



What are the opportunities for municipalities in glass packaging collection?

The perspective of local authorities for glass collection - a study carried out by ACR+



**close the
glass loop**



Opportunities for municipalities in glass packaging collection

The perspective of local authorities for glass collection

Municipalities are one of the key actors of the glass recycling value chain, at the closest point to the consumer and the point where consumers dispose of their waste. They are also key players for the collection of glass packaging, being in charge of municipal waste management. Many municipalities (or groups of municipalities) coordinate packaging waste collection, either themselves, or by commissioning a public or a private company to do so. Even when packaging waste management is coordinated by producer responsibility organisations, local authorities are closely associated with the design of the waste collection system, and have an important role to promote separate collection through communication or incentives such as Pay-As-You-Throw (PAYT) schemes.

Municipal waste collection performances depend on policies, regulation, and economic instruments that enable the recycling of glass packaging (“general framework conditions”), but also on the local choices made by local authorities or waste operators when it comes

to the dissemination of information, the technical operations, and the instruments implemented to incentivise waste separation by inhabitants.

The revised Packaging and Packaging Waste Directive is a major step forward, increasing recycling targets for glass packaging to 70% by 2025, and 75% by 2030 per country. Most importantly, new EU targets now measure the actual recycling of packaging materials – not just collection rates – making it all the more important to increase and improve collection to achieve these real recycling targets.

The study carried out by ACR+ was commissioned in the context of Close the Glass Loop, a multi-stakeholder Partnership bringing together glass manufacturers, glass recyclers, food & beverage producers, extended producer responsibility schemes, and local and regional authorities to achieve a 90% average EU collection rate of used glass packaging by 2030 (up from the current 76%) and improve the quality of collected glass.



Objective and approach of the study

The study carried out by ACR+ outlines the **perspective and roles of local authorities in the glass recycling value chain** and provides an overview of the **current framework conditions** and **waste collection organisation for glass packaging** in seven European countries : United Kingdom, France, Italy, Spain, Germany, Poland and Portugal (which together accounted for more than 80% of the total volumes of non-recycled glass in 2017).

It also compares the **performances of local waste collection systems**, highlights the **parameters which are driving high collection and recycling results**, and **identifies areas to improve local performances**.

The study is based on **collection of information and data** and **interviews** of local municipalities and glass collection and recycling experts.

The perspective and roles of local authorities in the glass recycling value chain

The role of local authorities in waste management

Municipal waste management serves different purposes: to provide a service of “removing” waste generated by households and possibly assimilated waste generators, to handle sorted materials to be used as “recycled materials” for manufacturing purposes, as well as to implement communication and education actions to properly orient citizens’ behaviour.

Local authorities...

- Provide a service to citizens;
- Promote a proper sorting behaviour; and
- Address various expectations: cleanliness, transparency, etc.

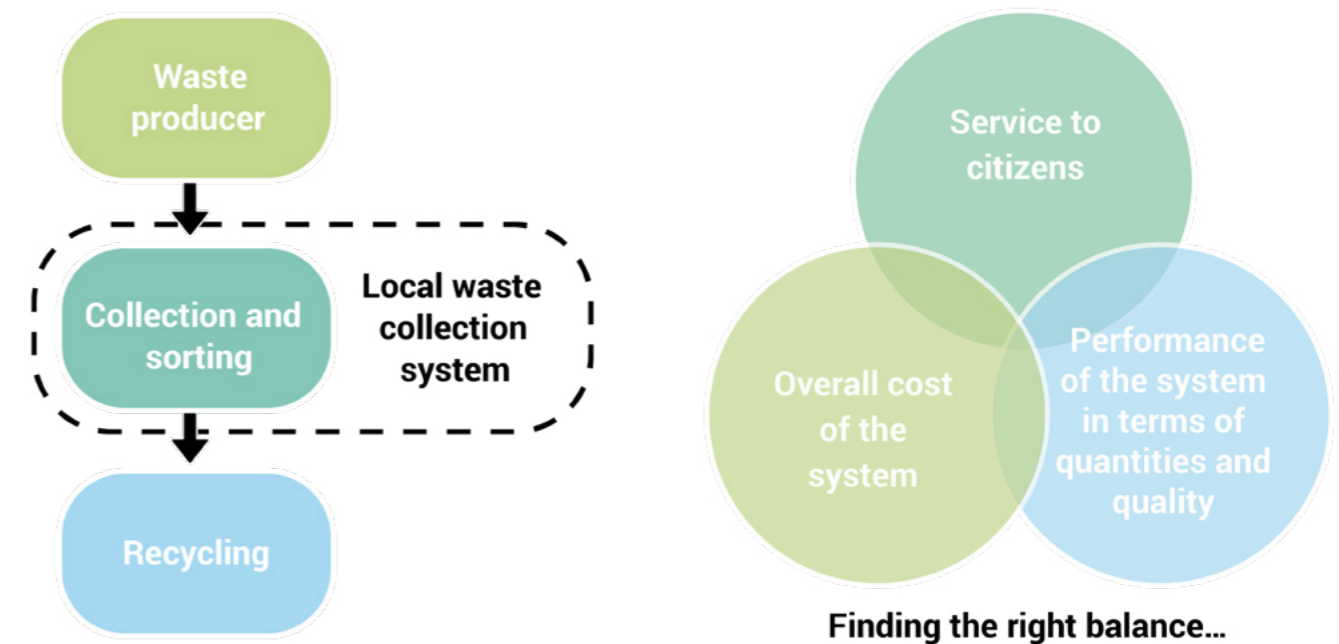
For inhabitants, the intention to sort waste is mostly conditioned by four factors: **information, environmental concern, social norms, and convenience.**

Resident population might not be the sole target of the waste collection system. **Transient populations** (commuters, tourists) can represent a significant share of waste generation and require specific collection systems and communications activities.

Waste collection systems play a significant role by converting waste into secondary raw materials that substitute virgin raw materials in the production process.

When it comes to glass recycling, what role do local authorities play in waste management?

For effective glass collection systems, municipalities need to strike a fine balance.



Separate collection of glass packaging is mandatory according to the Waste Framework Directive, which is enforced by Member States, mostly through **Extended Producer Responsibility systems (EPR)**. **EPR systems promote selective collection through various instruments**, e.g., take-back schemes for sorted materials that include a price depending on the quantities sorted, along with specific parameters regarding the quality of sorted materials (impurity rates, granulometry, humidity, etc.).

