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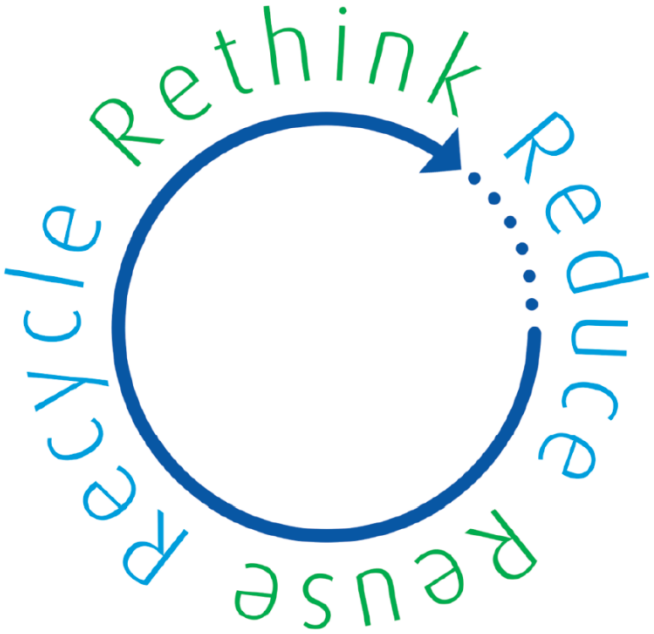
ASSOCIATION OF CITIES AND REGIONS FOR RECYCLING AND SUSTAINABLE RESOURCE MANAGEMENT

Comparison of municipal waste management in EU cities



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We would like to thank all the municipality representatives for their contribution in compiling the information for the factsheets. The views expressed in this report are those of ACR+ only.

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Abbreviations

ACR+	Association of Cities and Regions for Sustainable Resource Management
AD	Anaerobic Digestion
C&D	Construction and Demolition
Cap	Capita
CAS	Civic Amenity Site
DREC	Destination Recycling
ERP	Extended Producer Responsibility
GDP	Gross domestic product
Inh.	Inhabitants
MBT	Mechanical Biological Treatment
N.A.	Not Available
Nb.	Number
P&C	Paper and Cardboard
PAYT	Pay-as-you-throw
PET	Polyethylene terephthalate
PMC	Plastic Metal Cartons
RDF	Refuse-derived fuel
WEEE	Waste Electronic and Electrical Equipment

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Executive summary

Scope and content of the study

This study compares municipal waste management in cities and metropolitan areas. Data were collected in 17 cities across Europe, encompassing mostly dense metropolitan areas.

Figure 1: location of the cities covered by the study

To propose a consistent analysis, data were processed in the light of three parameters:

- **The scope of the data**: "municipal waste" being largely defined by the perimeter of the municipal waste service, e.g. to what extent non-household waste is included, the scope of data can greatly vary from one city to another;
- **The local context**: certain parameters can have an impact on waste generation or management, such as population density, tourism, or GDP;
- **The local waste strategy**: the modes of collection, sorting guidelines as well as financial instruments impact the performances, e.g. waste sorting and recycling rate.

The collected data are presented in factsheets allowing consistent comparisons. To ease comparisons, the study distinguishes two types of waste:

- "**Common waste**": waste that is produced by citizens on a regular basis and handled via traditional collection schemes (door-to-door, bring banks…). It is mostly composed of bio-waste, dry recyclables (paper, packaging waste) and residual waste;
- "**Other waste**": waste that is not "common waste", meaning that it is not collected with common waste for various reasons (bulkiness, hazardousness…). It includes all waste collected in civic amenity sites and within bulky waste collection schemes.

Collected quantities

The observed collected quantities vary from 300 kg/cap in Zürich to 700 kg/cap in Odense, with an average of 465 kg/cap. The collected data also show important discrepancies for the relative share of "common" and "other" waste, which is partly due to the fact that some waste can be regarded as common waste in some cities and as other waste in others (e.g. green waste that can be collected door-to-door, possibly with food waste, or in civic amenity sites).

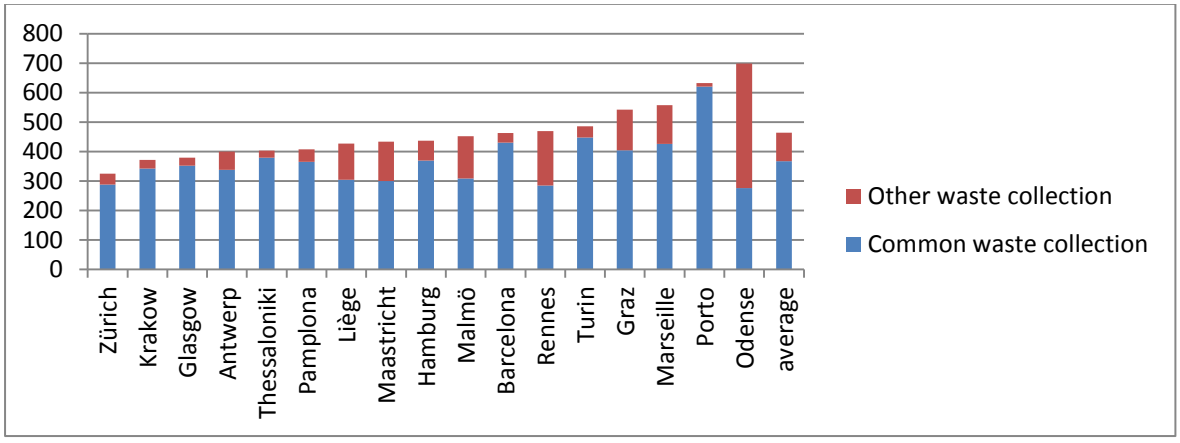


Figure 2: collected quantities of municipal waste per inhabitant (in kg/cap)

These differences among collected quantities can be explained by various factors. As explained above, the exact scope of municipal waste is not consistent among the cities: while most of the cities presenting the highest quantities per capita all include commercial waste, both Zürich and Glasgow's datasets exclude them, which can explain their relatively low quantities. Some external factors can also be linked with the collected quantities. Both Porto and Barcelona display higher figures on tourism and Porto has one of the highest figures of companies per inhabitant in the panel. However, it must be noted that no consistent correlation could be identified between the collected quantities and the various external factors for which data could be found (Tourism, GDP, living conditions…). This could be attributed to the fact that the studied panel is too small to identify consistent statistical correlation.

Common waste management

The first observation that can be made on common waste collection is that there is a great diversity in how it is organised: both on the sorted fractions (how inhabitants are invited to sort their waste) and the collection methods (door-to-door, bring banks…). The most common collection scheme for bio-waste is door-to-door collection of comingled food and garden waste. For dry recyclables, glass and paper/cardboard are generally source-separated while other packaging waste is commonly co-mingled. For most cities, paper/cardboard and bio-waste represent the most significant waste fraction when it comes to common waste.

