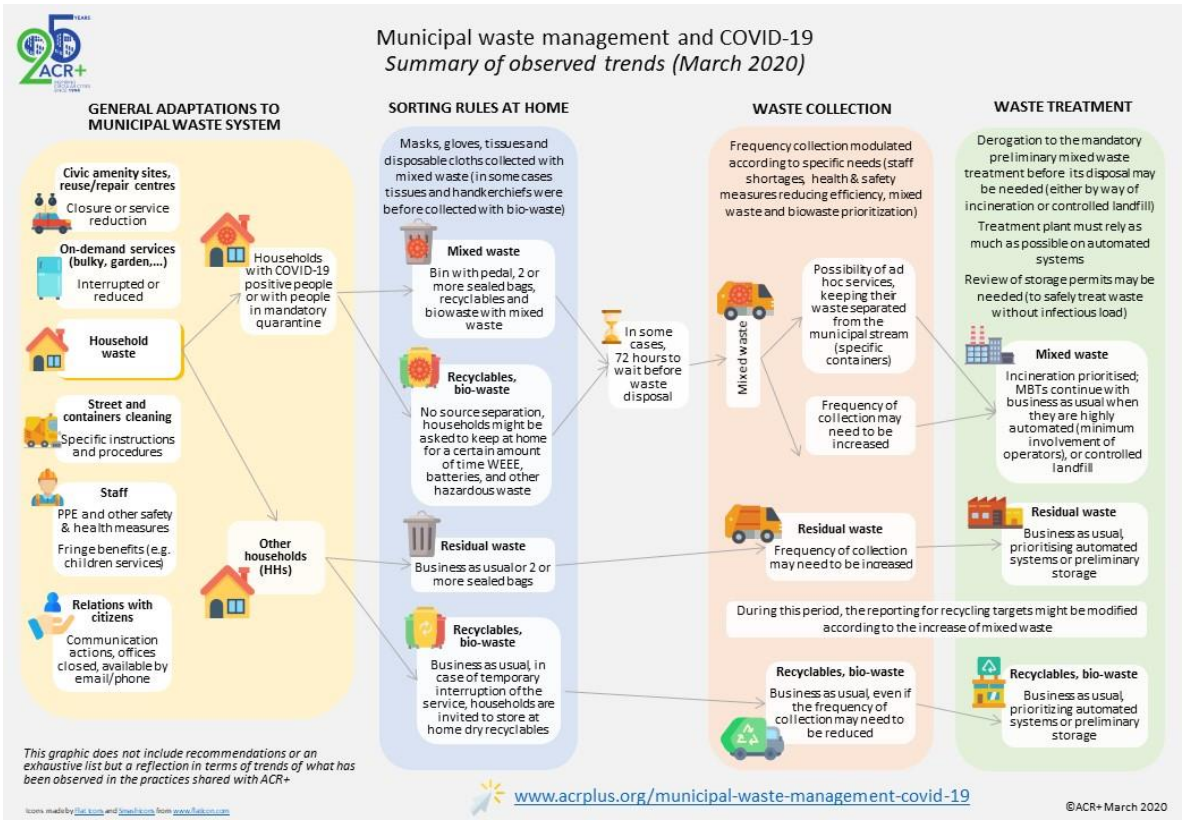


Figure 60: summary of observed trends in March 2020 after a screening of local, regional, and national practices

5.2.3.1 Safety of staff

The safety of collection staff is a key priority. It can be ensured by different measures:

- **Interruption of services** with contacts with citizens (e.g., civic amenity sites), or limiting these contacts by ensuring social distancing. This can also be achieved by limiting the number of simultaneous users (e.g., by introducing a mandatory booking, or by not accepting users when maximum capacity is reached).
- Giving **priority** to collection services that limit interactions with users, such as door-to-door or bring systems;
- Provide **suitable protection equipment** (gloves, masks, hydroalcoholic gel for hands and to disinfect equipment, e.g. truck cabins, etc.).
- **Train** collection staff about safety measures and use of PPE. This measure was implemented by almost all respondents of the COLLECTORS survey.
- **Rearrange shift duration**, to limit interactions among workers and to guarantee the implementation of additional health and safety measures
- **Adapting collection teams** and collection routes to avoid contacts in common areas.
- In sorting and treatment units, **ban any manual manipulation** and pretreatment process before disposal, or introduce a mandatory temporary storage (e.g. 72 hours) before starting the operations

5.2.3.2 Maintaining collection services

The report published by DG ENV on 14 April 2020[48], highlights the essential role of the separate collection of the municipal waste for safeguarding the trajectory towards a more circular economy and the jobs and businesses that depend on secondary raw materials supply. However, higher waste generation or shortage of staff might lead to the need to prioritise waste collection services, so that efforts can be put on high-priority waste streams. Several respondents of the COLLECTORS survey indicated significant increase in absenteeism, and almost all of them indicated that they had to adapt the working conditions and organisations to maintain the collection services.