The sorted quantities and associated quality are heavily dependent on the operational choices made by the local authority or by the organisation in charge of waste collection, as well as on how waste generators are involved in waste collection: source separation, the mode of collection, frequent controls of sorted fractions, regular communication activities, etc.

The organisation of municipal waste management

The organisation of municipal waste management is very heterogeneous across Europe. In many countries, the actual organisation of municipal waste management can also be very diverse in terms of competences, operational roles, or organisation of collection. In many cases, many different stakeholders are involved in the design and organisation of municipal waste collection.

Competences:

Municipalities can decide to organise waste collection on their own or to transfer their competences to other organisations for collection and/or treatment. Municipal waste management systems can be organised:

- By municipalities directly
- By an association of municipalities
- By public waste companies operating for municipalities or associations of municipalities
- By Producer Responsibility Organisations, mandated by municipalities
- By Producer Responsibility Organisations directly
- By private operators

Scope of action:

• **Municipal waste is defined in the Waste Framework Directive as:**

- Mixed waste and separately collected waste from households, including paper and cardboard, glass, metals, plastics, bio-waste, wood, textiles, packaging, waste electrical and electronic equipment, waste batteries and accumulators, and bulky waste, including mattresses and furniture;
- Mixed waste and separately collected waste from other sources, where such waste is similar in nature and composition to waste from households.

• **At local level, the exact scope of municipal waste can differ from one territory to another:**

- **Household waste** is the main component of municipal waste. However, part of household waste might be collected outside of “the municipal waste service” (e.g. Deposit-Refund System for beverage packaging).
- **“Assimilated waste”**, defined as waste from non-household sources but similar in nature and composition, is generally included in the scope of municipal waste but can be very different from one territory to another: commercial waste (e.g. Hotels, Cafés and Restaurants, HORECA) or waste generated by public institutions.

Operational roles:

While the organisation and planning of municipal waste collection is under the responsibility of local authorities and producer responsibility organisation, the actual operation can be conducted by various players:

- Some municipalities own their own collection equipment and directly operate waste collection;
- Some municipalities have set public or semi-public companies, possibly with other municipalities;
- In other cases, collection is contracted to private companies through tenders. Collection contracts with private companies are usually a few years.
- It is also possible to have a combination of systems.

Different types of contracts exist, including:

- **Public Private Partnership** where the assigned organisation has to design, build, finance and operate a public service;
- **Concession**, where the service provider will be directly paid by the users (e.g., citizens) and benefits from the incomes generated by the service.

These various types of contracts have an impact on the design of the collection systems and whether the local authority or the operator decides on the collection system.





Waste fees:

Waste management entails significant collection and treatment costs, and generates revenues related to the sales of sorted materials or of energy, or from subsidies received from EPR systems. The difference between the incomes and the costs are covered by waste fees, paid by the users of the municipal waste collection system (i.e. citizens and assimilated producers).

There is a great diversity of waste fees across Europe:

- Absence of “visible” fee (direct funding by the municipal budget)
- Waste tax based on the characteristics of the property (e.g. value, water consumption)
- Waste fee based on the characteristic of the household using the service
- Pay-As-You-Throw (PAYT) system based on the use of the waste service (in terms of volume, frequency, or weight)

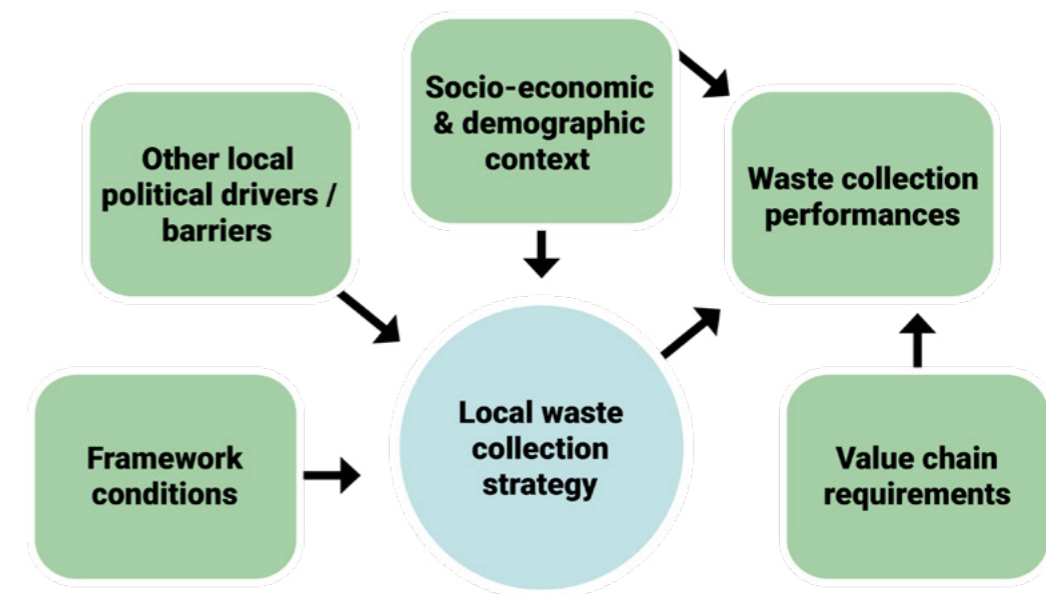
Ownership of sorted waste:

Local authorities are given more or less flexibility when it comes to the ownership of sorted waste materials. In some systems, the EPR organisations own the materials, decide on their destination, and perceive the associated incomes. In others, municipalities have much more leverage.

The perspective of local authorities

Even though several parameters can be listed to explain the design of municipal waste management at local level, it is challenging to clearly determine the impact of these different parameters. Municipal waste management systems are the results of the waste management system existing before the introduction of recycling strategies, local political decisions, framework conditions, constraints related to the local context, as well as local expectations or opposition from the population.

How are decisions on local collection and recycling systems made?








Main drivers behind changes brought to a waste collection system:

- Availability and cost of landfilling and incineration
- Economic drivers, incl. distribution of costs between different players
- EPR systems: subsidies, technical specifications, guidance
- Perception and satisfaction of citizens

Criteria to support decision-making:

- Collection for recycling rates
- Convenience and coverage of bring points
- Citizens' engagement and participation
- Collection costs and waste fees

To better understand the drivers behind the design of local collection systems and behind changes of collection, and the involvement of the different players in managing and improving glass packaging waste collection, three interviews were conducted to describe different waste collection systems, highlighting different contexts and situations at local level.