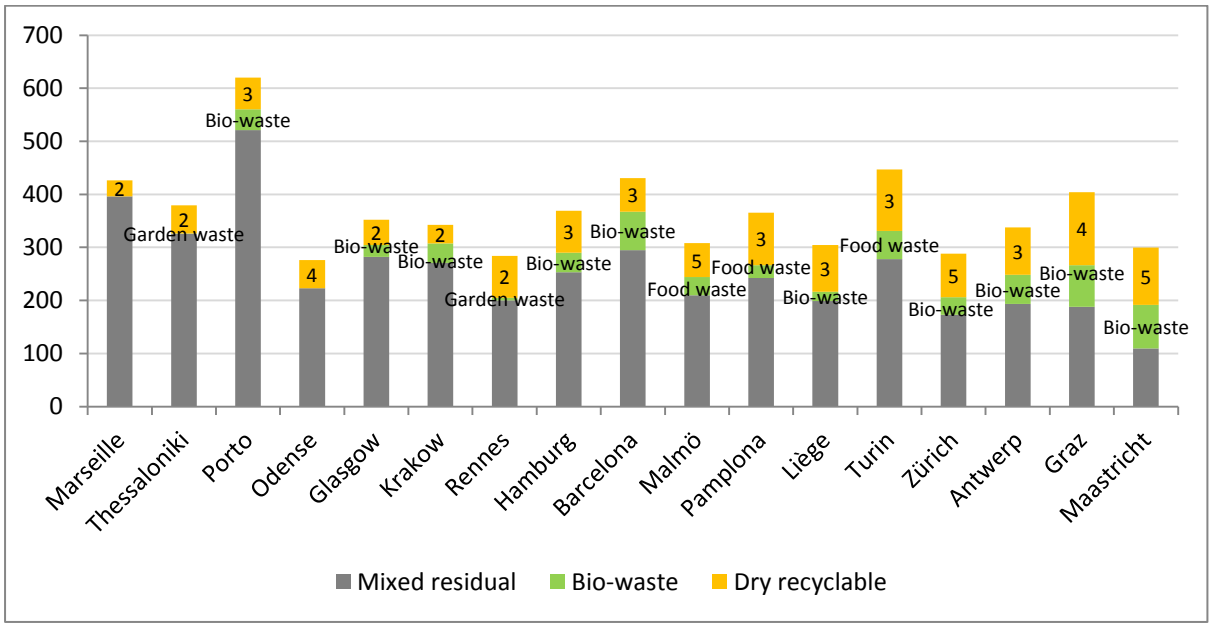


Figure 3: collected quantities of common waste (in kg/cap), with indications on the accepted bio-waste and the number of collected streams for dry recyclables

More source separation generally leads to higher sorting rates; cities co-mingling paper with packaging waste tend to present lower separated quantities. Source-separated fractions also present much lower contamination rates than co-mingled fractions. However, no clear link between the collection modes and the performances could be identified; high performances are achieved by cities resorting mainly to door-to-door collection as well as by cities using mainly bring banks.

It is also important to put in parallel the sorted quantities with the fractions that are collected within the residual waste. For instance, the sum of sorted and unsorted bio-waste ranges from 80 kg/cap to 225 kg/cap, the most significant arising being found in tourist cities. Cities presenting comparable sorted quantities can actually have very different sorting rates.

Other waste management

Data collected on other waste focused on the sorted and mixed fractions collected in civic amenity sites (CAS) and on the quantities associated with bulky waste collection schemes (on demand or at regular frequency).

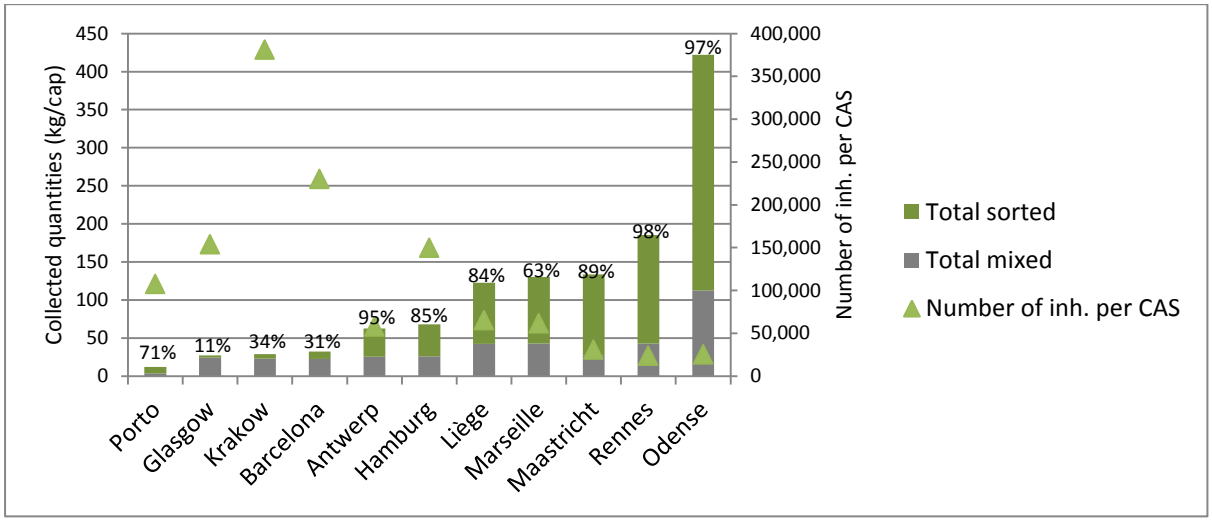


Figure 4: sorted and mixed other waste quantities (in kg/cap/yr), the number of inhabitant per CAS, and the share of other waste collected in CAS compared to the total quantities of other waste (in %)

Higher sorting rates of other waste are achieved by cities proposing a dense network of CAS and limited access to bulky waste collection (i.e. only collection on demand, possibly with a fee). Data were collected on the sorted fractions for the cities among the ones with the most significant quantities, which tend to show that the most significant fractions are construction and demolition waste as well as garden waste. In Odense, where commercial waste is accepted in CAS, both fractions amount to almost 250 kg/cap.

Best practices?

Despite the very heterogeneous practices identified in the different cities and the difficulty to ensure consistent comparisons, it is possible to find some common good practices shared by the cities with the highest recycling performances:

- **Source separation** seems to be the key to high recycling performances. The most advanced cities all rely on the following systems:
  - A selective collection of **paper and cardboard**, separated from the other fractions;
  - An effective separation of other waste in **civic amenity sites**, allowed by a dense network of CAS and a limited collection of bulky waste on demand;
  - An effective source separation of **bio-waste**.
- A Pay-As-You-Throw (PAYT) system for part or all of the waste.

On the contrary, the cities with lowest performances mostly use comingled collection for paper, cardboard and packaging, have a limited bio-waste separation system and a limited civic amenity site network, limiting the possibilities of source separation.

When it comes to common waste separation, high performances can be attributed to mainly 3 fractions: paper and cardboard, glass and bio-waste. Bio-waste is generally collected in door-to-door systems. For dry recyclables, it is interesting to note that well-performing cities resort either to door-to-door or to bring bank systems.

Foreword - ACR+ European Observatory on municipal waste performances

Launched in 2010, ACR+ European Observatory on municipal waste performances was created following a strong demand from ACR+ members to allow consistent comparisons among local and regional authorities. The Observatory was established to serve several purposes:

- Define methods for common comparisons based on common scope and definitions;
- Identify effective practices and measures to improve recycling performances;
- Allow benchmarking among territories sharing the same constraints (high density, tourism…);
- Compare local performances with EU targets.

The Observatory has led to the production of several reports:

- ACR+ developed a Waste Data Matrix, completed by approximately 17 members of the Observatory with their data for 2009. This first set of calculation with a harmonized methodology led to interesting comparisons and conclusions summarized in the Observatory Report published in early 2013;
- Cross-analysis of "Pay-As-You-Throw" schemes in selected EU municipalities;
- Report on bio-waste selective collection schemes.

Between, 2012 and 2014, ACR+ took advantage of the R4R project to consolidate its work on the Observatory. The main outputs of the projects were:

- The definition of a common language for local and regional authorities wishing to share good practices, based on a common method for data comparisons, a list of local instruments to detail waste strategies, as well as external factors impacting waste performances and strategies;
- The identification of 39 good practices detailing successful implementations of local instruments and documented with quantitative data;
- An online tool allowing any public authority to input and compare its data based on the R4R method;
- A final report drawing the main conclusions on effective instruments and good practices when it comes to municipal waste recycling.

Introduction

This report is part of the ACR+ European Observatory on municipal waste performances, a work platform launched in 2010 with the aim of allowing consistent comparisons among European local and regional authorities. The Observatory has been pursuing its objective through different activities, such as data collection with ACR+ Members, the production of several reports, and the participation in the "Regions for Recycling" project[1]. This project especially helped set the grounds for consistent comparisons and created a new indicator allowing the assessment of the quantities of waste sent to recycling in cities and regions: "Destination RECycling" (DREC).