According to the measures identified in Europe, the following levels of priority can be defined:

- High priority: residual waste, food waste, medical waste or residual waste from contaminated households, fly-tipping.
- Medium priority: dry recyclable waste, civic amenity sites.
- Low priority: bulky waste, garden waste.

Maintaining the operation of civic amenity sites might be useful to limit fly-tipping. More measures focusing on CAS are presented below.

5.2.3.3 Operation of civic amenity sites

As mentioned above, keeping civic amenity sites open has been reported as a good practice by many waste authorities, e.g., to limit the level of fly-tipping. Several measures were commonly reported by waste authorities:

- **Ensuring social distancing** is crucial to keep the staff and users safe. CAS has to undergo re-arranging to adapt the circulation of users and limit their number on sites: wider walk ways, on-way routes, etc. A very important measure is to limit the number of users on-site,

[48] EC (DG ENV), 2020, Waste management in the context of the coronavirus crisis

which can be done by different ways: making booking mandatory, limiting the conditions for accessing the site, etc.

- **Limiting the access:** many waste authorities reported measures aiming at limiting the use of civic amenity sites to reduce frequentation and maintain an acceptable level of service. Some defined several priority waste fractions (for instance construction and demolition waste, garden waste, etc.) or only allowed specific users (commercial activities, or only private vehicles), depending on the specific local needs.
- **Online booking:** this was reported by several waste authorities and seems to have received very positive feedback from users and appeared to be very effective to ensure social distancing. The online booking system can also require the user to list the type of waste that is going to be brought, which can help to enforce limitations on the access of the service. This also reduce queuing, improve logistic and organisation, and ease the work of the staff overall.
- **No manual handling of the waste by the staff**: this also means that staff are not in capacity to help users.
- **Storage time before handling:** many authorities indicated that waste had to be stored 72 hours before being collected and sent to treatment.
- **Communication on changes:** it is vital to make sure that the population is aware of the changes. Most waste authorities reported using their website or social media to detail the new arrangements. Signs were also displayed at the entrance of the CAS to remind the safety measures, or warn users of new specific conditions (limited waste fractions accepted, booking required, etc.).

5.2.3.4 Collection of waste from households presenting COVID cases

There are significant differences across territories when it comes to the management of household waste generated by COVID-positive or quarantined people. While some defined specific collection routes, asked these users to put all waste in residual waste, and classified it as infectious medical waste, other did not manage them differently from other households. However, most waste authorities asked potentially infectious waste (such as masks, gloves, cleaning equipment, tissues, etc.) to be put in two bags, and sealed, and possibly stored for a variable time (ranging from 24 to 72 hours in most of the observed cases) in a place with limited access before collection.

ECDC[49] recognises the need for specific measures as regards infection prevention and control for suspected or confirmed coronavirus cases self-isolating at home, notably that patients should have a waste bag in their room for used tissues, face masks and other waste, which should be disposed of in the residual waste.

UNEP proposed the following recommendations for identified quarantine locations[50]:

- For **inhabitants**:
  - Separate infectious waste, including masks, gloves, and tissues;
  - Use double bagged for this potentially infectious waste, and disinfect the bag;

[49] ECDC, 2020, *Infection prevention and control in the household management of people with suspected or confirmed coronavirus disease (COVID-19)*
[50] UNEP, 2020, *Waste Management during the COVID-19 Pandemic, From Response to Recovery*

- Keep recyclable waste for a certain period of time (until patients are cured) before putting it for collection;
- Stop using collection points.

- For **collection and transportation**:
  - Arrange special collection service;
  - Consider inter-city cooperation for such service;
  - Ban opening of bags or pre-treatment at transfer/treatment units, and try to transport directly to the final treatment process;
  - Disinfect the collection vehicles.

5.2.3.5 Communication

Communication is a key aspect of waste collection during the pandemic, to inform inhabitants on changes and new instructions. Many waste authorities reported an increasing number of questions and solicitations by inhabitants.

Many territories relied on **online communication** (website, social media) as well as hotlines to address the increasing solicitations of the population, and many set hotlines. In Milan, the public waste company also sent letters to building managers so that householders could be informed.