 Berlin (DE) Shifting from door-to-door to bottle banks	 Milan (IT) A well-performing door-to-door system in a dense context	 Cascais (PT) Glass collection in a very touristic area
<p>Mix of bottle banks and door-to-door Colour separation</p> <p>Quantities: 17 kg/cap Collection rate: 57% Loss rate: 15.5%</p>	<p>Door-to-door</p> <p>Mixed colours</p> <p>Quantities: 50 kg/cap Collection rate: 95% Loss rate: 15%</p>	<p>Bottle banks</p> <p>Mixed colours</p> <p>Quantities: 15.2 kg/cap Collection rate: 80% Loss rate: 14.5%</p>
<p>Initiated in 2013 by the Green Dot organisation, due to low quality</p> <p>Challenges: opposition of local decision-makers, difficulty to find suitable spots</p> <p>Overall: sharp increase of quality, increase of quantities</p>	<p>Door-to-door used for several reasons:</p> <ul style="list-style-type: none"> • Little space for banks • More contamination in banks • Typology of housing <p>Good performances: transparent bag for residual waste, regular controls and fines</p> <p>Challenges with commercial waste</p>	<p>Peak of production when both tourists and residents are here (May and December)</p> <p>Simplified, translated messages</p> <p>Dense network of containers, following national guidelines Visual + automatic inspection of filling-levels</p> <p>PAYT + inspection of big producers</p>

Framework conditions

Framework conditions (i.e. relevant policies, regulation, and economic instruments) play a key role to enable and promote the recycling of glass packaging. This section focuses on the framework conditions at national level for the seven targeted countries: Germany (DE), Spain (ES), France (FR), Italy (IT), Poland (PL), Portugal (PT) and the United Kingdom (UK).

**National
legislation on
glass packaging
waste**

**Taxes and bans
on disposal:**
Landfill
Incineration

**Pay-As-You-Throw
schemes**

EPR schemes:
Responsibilities:
Operational, Financial,
Communications
Technical and quality
requirements

Overview of framework conditions (2020)



Economic incentives			
Landfill ban	Untreated waste, focus on biowaste	-	-
Landfill tax	-	Regional, from 7 to 47 €/t	From 16 to 40 €/t
Incineration tax	-	Regional From 5 to 16 €/t	From 3 to 15 €/t
PAYT	100 %	In 10 to 20 municipalities	10% of the population
EPR systems			
Role	Financial and operational (full)	Financial and operational (partially)	Financial
Scope	Household and commercial	Household and commercial	Household
Competition	Yes	No	No
Collection systems			
Collection modes	90% bottle banks 5% door-to-door 5% civic amenity sites	Bottle banks (99% of municipalities) Door-to-door for HORECA	Bottle banks (80% of the population) Door-to-door
Separation system	Colour separation	Mixed colours	Mixed colours Co-mingling for 2% of the population
Recycling rates (2017)	84.4%	72.2%	77.9%
Key points from interviews			
	Collection contract duration is short, preventing investments More communication needed for quality High collection targets might lead to lower quality	Cooperation between PRO and municipalities is essential Additional investments needed to improve separate collection Inclusion of a bonus to increase quality	Cooperation through Charter Verre 100% Solutions is key Priority: HORECA and big cities Innovative collection systems can play a crucial role



Set at regional level	Biowaste Combustible waste	-	Regional
Set at regional level	About 65.5€/t	11 €/t	110 €/t
Set at regional level	-	Variable	-
8% of municipalities	None	Few pilots	None – Fines in Wales
EPR systems			
Financial	Financial	Financial	Financial (tradable certificates)
Household and commercial	Household and commercial	Household and commercial (below a weekly volume)	Household and commercial
No	Yes	No	Yes
Collection systems			
Bottle banks (main system) Door-to-door	No data. Bottle banks and door-to-door with plastic bags	Bottle banks Door-to-door used in specific areas and for HORECA	60% of door-to-door X co-mingling
Mixed colours Co-mingling for 20% of the population	Mixed colours	Mixed colours	60% of co-mingled collection
72.2%	63%	49%	67.7%
Key points from interviews			
Quality is a key priority Door-to-door schemes tend to have lower quality and higher cost PAYT has positive impact on quantities but negative on quality	Lack of regulation is the main challenge Lack of funding for collection, but investments are made by recyclers Door-to-door collection has lower quality due to the use of plastic bags	Increase of landfill tax in discussion Mismatch between local glass production and consumption Priorities: HORECA, awareness raising, more incentivising fee system	Wales reached high performances with kerbside collection Inconsistencies of local collection systems create confusion Current system only covers 10 to 20% of collection costs

Local waste collection system for glass packaging waste

To get more insight on the diversity of local approach and identify trends between local context, local strategies, and performances, a database of waste collection system (WCS) located in the seven targeted countries was established, based on data collected by the COLLECTORS projects (www.collectors2020.eu) and completed with further research and checking of data. The territories are either individual municipalities or “municipal associations” to which municipalities transferred their waste competences.

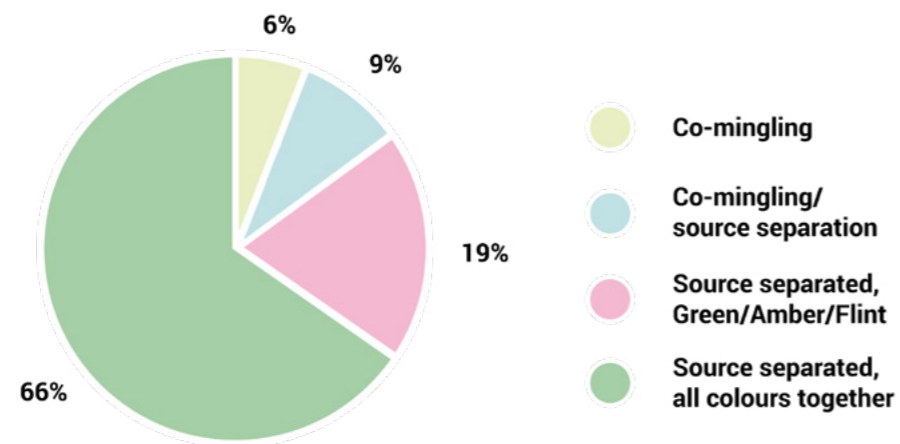
The study analyses 67 waste collection systems in the seven targeted countries for which data on glass packaging could be retrieved. The panel reflects many different contexts. Despite the fact that it cannot be presented as a representative view of glass packaging waste collection in Europe, it gives a good overview of the diversity of contexts and of organisation for waste management. The panel includes various types of contexts in relation to the density of population, GDP, and touristic activities. Different categories for these parameters were established, to ease cross-analysis among the waste collection systems.