This new report is a follow up of a 2014 report presenting an EU-capitals benchmarking. It aims to pursue the work of the observatory through the collection, presentation, and analysis of waste data from European medium and big cities. A particular effort was put on the comparability of data, especially through the identification of the actual scope of the data collected. The objective is identifying well-performing territories as well as offering to territories sharing the same challenges consistent comparisons to improve their own performances.

The report presents the following elements:

- The main challenges regarding municipal waste comparisons;
- The method, the exact scope and the definitions used in the factsheets;
- The completed factsheets;
- An analysis of the collected data and comparisons of performances.

This study will contribute to consolidate the Observatory's database allowing the improvement of benchmarking among territories. All the collected data are available in the factsheets, allowing the readers to perform further comparisons.

[1] Regions for Recycling was an INTERREG IVC project (2010-2012), http://www.regions4recycling.eu

1. Comparing municipal waste data

Comparing local waste data proves to be more complex than it looks. This is a paradox: while the common EU policy framework provides common definitions, scopes, and indicators, significant discrepancies can be observed when putting in parallel local data sets. This part details the challenges associated with municipal waste comparisons as well as the choices made by ACR+ to limit the biases linked with these difficulties.

1.1 The scope of municipal waste

"Municipal waste" is an operational concept rather than a theoretical one. It consists in a common basis: waste generated by households, to which other fractions are added depending on how the public service of waste management is organised:

- **"Assimilated" waste**: in most cities, waste similar to household waste in nature, composition, and quantity, produced by non-household organisations is managed with household waste for practical reasons: it is generated in the same place and in similar fashion and can be collected and treated using the same equipment as for household waste. The concerned waste producers can be small commercial activities, offices, administration building, schools…
- **Waste generated by municipalities**: some waste generated by the municipalities (e.g. offices, parks and gardens…) might be handled within the municipal waste system;
- **Waste from street cleaning**: all waste generated in public areas (street bins, sweeping, illegal dumping) might be also part of municipal waste.

Figure 5: scope of municipal waste (EPR: Extended Producer Responsibility / WEEE: Waste Electronic and Electrical Equipment)

The main challenge is that the actual scope of municipal waste varies from one place to another, due to various reasons: historical reasons, specific regulation, local organisation of municipal services (e.g. combined or separated services for municipal waste management and street cleaning…). The actual scope is more or less well defined by local, regional, or national regulation, and the way it is

defined does not necessarily provide clear indication on the actual scope. For instance, most municipalities set limits for the inclusion of commercial waste within municipal waste, but these limits vary: maximum volume produced per week, commercial surface of the activities, predefined lists of waste fractions and commercial activities that can be included… Local controls might also not be sufficient to ensure that these limits are respected by commercial activities.

Another issue is the fact that municipal waste might be handled by several different systems. The municipal services generally manage most of the waste, but other handling systems might also be involved, for instance:

- **EPR schemes** might have developed other collection points due to practical reason: for instance, collection of WEEE in retail stores is a common practice across Europe.
- **Deposit/take back systems**: several deposit schemes for packaging exist in Europe, whose figures cannot be included in municipal waste data;
- **On-site treatment**: home and community composting divert bio-waste from municipal services and are generally not closely monitored;
- **Charity organisations**: mainly involved for re-use, charity organisations can organise parallel schemes for some products/waste;
- **Illegal schemes**: due to their market value, several waste fractions can be captured by scavengers.

These figures are not always included in the data reported by local authorities, whose reports mainly concern the fractions included in the municipal service they provide. Some data might be available for some of these categories, but their scope might be different from the administrative borders of the municipality (e.g. a supermarket whose customers come from various surrounding municipalities).

Figure 6: the double scope of municipal waste

To summarise, the scope of municipal waste and the associated scope of data included will mainly depend on two parameters:

- The scope of the municipal waste service in terms of waste fractions and producers (e.g. the scope of similar waste);
- The scope of action of non-municipal collectors when it comes to municipal waste.

1.2 Definitions and indicators

The terminology used at local level is quite homogeneous across Europe. However the definitions applied to the different terms are heterogeneous. It is therefore important to clearly understand what are the actual definition and scope behind all the specific words used to ensure the information is consistent from one case to another.

1.2.1 Waste fractions

The definitions used to design the different waste fractions generally depend on the local sorting guidelines and the operational choices made by the public authority. Several examples can be listed:

- **Bio-waste** is a term commonly used for organic waste collected door-to-door. It can describe either a mix between food waste and garden waste, only food waste, or food waste excluding animal by-products;
- **Plastic packaging**'s scope might differ from one place to another. Commonly, it includes plastic bottles and flasks, but some local authorities include all types of plastic packaging (e.g. films) while others only collect specific types of plastic (e.g. only PET).
- **Residual waste**: while it generally refers to household residual waste and similar (e.g. the remaining waste after the separated fractions are sorted), it might also include other fractions, such as mixed street bins or even illegal dumping or mixed bulky waste collected on kerbside.

1.2.2 The problem with “recycling"

When it comes to indicators, “recycling” is one of the most problematic topics for data comparisons. Several reasons can be listed out, but they revolve around the fact that many different steps and players are involved, from waste generation to the use of recycled materials. Another difficulty comes from the fact that the recycling value chain is more or less complicated according to the material fractions (e.g. plastics include a wide diversity of materials) and some fractions require more sorting stages than others.

The complexity of the recycling value chain and the diversity of players involved can explain the difficulty to agree on a common definition for the calculation of “recycling”. When it comes to recycling, the objectives of each actor of the value chain differ, which explains why they monitor their progress using different calculations methods:

- **Local authorities** either collect recyclable materials separated at source or co-mingled and then send them to mechanical sorting centres (which can be run by the local authority in charge of waste collection, by another public authority, or by a private company). Depending on the situation, the local authority will primarily monitor collected quantities, sorted quantities, or both. The difference between collected and sorted quantities is due to impurities (improperly sorted waste) and sorting residues occurring in mechanical sorting centres.
- **Waste management companies** can manage sorted materials after collection/mechanical sorting through the delivery to the users of recycled materials. Their role can include further sorting, massification, trade, and transport of the materials.
- **Users of the sorted recyclable materials** will turn these materials into new materials or products. The final sorting stage might occur in their facility and before the processing stages.

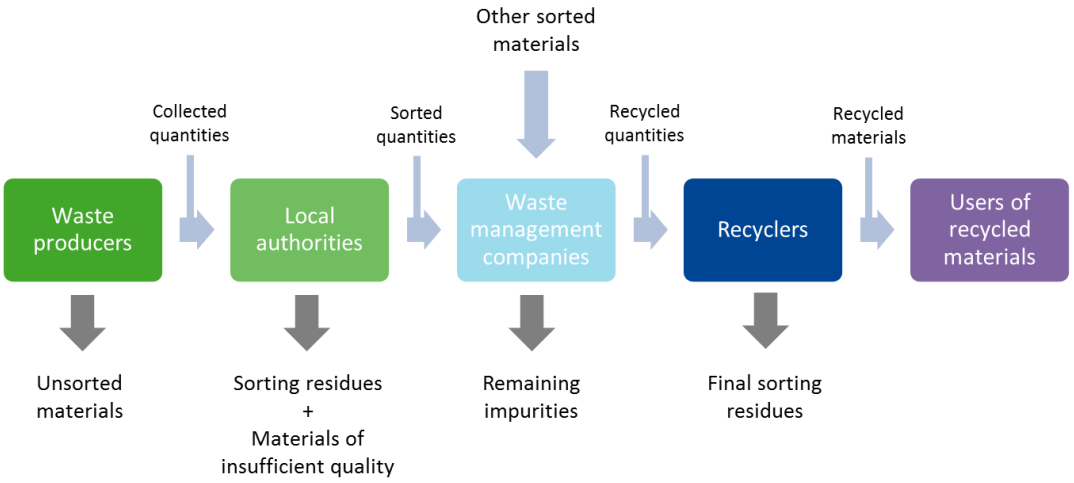


Figure 7: recycling scheme, from waste producers to the final users

The various steps lead to different measuring points for sorted quantities and each sorting stage involves the extraction of contamination (impurities, materials not complying with the quality requirements…).