Besides the instructions and practical information on changes, it is important to explain **the reasons behind these changes**, especially in case of interruption of selective collection or changes brought to the sorting guidelines. It is also important to keep the key messages simple and in accordance with national guidelines.

Finally, many respondents of the COLLECTORS survey reported communicating on waste prevention as a way to reduce the pressure on waste collection system.

5.2.3.6 Littering

Several measures addressing littering of mask were also identified, such as national communication campaigns reminding the importance of properly disposing of masks for environmental and health reasons, or the increase of the fines for littering.

5.2.4 Conclusion and key recommendations

The first wave of the COVID-19 pandemic impacted differently the different territories across Europe, and many different approaches and measures were set to respond to the changes. However, it seems that most waste authorities had to adapt to the new safety measures and to shortage of staff.

It is challenging to come up with recommendations based on the cross-analysis of quantitative performances with the measures taken. In general, local authorities had to balance different parameters: providing an essential service to citizens, keeping the staff safe, maintaining sorting performances, and tackling illegal practices. The recommendations identified try to address these different aspects, yet it is recognised that their implementation might be very challenging with very restrictive measures implemented. For the COLLECTORS guidelines, it was decided to list the

actions and measures that were either highlighted by the survey's respondents, as well as the recommendations provided by the other studies and publications mentioned above.

The results of the COLLECTORS survey, the review of measures implemented at national, regional, and local level, and other studies and guidelines identified allow to list the following key recommendations for handling waste collection in time of pandemics:

- **Flexibility** is key to ensure the continuation of priority collection services, and the territories that could maintain good collection were the ones that could re-allocate resources among the different collection schemes (e.g., from commercial waste to household waste collection). It might be relevant to multi-skilling the operational staff to help them to fulfil different operational roles to improve the resilience of the service.
- **Keeping civic amenity sites open** with adequate measure can be recommended. Online booking systems received very positive feedback from users, but also from staff.
- **Define priority levels** for collection services, focusing on collection modes limiting the interactions with inhabitants, or on specific waste fractions (e.g., residual waste, food waste, etc.). Keeping collection frequencies for sorted fractions greatly contribute to keep sorting performances steady.
- **Give priority to online communication** to reach inhabitants, provide clear information and simple, coordinated messages, and explaining the reasons behind changes. Taking advantage of the local media can also be recommended. It is also recommended to take the opportunity for giving the priority to messages on waste prevention.
- **Establish a consistent and continuous reporting** of the evolution of quantities.
- **Tackle illegal practices** such as fly-tipping by setting a closer monitoring, the enforcement of the regulation, an adequate communication, and ensuring that alternatives collection systems are still available (such as civic amenity sites).
- **Take advantage of guidance**, support systems and networks, to identify good practices and recommendations.
- **Follow UNEP recommendations** regarding the management of waste from COVID-positive households.

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ANNEXES

Annex 1: references for the conduction of composition analysis

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Annex 2: summary of the timeline and main restriction measures in Europe

Country	Date of the first case	Date of main restriction measures	Measures taken
Austria	25/02	16/03 to 20/04 17/11 to 06/12	Forbidden to leave home except for necessary professional activities and purchases, or outdoor activities with other ppl from the household
Belgium	04/02	17/03 to 03/05 02/11 to 15/12	Closure of non-essential shops, schools, discos, HORECA, cultural events Non-essential travels prohibited
Bulgaria	08/03	13/03 to 15/05	Closure of schools, shopping centres, cinemas, HORECA, non-essential business
Croatia	25/02		
Cyprus	09/03	15/03 to 21/05	
Czech Republic	01/03	12/03 to 17/05	Closure of schools, HORECA, non-essential retailers and services and ban of non-essential movements
Denmark	27/02	13/03 to 15/04	Non-essential workers to work from home, closure of schools, then closure of HORECA, contact services
Estonia	27/02	13/03 to 17/05	Closure of schools, then closure of shops and further restrictions on movements
Finland	28/01	16/03 to 13/05	Closure of schools, gvt-run facilities, restrictions on private services such as restaurants and organization of events
France	24/01	13/03 to 02/06	Closure of schools, non-essential shops, HORECA, then restriction of non-essential movements.
Germany	27/01	13/03 to 15/04	Closure of schools, then HORECA, curfews (different measures and timelines depending on the states)
Greece	26/02	09/03 to 04/05	Closure of school, then restrictions on nonessential movements
Hungary	04/03	11/03 to 16/06	Closure of schools, events, HORECA
Ireland	29/02	27/03 to 18/05 21/10 to 01/12	Closure of non-essential shops and services incl HORECA, and stay-at-home order
Italy	31/01	08/03 to 04/05	Restriction of movement, closure of non-essential shops and businesses (started in late Feb for several areas), schools
Latvia	02/03	13/03 to 10/06	Ban on public events, private arrangements, meetings, etc. HORECA remained open with 2-m social distances
Lithuania	28/02	16/03 to 16/06	Closure of non-essential shops and services, HORECA. Re-opening of different sectors started in mid-April
Luxembourg	29/02	15/03	Closure of non-food businesses and HORECA.
Malta	07/03	13/03 to 01/05	Closure of schools, public events, then closure of non-essential retailers and services.
Netherlands	27/02	15/03 to 08/06	Closure of schools and public events, HORECA, some non-essential services, promotion of home-working. Re-opening of different sectors starting early April.
Poland	04/03	12/03 to 03/05	Closure of schools, offices, events, restriction of movements
Portugal	02/03	18/03 to 04/05	Closure of schools, non-essential retails and services, HORECA
Romania	26/02	16/03 to 15/05	Closure of schools, HORECA, then restriction of movements
Slovakia	06/03	12/03 to 22/04	Closure of schools, venues, non-essential shops, restriction of movements during holidays, then progressive re-opening