A number of parameters could not be properly documented due to a lack of data. Moreover, data about costs (running costs, waste fees, etc.) prove to be hardly comparable and difficult to analyse: definitions and calculation methods are likely to be very different from one waste collection to another (e.g., whether incomes from materials sales or subsidies are included in the costs or not, how the costs are allocated to the different waste fractions for which resources are shared, whether administrative costs are included or not, etc.). It also proved very challenging to identify local data on the quality of sorted fractions.



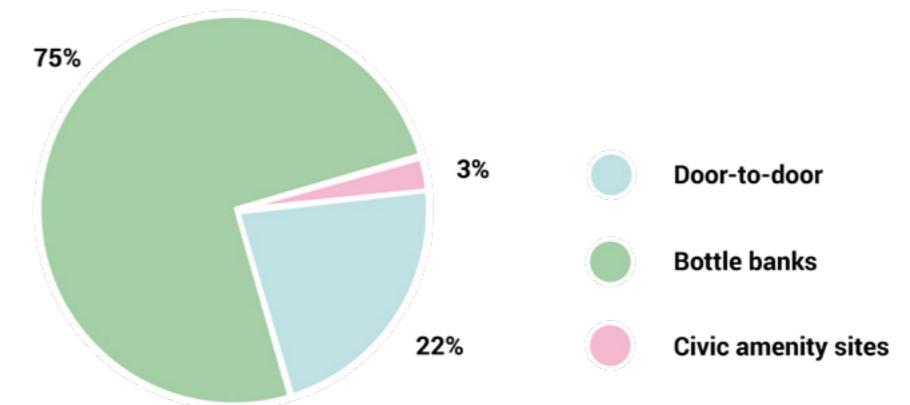
Organisation of glass packaging management

Source separation is the dominant approach



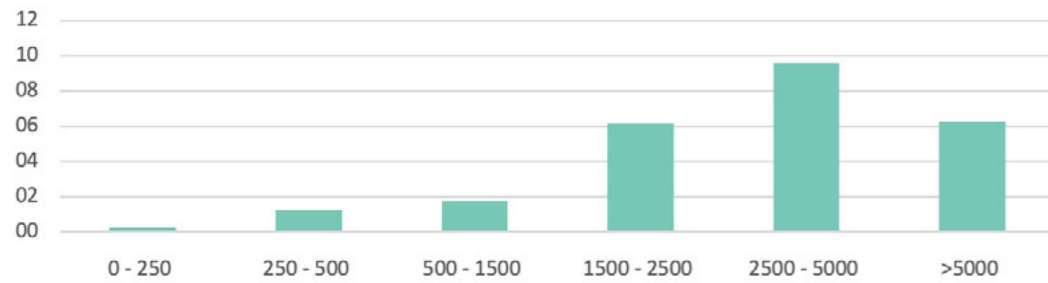
- In this panel, all waste collection systems with colour separation are located in Germany.
- Systems using co-mingling are located in Italy (5), the UK (3), France (1) and Poland (1) and work on different combinations (glass + metal packaging; glass + metal + plastic packaging; all dry recyclables).

Bottle banks are the main collection mode



- The collection modes are quite diverse among the documented waste collection systems : door-to-door, bottle banks, civic amenity sites.
- These categories encompass different practices that might lead to different behaviours or outcomes in terms of quality.
- In many territories, different collection modes are used in parallel, either depending on the location, the type of housing, or the type of waste producer.
- Bottle bank is the main collection mode used (used in 60% of the WCS documented and representing 75% of the quantities collected).

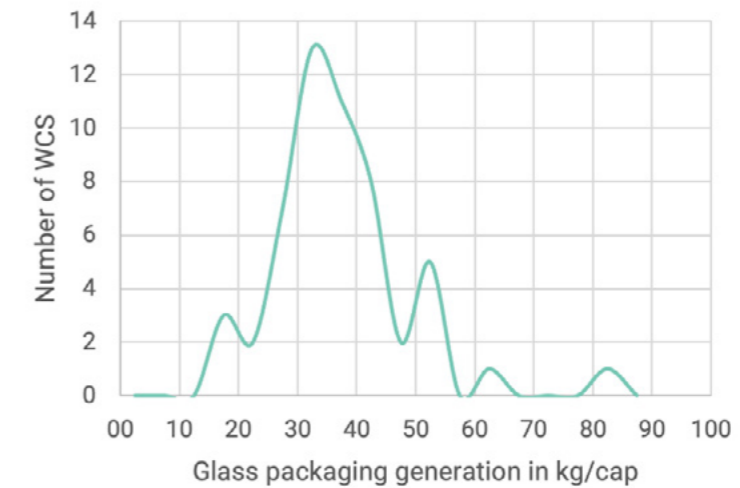
Average number of bottle banks per km² according to the category of population density, for systems using mostly bottle banks for glass collection



- The number of bottle banks per 10,000 inhabitants is quite heterogeneous, and ranges between 2 and 65 among the 38 WCS for which data on the number of bottle banks are available.
- There is no clear correlation between the local context and the number of bottle banks, despite the fact that denser territories tend to have denser networks of bottle banks.