It is possible to agree on one common measuring point to obtain comparable data, depending on what is to be assessed and the available data. However, some discrepancies might also arise from the fact that quality requirements for sorted materials might not be similar from one territory to another, either depending on different recycling processes that do not require the same level of purity, or different frameworks (e.g. requirements set by EPR systems).

1.2.3 Calculation standards

In addition to these considerations, local indicators depend on the calculations standards set by the local, regional, or national authority, which will reflect strategic choices. For instance, metal extracted from incineration can be regarded as recycled quantities in some territories while others will only regard the quantities incinerated as such and not consider the outcome of by-products.

1.3 Local conditions

Besides the scope and calculation standards, other parameters come into play to explain the difference in performances for local waste management. These “external factors” can impact waste generation or make the implementation of specific local instruments more challenging. The “Regions for Recycling” project listed some of them to act as “filters” or “categories” among which comparisons could be made on more similar grounds. Some of them are highlighted below:

- **Population density / typology**: very urban areas with high population density face major challenges to organise waste management. The lack of available space makes it challenging to ensure separation at source (civic amenity sites, number of containers available for sorting…). The presence of vertical housings generally leads to the use of either bring banks or of shared containers which can impact the quality of sorted fractions and make it challenging to associate the sorting performances with single households, limiting the possibilities for implementing effective local instruments such as addressed communication, PAYT systems, or fines.

- **Tourism:** cities with high tourism intensity also face several challenges: transient population entailing variations in waste generation over the year that might be difficult to absorb by the collection/treatment system. Tourists also require specific equipment and communication (language barrier, different sorting guidelines compared to their own, unwillingness to make efforts during holidays…).
- **Weather conditions:** weather conditions can impact waste generation (e.g. green waste) and impose further requirements for specific fractions (e.g. increase collection frequency for bio-waste to limited odours).
- **Cultural context:** consumption patterns might change depending on the location, such as consumption of more fresh products or more packaged drinks, different gardening practices…

Other parameters can be listed, such as the average size of the household or the average income by inhabitant, which will also impact consumption patterns.

1.4 ACR+' methodological choices

Considering the challenges listed above, several choices were made to limit their impact on the relevancy of the comparisons. These choices were made taking into consideration previous works by the Observatory, the general objectives of the study, as well as local data available. In certain cases, some assessments were also made.

Therefore, when it comes to the scope of municipal waste for all the local datasets, it was decided to provide as much information as possible on the actual scope of the data presented. Indeed when street bins or commercial waste are included in municipal waste, it is generally not possible to tell them apart from the household waste. Therefore, it was decided to present information on the various categories included within the scope of municipal waste: a description indicating the criteria for the concerned waste to be included within municipal waste and an assessment of the percentage they represent compared to the total quantities of municipal waste, if available.

Construction and demolition (C&D) waste is sometimes excluded from the scope of municipal waste. For instance, Eurostat excludes it from the definition of municipal waste, along with waste from sewage networks. For this study, C&D waste is included in the presented data since it is not necessarily easy to put them aside, especially when it is collected as mixed bulky waste (e.g. on the kerbside). When specific data are available on the quantities of inert waste, the inert C&D waste is reported as sent to "Inert waste treatment" rather than to landfilling or recycling, due to the difficulty of classifying certain operations such as backfilling or uses as construction material for non-hazardous waste landfills.

Data on waste collection were restricted to the most common collection streams, namely:

- "**Common waste**", e.g. residual waste, packaging waste and bio-waste collected door-to-door or in bring banks;
- "**Bulky waste**", which cannot be collected with "traditional waste" and is collected either on the kerbside, on demand, or in civic amenity sites;
- Fractions collected in **civic amenity sites**[2], with a distinction between sorted fractions (whether they are sent to recycling or other specific treatment) and mixed fractions that are then sent either to landfills, incineration, or sorting centres.

[2] Civic amenity sites are guarded, fenced-off areas where residents can dispose of and sort out their household waste into receptacles in order to be recycled or otherwise treated, under the control of an on-site supervisor.

Other specific fractions (for instance WEEE collected in retail stores, textiles collected in dedicated containers…) are not reported in the collected quantities in order to make the factsheet more readable and ease data collection. The availability of such data at local level is also inconsistent.

For the assessment of the sorted quantities and treated quantities, the R4R approach was used. The detailed method is presented in the following document. The main principles of this approach are the following:

- "**Recycled quantities"** are assessed as "**DREC**" (Destination Recycling): DREC quantities include the sorted, homogeneous fractions sent to the recycling sectors, whether separated at source or sorted in sorting centres;
- **Sorting residues** from mechanical sorting centres are reported as "residual waste";
- **Organic waste** extracted from residual waste in Mechanical Biological Treatment units (MBT) can be labelled as DREC if it is composted or digested and the compost/digestate is actually used as organic amendment or fertilizer. This means that if MBT is used to stabilise residual waste before landfilling, all the quantities sent to MBT will be assigned to "landfilling" as final treatment;
- Quantities sent to **incineration** are labelled as "incinerated", and the output of incineration plants are not reported, regardless of if they are sent to landfilling or recycling.

More details will be presented in the part 3 of the report where the factsheet are detailed. Even though many efforts were made to ensure the consistency of data, it is likely that some uncertainties will still limit the relevancy of comparisons. These possible uncertainties will be acknowledged when analysing the data.

2. Data collection and presentation

2.1 Scope of the study

This study focuses on waste management at local level, i.e. in cities or metropolitan areas. Considering the fact that capital cities were already documented in a previous ACR+ study, a decision was made to focus on medium to big cities in order to expand the knowledge on local waste performances. The cities were chosen according to various parameters: medium to big cities, favouring ACR+ members and accessible, quality data. A conscious effort was made to try to achieve a consistent geographical coverage.

Figure 8: location of the cities covered by the study

It is important to note that the exact territories of the collected data are not necessarily the administrative boundaries of the cities. Indeed, some of these cities are part of a consortium of municipalities to which they delegated their competence for waste collection. For these cities, individual data sets for each of the municipalities are not necessarily available. The exact scope of the data is detailed for each factsheet and the associated data on population and density are the ones referring to the considered territories. In the following tables and graphs, the name of the main city is used to name these territories for the sake of readability.

The main characteristics of the studied territories are presented in the following table:

Table 1: main characteristics of the different cities (Source: Eurostat, 2017). Higher values are in bold and red, lower values in bold and green

City	Country	Population	Density	Nights spent by tourists per inhabitant	Average size of households	GDP/inh. (region)
Marseille*	France	1,045,823	1,729	3.6	2.2	106
Rennes**	France	426,502	**605**	3.5	2.0	96
Porto	Portugal	216,400	**6,943**	**13.2**	2.3	**51**
Antwerp	Belgium	517,042	2,500	3.3	2.1	150
Liège	Belgium	196,970	2,824	**1.2**	2.0	91
Barcelona	Spain	1,604,555	**16,000**	**11.4**	2.4	96
Turin	Italy	890,529	**6,940**	3	2.0	100
Maastricht	Netherlands	122,753	2,175	7.2	**1.8**	117
Graz	Austria	274,207	2,150	3.7	2.0	122
Zürich	Switzerland	415,682	4,524	7.6	2.0	-
Odense	Denmark	200,917	**660**	**1.6**	2.0	150
Pamplona***	Spain	329,531	**256**	3.1	**2.6**	101
Krakow	Poland	761,873	2,328	5.6	2.3	**35**
Malmö	Sweden	322,574	1,946	4.2	-	133
Glasgow	UK	606,300	3,520	-	2.2	117
Hamburg	Germany	1,797,000	2,380	6.8	**1.8**	**214**
Thessaloniki	Greece	325,200	**7,100**	4.6	2.1	**43**