Slovenia	04/03	16/03 to 15/05	Closure of schools, HORECA
Spain	31/01	14/03 to 09/05	Lockdown, restriction of movement for non-essential workers, closure of non-essential shops and services, HORECA
Sweden	31/01		Social distancing, bans on large gathering, travel restrictions
United Kingdom	31/01	23/03 to 10/05	Stay at home order

Appendix 3: summary of the measures taken in several European countries

Table 26: overview of national recommendations and measures implemented at local and regional level across Europe (source: ACR+)

Regions	Measures taken
Austria	
Upper Austria Land Salzburg Vienna	▪ Citizens asked to reduce waste and keep source separation ▪ Social distancing when disposing of waste ▪ Corona-infected household waste has to be disposed in the residual waste, interruption of selective collection. ▪ Corona-infected waste (tissues, etc.) has to be put in smaller, tearproof bags tightly closed and put in the residual bin ▪ Reallocation of teams between collection, street cleaning, and other municipal services, three different shifts organised to limit contacts among staff members
Belgium	
Brussels Region Wallonia Region Flanders Region	▪ Specific circular to address staff shortages and set priorities and essential services for waste authorities ▪ Priority given to door-to-door and bring collection, which limit contacts between inhabitants and staff / reduction of collection in re-use centres and CAS (access limited to batteries, used oils, WEEE, hazardous waste) ▪ For door-to-door collection, priority to residual and food waste ▪ Priority given to high-densely populated areas ▪ Reduction of collection frequency for recyclable waste over a short period of time ▪ Inhabitants asked to keep residual waste 7 days before putting it for collection ▪ If the household is positive, double bag the residual waste ▪ Communication by waste authorities on changes in collection guidelines and CAS, and reasons behind these changes
Croatia	
Zagreb	▪ Disinfection and washing of residual waste containers by the waste authority at a defined schedule
Czech Republic	
National recommendations	▪ National guidelines for used personal protective equipment ▪ For COVID-positive households, masks should be put in in a plastic bag with a minimum thickness of 0.2 mm and disinfected (or use 2 bags); ▪ Local authorities must determine processes to store and dispose waste from COVID-positive households, in agreement with the public health authority
Estonia	
National recommendations	▪ Different storing and collection routes for infected/quarantined people. Such waste must be placed in a sealed bag and disposed as residual waste, with no source separation, and not handled manually. ▪ For CAS, the following arrangements must be made to maintain the service: re-arrangement to ensure social distancing, citizens should be asked to avoid using them, waste should not be processed manually and stored 72 hours before treatment, no cash payment, and disinfectant available
Finland	
National recommendations	▪ National recommendation published by the end of March, on prioritisation of waste management activities and waste collection ▪ Instruction to households: in case of delay for waste collection, store the waste in a sealed bag in a place where no one and no animal can access ▪ Tissues and napkins can be disposed in bio-waste (it was advised to put them in residual waste for a short period of time but it was reassessed as safe) ▪ Collection of infected households to be collected in specific routes