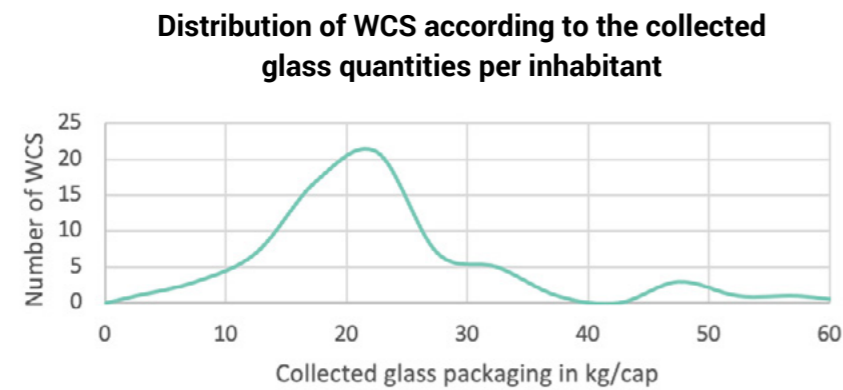
Generation of glass packaging

Distribution of WCS according to glass packaging generation in kg/cap

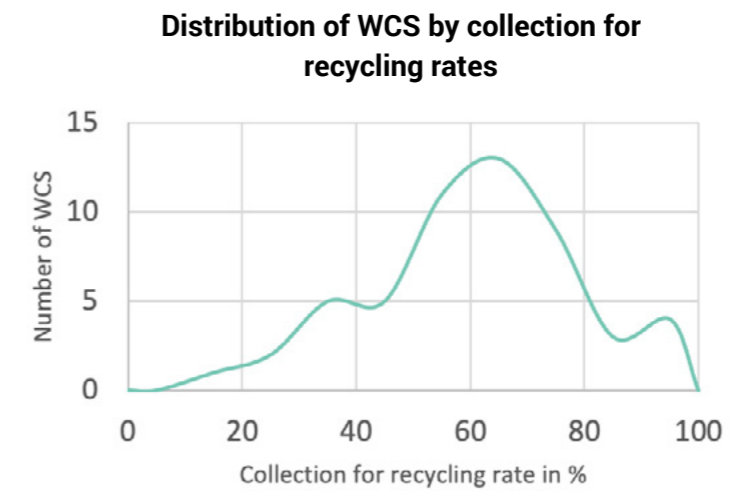


- Glass generation per capita is very heterogeneous among the panel, and ranges from about 20 to 85 kg/cap, with an average of 32.5 kg/cap for the 53 waste collection systems for which generation data are available.
- The average glass packaging waste generation reported by Eurostat is close to the average of the panel studied here (32 kg/cap in 2016).
- For the panel analysed, glass packaging represents in average 20% of the total production of paper and packaging in terms of weight. There are significant differences within the panel: glass represents from 10% to 40% of the generated paper and packaging waste (PPW) at local level.

Performance of glass packaging collection

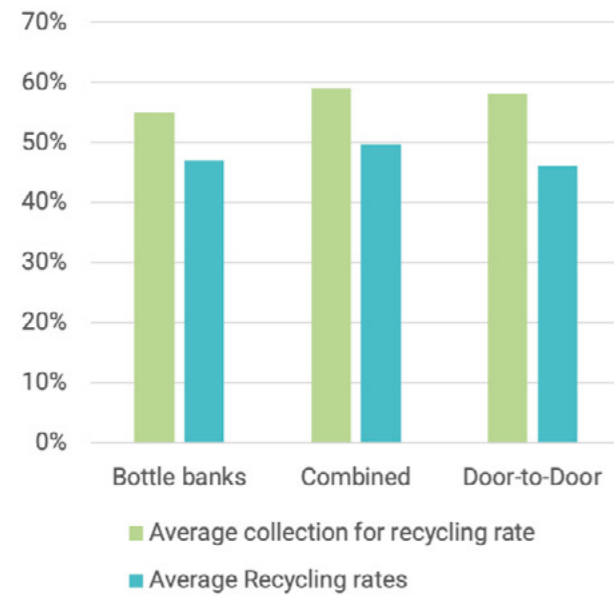


- Collected quantities varies very much within the panel, ranging from 4.5 to over 60 kg/cap.
- Glass represents between 5 and 70% of the total collected quantities of paper and packaging waste, with an average of 29%, which is above the share of glass waste in the total PPW generated quantities.
- The generated quantities can greatly vary from one WCS to another, which means that glass collected quantities do not provide a clear information on the actual performance of the system. The “collection for recycling” rate is needed.



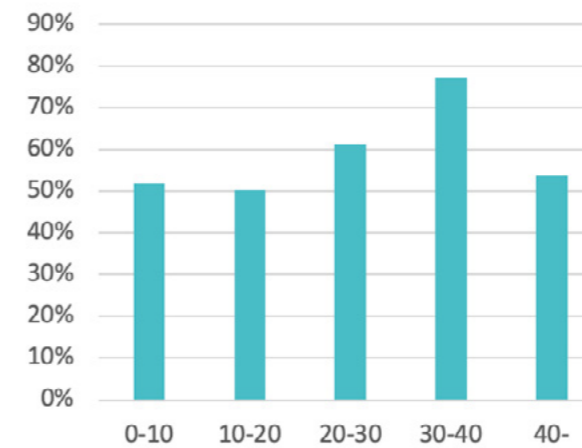
- The panel encompasses rather well performing systems, 6 of them capturing more than 80% of the glass packaging.
- It also includes 14 systems with poor to average collection for recycling rates, less than 50%.
- Half of the documented WCS are below the average European collection for recycling rate.
- The average collection for recycling rate is 60%, which indicates that the panel does include a wide variety of performances.

Average collection for recycling rates and recycling rates by collection mode

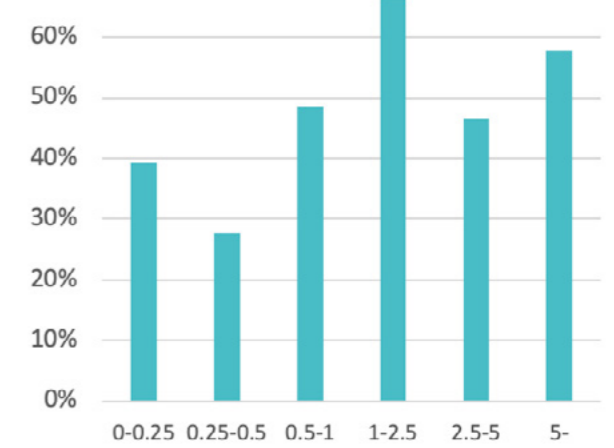


- The data on collected quantities have been collected by the COLLECTORS project and consolidated by ACR+, while the impurity rates are assumed on the basis of the data provided by FERVER. The rate used for door-to-door system is based on a small number of systems, and therefore there are uncertainties regarding the average recycling rate presented.
- The nine documented door-to-door WCS generally presents a slightly higher average collection for recycling rate compared to bottle banks. However, the bottle banks systems and the door-to-door systems included in the panel have quite similar average recycling performances when taking into consideration both the collection for recycling rates and the impurity rates.
- Door-to-door collection systems seem to lead to the collection of higher quantities, but the lower quality leads to an average recycling rate that is comparable to bottle bank systems in the panel.
- There are significant discrepancies among systems using bottle banks and door-to-door systems: both categories include both systems performing very well and other performing very poorly.