*** The exact territory considered here is "Marseille Provence Métropole", including 18 communes**
**** The exact territory considered here is "Rennes Métropole" including 43 communes**
***** The exact territory considered here is the "Mancomunidad de la Comarca de Pamplona" bringing together municipalities around the city of Pamplona**

It is unsure whether these data are calculated according to the same methods, so they should be considered with caution. The following elements can be highlighted:

- On average, the different cities present a high population density. Barcelona is extremely dense, while Thessaloniki, Porto and Turin all present a higher density than the average. Odense has a lower density, as it is the case for Pamplona and Rennes. However for these 2 cities, it must be noted that the low figures are due to the fact that their territory for waste collections also encompasses surrounding municipalities presenting quite low density, while the city centre can be considered as dense;
- Two cities seems to attract many more tourists than the others: Barcelona and Porto;
- The average size of households is quite homogeneous among the cities. Pamplona presents a slightly higher figure while Maastricht and Hamburg are a bit below the average;
- When it comes to GDP per inhabitant, the figures are quite different. Krakow, Thessaloniki and Porto are far below the average while Hamburg is far above.

The local contexts are heterogeneous, which might have an impact on both the waste generation and the possibilities of implementing specific collection schemes. The impact of these factors on waste generation and performances will be analysed in part 5.

2.2 Data collection

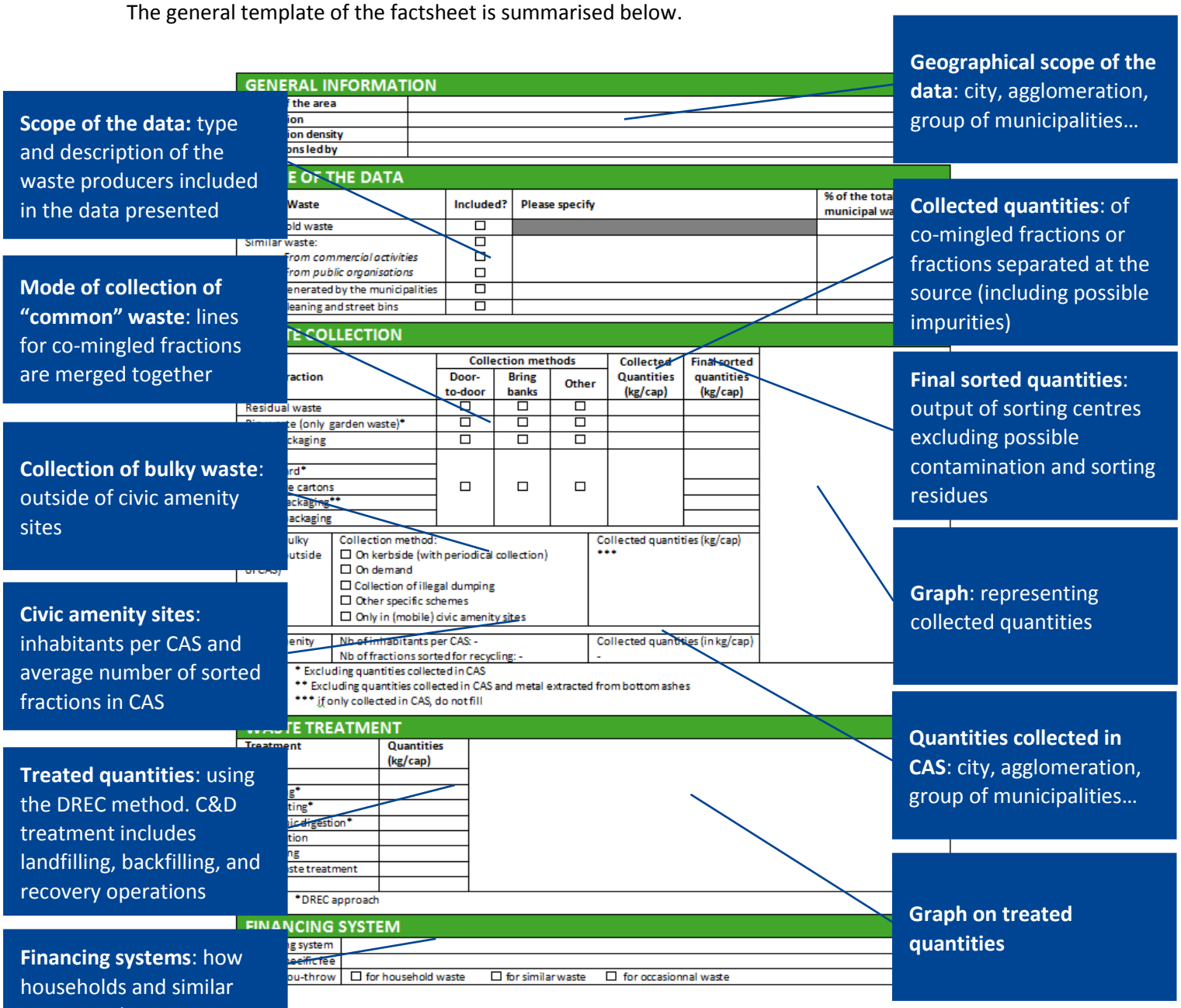
Data collection was performed by ACR+ staff members following common guidelines. Data collection was performed through the collection of public data (made available online, in publications or presentations, sorting guidelines…), completed with further contacts with the local authorities if necessary.

As specified above, a special effort was made to ensure the collection of consistent data on the municipal waste scope, as well as on the meaning and definition of different waste fractions.

2.3 Factsheet

General layout

The general template of the factsheet is summarised below.



Scope of the data: type and description of the waste producers included in the data presented

Mode of collection of "common" waste: lines for co-mingled fractions are merged together

Collection of bulky waste: outside of civic amenity sites

Civic amenity sites: inhabitants per CAS and average number of sorted fractions in CAS

Treated quantities: using the DREC method. C&D treatment includes landfilling, backfilling, and recovery operations

Financing systems: how households and similar waste producers are charged for waste management

Geographical scope of the data: city, agglomeration, group of municipalities…

Collected quantities: of co-mingled fractions or fractions separated at the source (including possible impurities)

Final sorted quantities: output of sorting centres excluding possible contamination and sorting residues

Graph: representing collected quantities

Quantities collected in CAS: city, agglomeration, group of municipalities…

Graph on treated quantities

The various items presented in the factsheets are detailed below.

General information

Name of the area: it is possible that waste management is not organised at the level of the city/municipality, but rather for a whole agglomeration (e.g. one big city and the surrounding municipalities). This line aims to present the geographical scope of the data collected.

Population and density: if available, the reference data provided by the local authority are used for population and density. If not, the official statistical data are used.

Operated by: this field presents the organisation that actually handles waste collection and management. It can either be the city itself (e.g. the municipality has its own staff and collection lorries), a dedicated public waste company owned (at least partly) by the city, a subcontractor (a waste management company providing its own equipment and staff), or a combination.

Scope of the data

As explained in the previous part, the scope of municipal waste can differ greatly from one city to another. There can be a complete distinction between household waste and commercial waste, a share of similar waste (whose criteria to be considered as such can differ from a place to another, and whose actual share will heavily depend on the presence of commercial activities), waste generated by the municipalities themselves (e.g. by their technical services) and waste linked to cleanliness, i.e. street cleaning and street bins (in some places, cleanliness is under the responsibility of municipalities while the waste handling is transferred to a public consortium). Therefore, having this information is crucial to assess the relevance of comparisons.

The table presents the waste fractions included in the data presented in the factsheet. The data collected were centred on household waste as much as possible, meaning that if commercial waste is collected as municipal waste but separate data are available, these data are not included in the factsheet. In this case, it is clearly stated that the data presented in the factsheet do not include commercial waste.