France	
National recommendations	▪ Derogation to dispose of (incinerate or landfill) waste for which it is usually not authorised, and the usual penalised taxes on disposal for such waste are lifted. ▪ Guidance on the protection of waste collection staff, especially for medical waste, PPE for collection and sorting staff ▪ Household and medical waste handling is regarded as essential and services should be maintained. CAS should define a minimum service for businesses (e.g. for construction and demolition waste), if possible.
Amiens Métropole Grand Besançon Métropole Nantes Métropole Paris	▪ Interruption of bulky waste collection and textile waste collection, and partial interruption of selective collection in specific areas or for commercial waste ▪ Closure of CAS (not included in authorised movement for the population) and collective composting units ▪ Cancellation of reusable diaper renting systems ▪ Potentially infected items should be put in sealed bags ▪ Re-organisation of teams to limit the number of agents at the same location and ensure their rest.
Germany	
National recommendations	▪ Business as usual for non-infected household ▪ For infected household: all waste in residual waste, with bags sealed., except for glass, deposit packaging, WEEE, batteries and hazardous waste that must be disposed as usual.
Bavaria	▪ COVID-19 positive households must dispose heir tissues and similar waste, as well as packaging from where food was eaten (e.g. yoghurt cups) in residual waste; beside glass waste, other fractions should not be sorted. ▪ Recommendations on waste treatment: residual waste to be delivered in secure bags. ▪ In case of shared containers, household must store them as much as possible and only dispose of them shortly before collection
Ireland	
National recommendations	▪ €1 M funds to help local authorities deal with illegal dumping during lockdown (to cover waste removal and CCTV installation) ▪ Specific recommendations for waste generated by a contaminated person: in residual waste, tie the bag when ¾ full, and put the bag in another bag, and store the bag 72 hours before putting it for collection ▪ The three regional authorities issued a report to summarise the impact of the first lockdown on waste management, key decisions, strengths and vulnerabilities.
Italy	

National recommendations	▪ For municipal waste generated by COVID-19 positive households, waste is regarded as infectious medical waste (hazardous waste), and handling must comply with the regulation for this waste. To make it possible for municipal waste services, adaptations were enforced, e.g.:
	  ▪ All waste is regarded as residual waste, double bagging, daily collection. The bags have to be tied (with string or adhesive tape) using single use gloves;
	  ▪ Do not press the bags with hands;
	  ▪ Do not allow pets getting close to waste bags;
	  ▪ Deliver the waste for collection according to the system in place;
	  ▪ If the person in isolation/quarantine cannot deliver the waste for the collection service, the local authority must set up a specific service with specialized staff.
	▪ Municipal waste generated by other inhabitants comply with the “usual” system, and have to put tissues, masks, and single-use gloves in residual waste, using 2 bags.
	▪ Waste staff has to wear PPE and sanitize vehicle cabins
	▪ Specific guidelines were also published with recommendations for municipal waste management and treatment

Basilicata Region Emilia-Romagna Region Calabria Region	▪ Publication of orders and notes on municipal waste management on treatment plants, waste from healthcare facilities, and waste from COVID-19 positive households ▪ An ordinance on COVID-19 households include: ▪ The identification of the concerned household communicated by the local healthcare