Average collection for recycling rate according to the number of bring points for 10,000 inhabitants

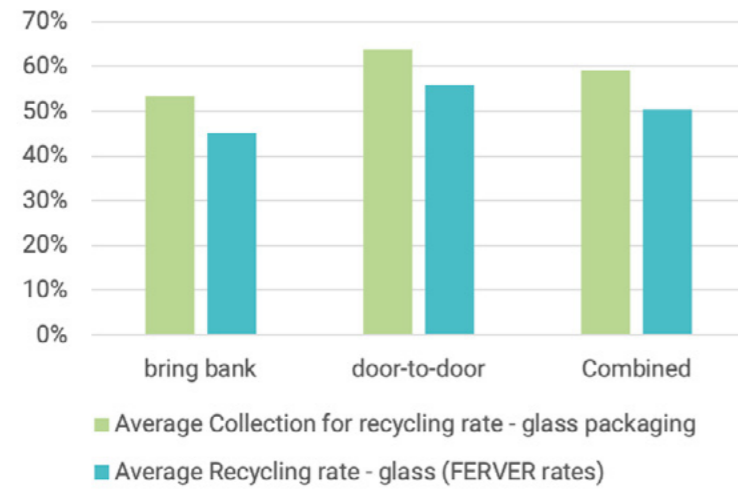


Average collection for recycling rate according to the density of bottle banks in km²



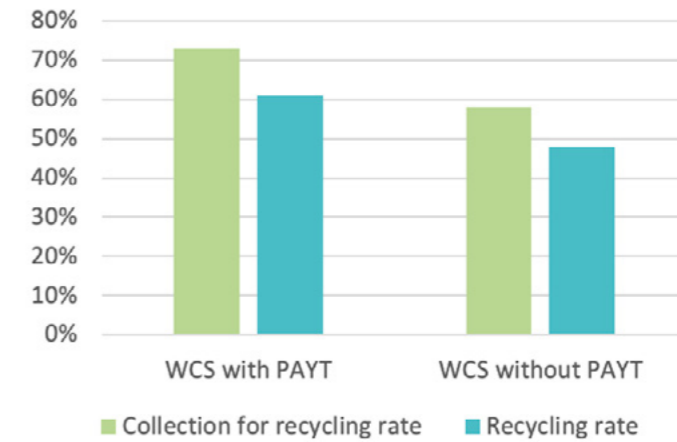
- It seems that there is a slight correlation between the average collection for recycling rates and the number of bottle banks per inhabitant, as well as the density of bottle banks is, even though the differences are not significant.
- This might reflect the fact that both indicators are not sufficient to properly reflect the convenience of the system, or that the accessibility of bottle banks is not a sufficient criterion to lead to a proper collection for recycling rate.

Average capture and sorting rates for bottle bank systems, depending of the main collection system for all paper and packaging waste



- Bottle banks systems present in general higher collection for recycling and recycling rates when other fractions such as paper and PMC are collected door-to-door. A distinctive system for glass packaging might make sorting guidelines clearer for inhabitants.

Average collection for recycling rate for glass packaging depending on PAYT



- There is a noticeable difference regarding the average collection for recycling rate of WCS between systems using PAYT and systems not using PAYT.
- Besides, the five waste collection systems with the highest collection for recycling and recycling rates all have PAYT, or a sorting obligation with controls of the presence of recyclables in residual waste.
- It should be noted that there seem to be some exceptions: some very well performing systems could reach high performances without such fee systems, and low-performing systems might have implemented PAYT.
- The use of incentivising instruments such as PAYT and sorting obligations seems to be the main factor differentiating top-performers from other waste collection systems. The top-performers also present quite high performances for the other recyclables (paper and packaging waste), which reflects a well-integrated municipal waste management system.



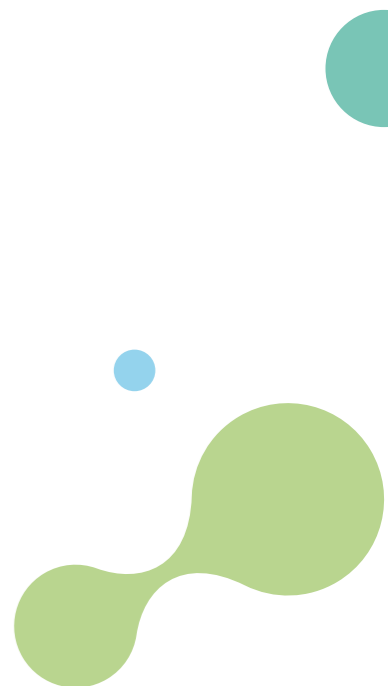
Quality of the collected fraction

The quality of collected glass packaging waste is a key parameter to enable closed-loop recycling. Two parameters are important when it comes to quality:

- The presence of impurities, for instance infusible elements (ceramics, stones, porcelain), that will reduce the efficiency of the sorting processes in the glass treatment plants, and could be detrimental to the manufacturing process;
- The density of the glass: if the particles are too fine, the glass cullet cannot be used for glass packaging re-manufacturing: below certain particle size called as "fines", it is not possible to remove impurities such as infusible fractions from the cullet.

Even though the cullet treatment plants include several sorting steps that allow the removal of impurities, the quality of collected glass brought in these plants heavily influences the quality of the produced cullet, and lower impurity rates will lead to lower losses during the sorting stage. It is therefore important to ensure the quality of the collected glass between the collection and the glass processing.

When comparing the yield of furnace-ready cullet, it appears that bottle bank systems with colour separation give the best performances in terms of quality, followed by bottle banks with mixed colours, and kerbside collection. Co-mingling leads to significantly lower yields, even if co-mingling of glass and metal seems to lead to higher quality than other types of co-mingling. Collection with plastic bags also leads to a significant drop of quality.