In the "**please specify**" section, further details on the actual scope are presented in a concise way, such as the types of waste included, the possible limit for commercial waste for being regarded as municipal waste, or the type of organisations that can benefit from municipal waste services. These elements are either based on the local regulations or on the information retrieved from the public authorities. The share of each of these fractions is presented, if available: either the municipality has actual data some of the specific waste streams by producers, or it has made some assessments by conducting a waste composition analysis. In many cases, these streams are collected and treated altogether, making this information unavailable.

Waste collection

The first part of the table is on "**common waste**" collection, e.g. all the waste that is produced by citizens on a regular basis and handled via traditional collection schemes (door-to-door, bring banks, vacuum systems…). It means that for these waste fractions, the quantities collected in civic amenity sites or through bulky waste collection are not reported. For instance, hard plastics collected in CAS are not included in these data. However, if part of the packaging is collected in CAS, they will be reported here to make comparisons consistent with other cities.

The classification between door-to-door and bring bank collection systems can be challenging. Here, a system resorting to containers located on the public space and not allocated to a very specific group of housing is regarded as a "bring bank" system. A set of containers located within the premises of one given group of vertical housing and dedicated to this group will be regarded as a door-to-door system. The 'other' category designates any other collection schemes that cannot be

regarded as door-to-door or bring banks. For instance, some packaging waste fractions can be collected in CAS; in this case, the collected quantities are reported here and removed from the CAS data.

The lines of the "collection methods" and "collected quantities" columns of **co-mingled** fractions are merged together. **Bio-waste** refers to the organic waste collected door-to-door or in bring banks, excluding quantities collected in CAS. The nature of bio-waste is detailed (food waste, garden waste, mix of food waste and garden waste). Organic fractions separated in a mechanical-biological treatment facility are not reported as collected quantities of bio-waste. **Metal packaging** data does not include the metal packaging extracted from incineration slags or collected in civic amenity sites.

Quantitative data are reported in 2 columns: **collected quantities** and **final sorted quantities**. **Collected quantities** consists in the total quantities collected at the source (either in single fraction or co-mingled), including the possible contamination.

The "**final sorted quantities**" column presents the homogeneous fractions separated at the source (e.g. glass collected in bring banks) and the single material fractions sorted in sorting centres (packaging sorting centres, MBT, residual waste sorting centres). When available, detailed data for each waste fraction are presented. In accordance with the R4R method, the following calculations are made:

- **Residual waste:** the final sorted quantities also include the sorting residues sent to incineration or disposal going out of sorting centres and MBT.
- **Bio-waste:** if the organic fraction is extracted from residual waste with an MBT unit, the sorted quantities are the following: organic fraction undergoing an organic recovery and the resulting compost/digestate is actually used on land. Any bio-waste extracted from residual waste by MBT that is then sent to incineration/landfilling (e.g. due to insufficient quality) is not included in the final sorted quantities.
- **For streams that are separated at source,** the sorted quantities excluding impurities are presented if these data are available, which is unfortunately not always the case.

Mixed bulky waste: this part presents the collection schemes for bulky waste outside of civic amenity sites. Bulky waste can be collected through:

- **Kerbside collection**: the collection of household bulky waste takes place from door to door or from one house to the next. Waste materials are collected from resident's doorsteps at regular frequency (e.g. once a month);
- **Collection on demand**: citizens can order a punctual collection of their bulky waste by phone or online, and then indications on the date and organisation of the collection is provided by the waste collector;
- **Illegal dumping**: illegal dumping might be collected with other bulky waste. If the associated quantities are included in the mixed bulky waste quantities, the box is ticked.

Civic amenity sites are guarded, fenced-off areas where residents can dispose of and sort out their household waste into receptacles in order to be recycled or otherwise treated, under the control of an on-site supervisor.

- The **number of sorted fractions** presents the different fractions that can be sorted by users (excluding mixed bulky waste containers), regardless if they are then sent to recycling or specific treatment (e.g. hazardous waste…)
- For the **collected quantities**, 2 streams are presented. "**Mixed fractions**" includes mixed bulky waste, combustible waste, non-combustible waste, or RDF (Refuse-derived fuel) fractions. All the other fractions which are sorted in a specific container are included under "**sorted fractions**", whether they will be sent to recycling or not.

If mobile civic amenity sites are also used, the associated collected quantities are included. However they are not taken into account when counting the number of inhabitants per CAS.

The **Graph** in this section depicts "collected quantities".

Waste treatment

The data are reported according to the R4R methodology.

- **Re-use**: it is common to find that little data are available for re-use. When available, the following data are presented:
  - Any re-used packaging (re-usable glass/plastic bottles within the framework of a deposit system, if data are available);
  - Quantities collected either in CAS or on demand and directed toward re-use centres.
- **Recycling**: the DREC approach is used here, meaning that the data refer to the quantities sorted (either at the source or going out of sorting centres) and sent to material recycling. The output of incineration plants, even if sent to recycling (e.g. bottom ashes used in road construction or metals extracted from slags), is not included.
- **Composting/anaerobic digestion**: the data presented are the treated quantities if the compost/digestate is actually used on land. If its quality does not allow the use on land, the final destination of the compost/digestate is reported as treated quantities.
- **Landfilling**: the outputs of incineration sent to landfilling are not reported here.
- **Inert waste treatment**: all inert waste quantities sent to landfilling, backfilling, or recycling are reported here. Considering the fact that there are uncertainties on the status of inert waste treatment (e.g. how to consider backfilling or the use of inert waste in landfills for landscaping), it was decided to report all inert waste treatment here.

Sorting residues from packaging sorting centres, bulky waste sorting centres, MBT units, or residual sorting centres are reported in their final destination (e.g. incineration or landfilling). Residual waste sent to MBT prior to landfilling or incineration is reported as landfilled or incinerated.

Financing system

Financing system: general description on how the users of the system are charged for waste management.

Specific fee refers to other fee/taxes implemented by the city (for the use of special services or for CAS).

Pay-as-you-throw (PAYT): if households, similar waste producers, and other waste are charged according to their waste production, the corresponding boxes are ticked. Different systems are regarded as PAYT: from systems in which the waste fee is set according to the volume of the residual bin and the frequency of collection to systems in which each waste bin is weighed. It is important to note that in many cases, the variable fee is only one part of the global fee, meaning that all users pay a basic fee in addition to a fee calculated based on the waste collected. The PAYT fee on other waste can take different forms, from fees for bulky waste collection on demand or for garden waste collection on the kerbside, to charges applied to mixed bulky waste brought to civic amenity sites.

3. Factsheets

This part will detail the collected data presented in the factsheet format as indicated previously. To make the reading more comfortable, the various sources for the data and information will be presented at the end of the report, sorted by city.

The analysis and comparisons will be conducted in section 5.

GRAZ – AUSTRIA - 2015

Name of the area	City of Graz
Population	274,207 (2015)
Population density	2,150 inh./km²
Operations led by	Collection and treatment operated through a public-private partnership bringing together Holding Graz, the public waste management company, and several private waste companies

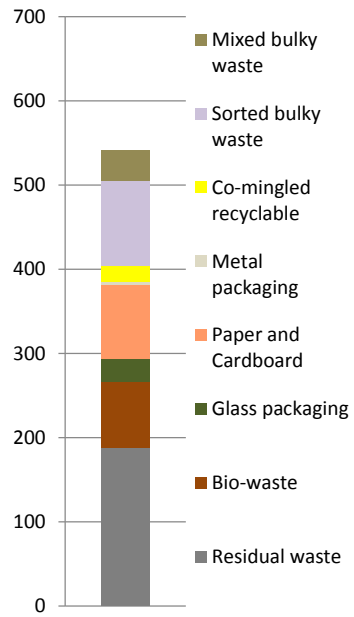
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: *From commercial activities* *From public organisations*	☒ ☒ ☒	Residual waste from commercial activities is collected within the municipal waste.	
Waste generated by the municipalities	☐		
Street cleaning and street bins	☒	Street bins included – street sweepings excluded	