Piemonte Region Tuscany Region	unit ▪ Special kit delivered by the local waste facility to the household (with bags, tape, and special bin ▪ Collection operated every 3/5 days upon phone call, as residual waste collection, which is stored apart from other residual waste ▪ Treatment of waste in selected incinerators, without any pre-treatment
Milan Treviso	▪ Limited number of CAS opened, with limited number of users accepted, reduction of sweeping service ▪ Specific sanitation activities in street and public areas ▪ Protection equipment distributed to workers ▪ Specific communication campaigns to citizens (website, smartphone app, flyers, social media, letters to building managers)
Luxembourg	
Luxembourg	▪ Interruption of on-demand collection for bulky waste, still available for grass clippings ▪ Closure of CAS, then opening limited to 12 vehicles on site ▪ Closure of second-hand shops ▪ Mobile and door-to-door collections of occasional waste were interrupted
The Netherlands	
The Hague Amsterdam	▪ Many people cleaned their house, making CAS too busy. Citizens asked to access CAS only in real necessity ▪ Collection routes started earlier as a preventive measure to ensure the health of workers
Norway	
National recommendations	▪ Higher demands in some CAS, leading to some closures. People are asked to keep their waste home ▪ Possibility to rent private containers for bulky waste ▪ Some municipalities set unattended hazardous waste collection points ▪ Temporary changes in landfilling permits or permits to carry waste to other locations ▪ Several recommendations for local authorities: ▪ Inform households on changes and instructions via social media ▪ Limit CAS access to specific waste fractions, and ban cash payment
Portugal	
National recommendation	▪ Specific orders to ensure the continuity of waste management services ▪ Guidelines and recommendations for municipal waste management (protecting workers) ▪ In case of lack of capacity, recyclable waste must be disposed with residual waste ▪ Keep selective collections as much as possible to avoid overloading residual waste ▪ Possibly contaminated materials (masks, gloves, etc.) should be put in residual waste in sealed bags. ▪ Municipalities must foresee possible disruption and prepare for increasing residual waste collection, but changes should be limited to avoid waste deposited in the streets. ▪ Priority given to incineration over landfill when possible. MBT must be stopped ▪ Storage of municipal selectively collected waste during 72 hours.
Serbia	
Belgrade	▪ Disinfection of disposal containers ▪ Instructions to citizens to keep sorting habits and avoid fly-tipping
Slovakia	
National recommendations	▪ Continuation of waste collection services but CAS, that were then partially re-opened ▪ Masks, tissues and gloves to be put in sealed plastic bags and put in residual waste bags.
Spain	
National recommendations	▪ A special Order was published giving instruction on household waste collection and treatment, as well as healthcare waste. ▪ Household with COVID-19 cases have to dispose their residual waste sealed and deposit them in the locations indicated by the municipality. For other household, no changes are required. ▪ Bags from places where high levels of COVID-19 cases are identified (residences, hospitalised hotels, etc.) have to be identified by a specific mean (tape, sticker, etc.) and

	deposited in specific containers as indicated by local authorities, to have a specific treatment ▪ When it comes to treatment, incineration is given the priority, and no manual handling of waste or pre-treatment should be performed. ▪ A 72-hour storage can also be decided by the local authorities. ▪ Gloves, masks, etc. from healthcare centres will be assimilated to infection medical waste and handled as such. ▪ Competent authorities may require the coordination of waste management companies to handle the infectious waste, and cement plants allowed to co-incinerate waste can be required to treat it. ▪ Instructions are given for people infected with COVID-19: any disposable material used by positive people should be put in a bag, then sealed, and put in another bag before being deposited in the household garbage bad.
Andalucia Catalonia Ayuntamiento de Palma Mancomunidad de Debagoiena Balearic Islands	▪ Regional guidelines provided by regional governments, based on national instructions ▪ Instructions published online to citizens, including prevention instructions to reduce the quantities, and to store occasional waste (WEEE, etc.) ▪ Guidelines were published on waste prevention for businesses ▪ Masks, gloves, wipes, etc. should be disposed in sealed plastic bags and disposed as residual waste ▪ PPE for staff of treatment units and reduction of manual operations, 72-hour storage for waste before recovery. ▪ If there is a lack of treatment/recovery capacity, all waste must be sent to disposal, preferably incineration. ▪ Increase of collection fees was cancelled to reduce the impact on households and commercial activities affected by the lockdown.
Sweden	
National recommendations	▪ Guidance on classification of waste regarding their infectious character ▪ The risk of contamination through household waste was assessed as low, so waste from contaminated household is managed as usual. However, waste that is potentially contaminated by airway secretion or bodily fluids (tissues, diapers, etc.) should be disposed in sealed plastic bags
Switzerland	
National recommendations	▪ Household contaminated by COVID-19 should put all their waste in the residual bin ▪ Masks, tissues, etc. must be disposed in sealed bags and put in residual waste bins ▪ CAS must be kept open with or without staff (in this case with posters providing guidance). Citizens must be instructed not to use CAS for non-perishable or clean waste. ▪ PPE and protective measures must be ensured for workers
United Kingdom	
England Scotland Central Scotland	▪ Specific regulatory position statements allowing longer storage time than indicated in the permits, for incinerators to treat waste potentially infected by COVID-19, and for healthcare workers treating patients at home to dispose of PPE waste in residual waste ▪ Priority should be given to residual waste, food waste, and recyclable should be maintained if possible ▪ Municipalities are invited to re allocate staff for the priority waste services ▪ Priority waste streams are residual waste, food waste, fly-tipping, and healthcare waste ▪ Medium priority waste is dry recyclable, CAS, commercial waste ▪ Low priority is bring sites, weekly collection of dry recyclables, garden waste bulky waste ▪ Waste potentially contaminated (used for cleaning or by infected person) must be put in two bags, sealed, and stored out of reach during 72 hours

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