Costs of glass packaging collection

Benchmarking on costs figures is a challenging exercise, due to the significant inconsistency of cost reporting by local authorities. Data labelled as collection costs are generally based on various assessment (e.g., calculation methods to allocate the different costs to the different waste fractions) and might encompass different elements. benchmarking should be made based on costs reported according to a common method, using the same repartition keys and following the same data matrix.

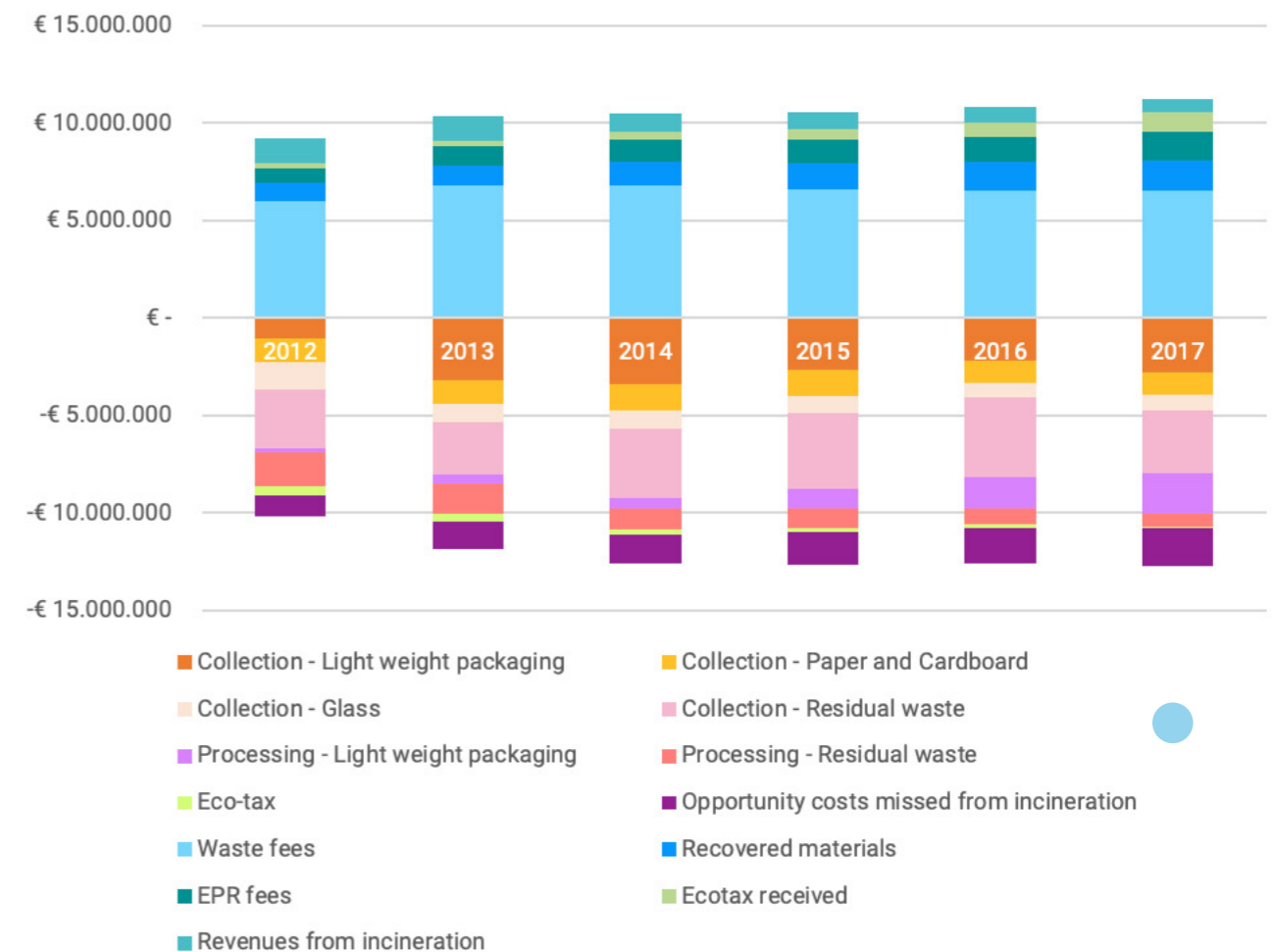
The COLLECTORS project conducted in-depth analysis of the cost-benefit balance of five waste collection systems for paper and packaging waste. It consisted in the assessment of the actual costs linked with paper and packaging waste collection and processing, including the unsorted fractions remaining in residual waste, and possibly the management of littered packaging, as well as detailing the different “revenues”, e.g., from EPR schemes, local waste fee, and other existing subsidies. The analysis highlighted very different costs and

benefits structures across the different documented case studies.

The COLLECTORS project analysed the evolution of costs for the municipality of Parma, that significantly improve selective collection of paper and packaging over a relatively short period of time, through the modification of its collection system and the introduction of a PAYT.

This evolution shows that **improving selective collection led to an increase of collection and processing costs.** However, the municipality managed to keep the local waste fee relatively stable. This seems to have been possible thanks to the **savings made on residual waste treatment** (which is quite expensive partly due to an incineration tax), and the **increase of revenues from the EPR systems and recovered materials.** This example highlights the importance of proper framework conditions (EPR system, tax on disposal) to make separate collection economically sustainable for local authorities.

Parma – overview of costs and benefits 2012 – 2017
Paper and packaging waste management





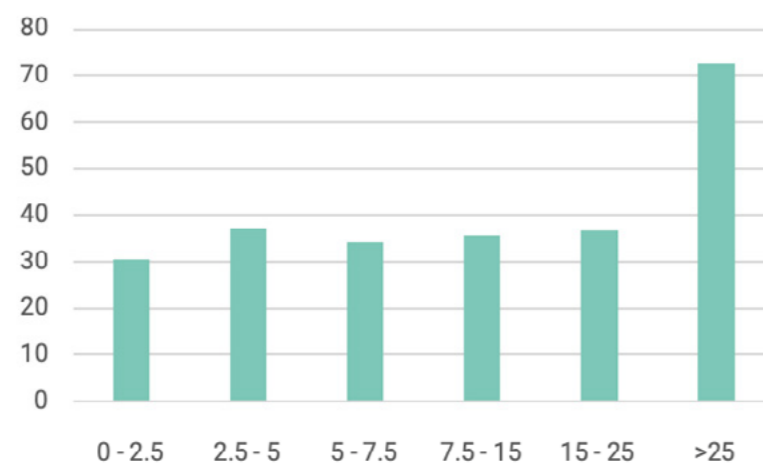
The impact of local context

There are two main reasons for which generation per capita varies from the average:

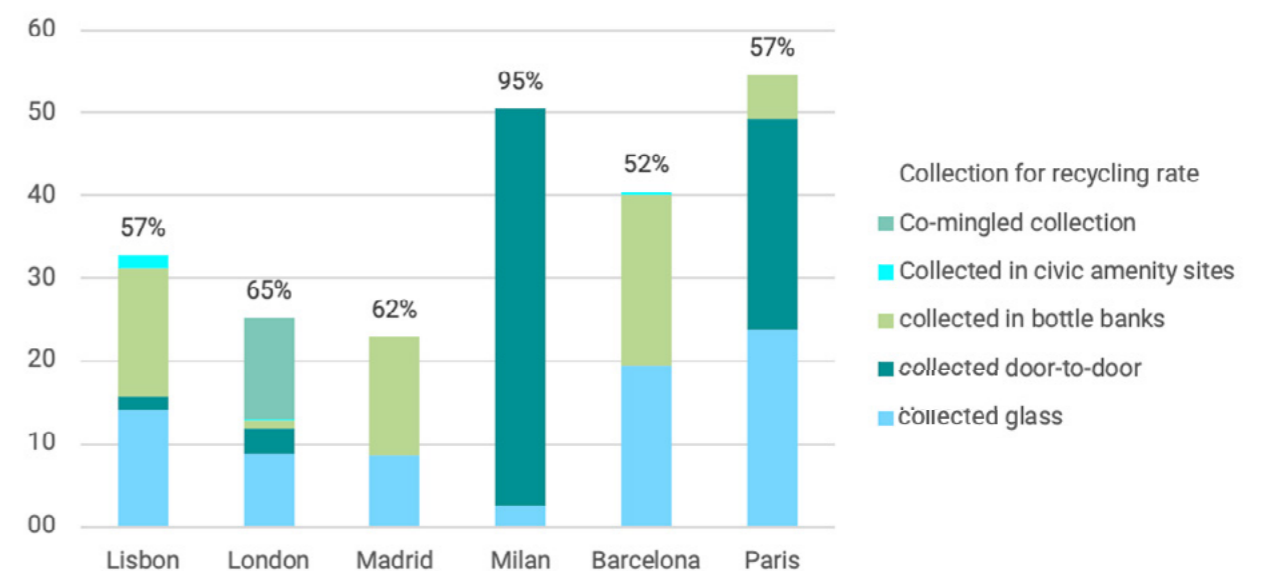
- The generation of glass packaging waste is linked with consumption patterns that might vary at local level, and depends on the scope of the considered data (e.g., the inclusion of commercial glass in municipal waste collection and data);
- The presence of non-resident waste generators (tourists, inhabitants in secondary houses, commercial activities...), which are not accounted in the statistics on the resident population.
- **Tourism** appears to have a strong impact on glass packaging waste generation per inhabitant, especially in small areas with low resident population. All of the top “glass producers” are rather small territories with relatively high number of overnight stays.

- The COLLECTORS project also identified other parameters for which there are correlations with glass packaging waste generation: glass packaging waste generation seems to tend to be higher in high-density territories, and lower in low-GDP areas.
- Collection for recycling rates are mostly average, except for Milan. Among this panel, Milan is the only city that implemented an incentivising instrument by introducing transparent bags for residual waste collection, allowing to control the sorting behaviours.

Average glass generation per number of overnight stays per resident (kg/cap)



Sorted and unsorted quantities of glass packaging in the densest cities in the panel, and collection for recycling rates



Conclusions and outlooks

Conclusions

1. High diversity of local approaches, reflecting diverse national and regional frameworks

2. Framework conditions are key drivers, especially:

- Legal and economic incentives, especially the EPR system
- Clear guidance and guidelines to improve local performances
- Homogeneous sorting guidelines for inhabitants
- Close cooperation between PROs and local authorities

3. Main collection systems: bottle-bank & source-separation:

- Co-mingling still used in the UK and Italy
- Door-to-door used in parallel with bottle banks or alone, mainly in urban context, and when other packaging is collected door-to-door

4. Variable performances:

- High performances can be reached both by bottle banks and door-to-door schemes, but quality seems to be lower with door-to-door
- Importance of incentives (controls, PAYT...)

5. Importance of local context:

- Tourism leads to higher generation
- Performances generally lower in dense areas

Areas to further investigate

- **Addressing the framework conditions in the low-performing countries** is a pre-requisite for improving local performances, especially how EPR systems contribute to local cost coverage and incentivise quality, and taxes on disposal. Investments should be made in collection and sorting equipment to increase recycling performances ;
- Further work on glass collection in **dense contexts** is needed, either focusing on collection in vertical housing, or on solutions to improve collection points in dense contexts;
- The promotion of **incentivising methods such as sorting obligations and PAYT systems** has to be extended, as most high-performing collection systems implemented such instruments. These instruments seem extremely important in order to reach collection performances over 90%;
- Interviews of both representatives of case studies and national contact points tended to highlight the need to focus on **glass collection from HORECA**, for which high quality seems more challenging to reach;
- **A better understanding on local costs** is needed, to identify solution to optimise the costs, and ensure that the current incentives are sufficient to promote source separation; a further analysis identifying the overall financial balance (costs and revenues) per type of collection system would help decision-makers select the most efficient system in their local situation.
- Better information is also needed for local authorities and waste collection organisations regarding **quality requirements and way to improve quality of sorted glass**. Including criteria concerning quality for the EPR subsidies to collection is a good way to promote this. Providing data to local authorities regarding the quality of their collected waste, and inviting them to report it along with collected quantities, could also contribute to give more importance to quality.

Analysis and comparison of data tend to show that **there is no "ready-to-use" best practice when it comes to glass collection**. The improvement of local performances requires tailored strategies following an analysis of the local system, and a continuous improvement connected with consistent monitoring.



**close the
glass loop**