WASTE COLLECTION

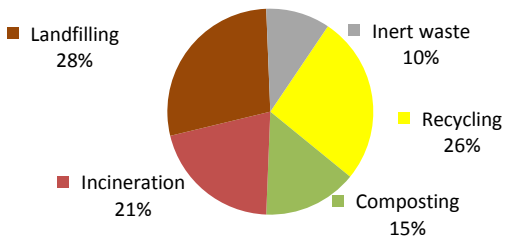
Waste fraction	Collection methods			Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
	Door-to-door	Bring banks	Other		
Residual waste	☒	☐	☐	188.1	192
Bio-waste (including garden waste, excluding public gardens and parks)	☒	☐	☐	78.3	78.3
Glass packaging	☒	☐	☐	27.0	27.0
Paper Cardboard	☒	☐	☐	88.7	88.7
Metal packaging	☒	☐	☐	3.1	2.8
Beverage cartons Plastic packaging	☒	☐	☐	18.7	15.1

Mixed bulky waste (outside of CAS)	Collection method: ☐ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) Sorted fractions: 101.8 Mixed fractions: 36.2
Civic amenity sites	Nb. of inhabitants per CAS: 140,100 Nb. of fractions sorted for recycling: 20	



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	N.A.
Recycling	140.3
Composting	78.3
Anaerobic digestion	-
Incineration	109.3
Landfilling	149.3
Inert waste treatment	53.5
Other	-



FINANCING SYSTEM

Financing system	Yearly fee according to the size of the residual waste container and the frequency of collection. Additional fee for the collection of bio-waste and bonus when doing home composting of kitchen and garden waste.
Other specific fee	Fee for garden waste collection on demand or when brought in CAS. Fee for accessing the CAS where residual fractions are accepted and for disposing bulky waste and several other fractions.
Pay-as-you-throw	☒ for household waste ☒ for similar waste ☒ for other waste

ANTWERP – BELGIUM - 2017

Name of the area	City of Antwerp
Population	517,042
Population density	2,500 inh./km²
Operations led by	Collected by the municipality, sorted by an outside contractor

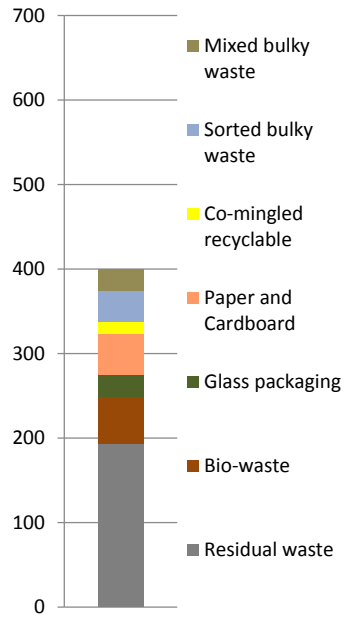
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: *From commercial activities* *From public organisations*	☒ ☒ ☒	Commercial waste similar in nature and composition with a similar production to a household (e.g. below 240 l/week) can be placed in municipal residual waste bags. Alternatively, businesses can bring the waste to a bring bank/collection point for which they would need an access pass.	
Waste generated by the municipalities	☐		
Street cleaning and street bins	☒	Clean-up trucks, manual street clean up, paper bins. Illegal dumping and street bins respectively represent 2.3% and 4.1% of the quantities of residual waste.	

WASTE COLLECTION

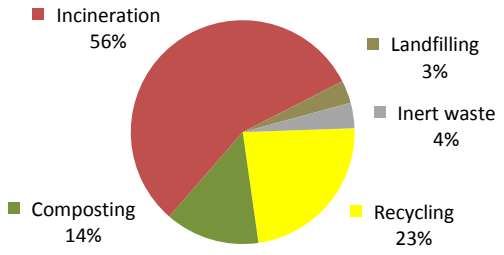
Waste fraction	Collection methods			Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
	Door-to-door	Bring banks	Other		
Residual waste	☒	☐	☐	193.21	202.38
Bio-waste (incl. garden waste)	☒	☒	☐	55.44	49.90
Glass packaging	☐	☒	☐	25.82	25.82
Paper Cardboard	☒	☒	☒	49.1	49.1
Beverage cartons Metal packaging Plastic packaging	☒	☒	☒	13.94	10.32

Mixed bulky waste (outside of CAS)	Collection method: ☐ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) 3.18
Civic amenity sites	Nb. of inhabitants per CAS: 57,500 Nb. of fractions sorted for recycling: 14	Collected quantities (in kg/cap) Sorted fractions: 37.1 Mixed fractions: 22.4



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	N.A.
Recycling*	85.24
Composting*	49.90
Anaerobic digestion*	-
Incineration	205.13
Landfilling	12.02
Inert waste treatment	13.44
Other	-



FINANCING SYSTEM

Financing system	Differentiated fees on plastic bags, containers and bags put in underground containers (according to their volume) depending on the collected fractions. Residual waste is more expensive than the sorted fractions.
Other specific fee	Specific fee on rubble and mixed bulky waste in civic amenity sites, per m³.
Pay-as-you-throw	☐ for household waste ☒ for similar waste ☒ for other waste

LIÈGE – BELGIUM - 2016

Name of the area	City of Liège
Population	196,970
Population density	2,824 inh./km²
Operations led by	INTRADEL – public waste management company managing waste from 72 municipalities in the region of Liège

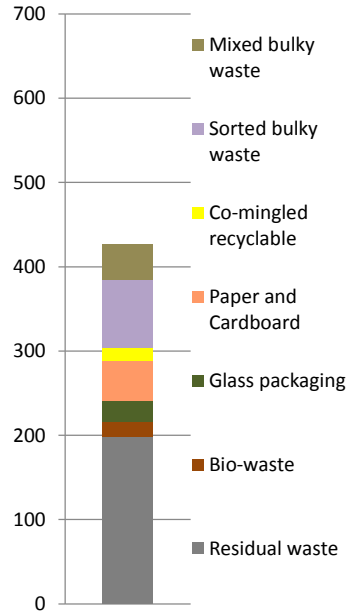
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☒ ☒ ☒	No limit on quantities/volume to be considered as assimilated waste. Private contracts in case the waste cannot be placed in the regulated containers because of its nature, requires higher collection frequency than 1x/ week, or originates from HORECA.	
Waste generated by the municipalities	☒		
Street cleaning and street bins	☒		

WASTE COLLECTION

Waste fraction	Collection methods			Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
	Door-to-door	Bring banks	Other		
Residual waste	☒	☐	☐	198.8	215.1
Bio-waste (incl. garden waste)*	☒	☐	☐	17.3	12.7
Glass packaging	☐	☒	☐	25.8	22.5
Paper	☒	☐	☐	46.3	46.3
Cardboard					
Beverage cartons	☒	☐	☐	16.1	1.5
Metal packaging					4.5
Plastic packaging					6.8

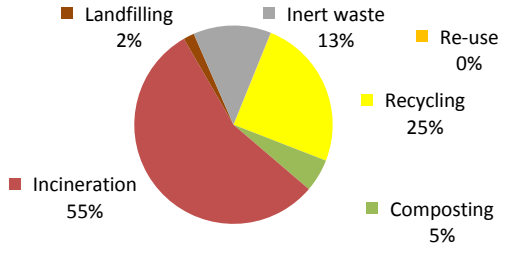
Mixed bulky waste (outside of CAS)	Collection method: ☒ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) 19.4
Civic amenity sites	Nb. of inhabitants per CAS: ~65,300 Nb. of fractions sorted for recycling: 22	Collected quantities (in kg/cap) Sorted fractions:80.1 Mixed fractions: 23.1



*In some districts of Liège, green waste is also collected through containers managed by a neighbourhood committee. Data on quantities is not available. Final sorted quantities of bio-waste include quantities directed to anaerobic digestion, the rest being burned with energy recovery.

WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	0.4
Recycling	103.3
Composting	22.4
Anaerobic digestion	
Incineration	231.7
Landfilling	7.4
Inert waste treatment	53.0
Other	-



FINANCING SYSTEM

Financing system	The waste fee for citizens consists of a fixed part (including 50 yellow bags for residual waste and depending on the number of people per household) and a variable part (the number of yellow bags they buy additionally). The system is similar for shops (consisting of a fixed and a variable fee).
Other specific fee	No
Pay-as-you-throw	☒ for household waste ☒ for similar waste ☐ for other waste

ZÜRICH – SWITZERLAND - 2016

Name of the area	City of Zürich
Population	415,682 (31.12.2016)
Population density	4524.14 inh./km²
Operations led by	ERZ Entsorgung + Recycling Zürich – public waste management company, part of the civil engineering and waste disposal department of the city of Zürich (TED)

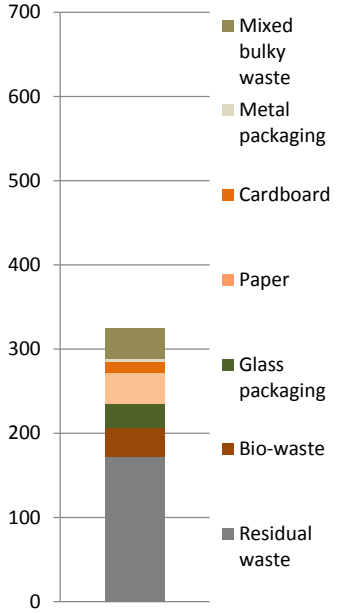
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☒ ☐ ☒	Similar composition to household waste. Companies have their own special container, which is collected separately and charged to the companies. Large companies of over 250 employees are not obliged to manage their waste via ERZ.	
Waste generated by the municipalities	☒		
Street cleaning and street bins	☒	Street bins included (destination: incineration and recycling)	7.6%

WASTE COLLECTION

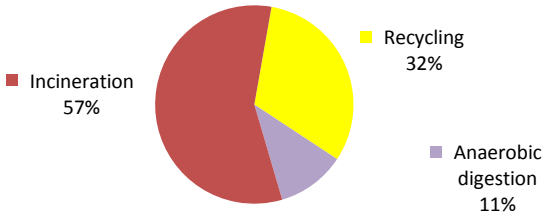
Waste fraction	Collection methods: Door-to-door	Collection methods: Bring banks	Collection methods: Other	Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
Residual waste (incl. bulky waste)	☒	☒	☐	172.7	
Bio-waste (incl. garden waste)	☒	☐	☐	33.7	
Glass packaging	☐	☒	☐	28.4	
Paper	☒	☐	☐	37.4	
Cardboard	☒	☐	☐	13.1	
Beverage cartons	☐	☐	☐	No collection	
Metal packaging	☐	☒	☐	2.82	
Plastic packaging: PET bottles	☐	☒	☒	National scheme (no local data)	

Mixed bulky waste (outside of CAS)	Collection method: ☐ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☒ Other specific schemes: Cargo-Tram (mobile CAS) ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) No information, bulky waste is often collected together with normal household residual waste.
Civic amenity sites	Nb. of inhabitants per CAS: 207,841 Nb. of fractions sorted for recycling: 9 **Cargo-tram** = mobile CAS **E-tram** = mobile CAS for WEEE	Collected quantities (in kg/cap) **Total:** 36.4



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	-
Recycling	94.9
Composting	-
Anaerobic digestion	33.7
Incineration	172.7
Landfilling	-
Inert waste treatment	-
Other	-



FINANCING SYSTEM

Financing system	Infrastructure price for property owners. Tenants are usually billed for this fee as part of their additional costs. A yearly bio-waste subscription fee can be paid for the collection of the bio-waste container. Fee on the bags used for collection.
Other specific fee	Specific fees for collections on request of bulky waste, metal, electrical appliances, stoneware, or flat glass.
Pay-as-you-throw	☒ for household waste ☒ for similar waste ☒ for other waste

HAMBURG – GERMANY - 2015

Name of the area	City of Hamburg
Population	1,797,000
Population density	2,380 inh./km²
Operations led by	Stadtreinigung Hamburg (SRH) – public waste management company

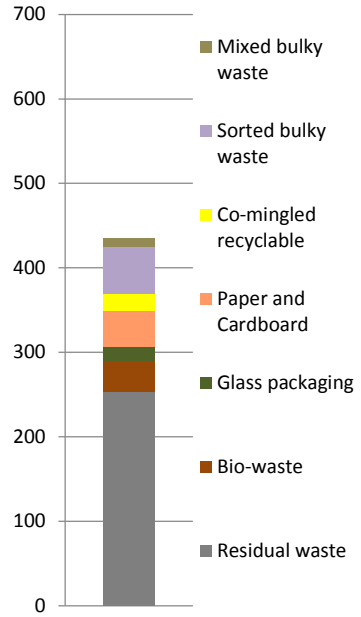
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☐ ☒ ☐	Waste from shops collected in 60 l bins together with the household waste	
Waste generated by the municipalities	☐		
Street cleaning and street bins	☒		

WASTE COLLECTION

Waste fraction	Collection methods: Door-to-door	Collection methods: Bring banks	Collection methods: Other	Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
Residual waste	☒	☐	☐	253	N.A.
Bio-waste (incl. garden waste)	☒	☐	☐	37	
Glass packaging	☐	☒	☒	16	
Paper	☒	☒	☒	43	
Cardboard					
Beverage cartons	☒	☐	☒	20	
Metal packaging (incl. metal items)					
Plastic packaging					

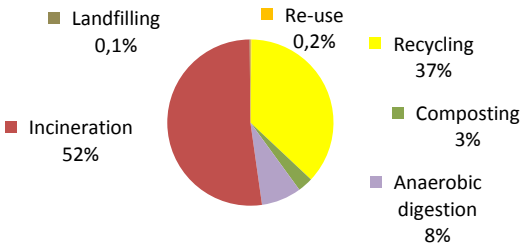
Mixed bulky waste (outside of CAS)	Collection method: ☐ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☒ Other specific schemes* ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) 10
Civic amenity sites	Nb. of inhabitants per CAS: 149,750 Nb. of fractions sorted for recycling: 12	Collected quantities (in kg/cap) Sorted fractions: 42 Mixed fractions: 16



* Second-hand shop

WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	1
Recycling	163
Composting	13.2
Anaerobic digestion	34.5
Incineration	230.8
Landfilling	0.7
Inert waste treatment	-
Other	-



FINANCING SYSTEM

Financing system	Based on the number of bags, size of the bins, collection frequency.
Other specific fee	Specific fees for collection on demand of bulky waste, and disposal of specific items at CAS.
Pay-as-you-throw	☒ for household waste ☒ for similar waste ☒ for other waste

ODENSE – DENMARK - 2016

Name of the area	City of Odense
Population	200,917
Population density	660 inh./km²
Operations led by	Odense Renovation – public waste management company

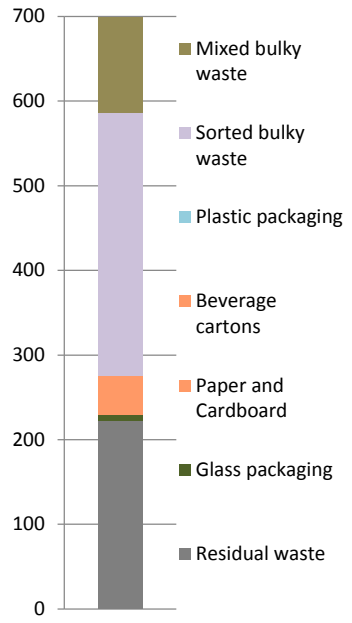
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☒ ☒ ☒	Collection service for commercial activities with 1 m³ containers for residual waste. Small companies can bring waste in civic amenity sites against a fixed fee. Municipal institutions are also collected by Odense Renovation (possibility of collection on request).	
Waste generated by the municipalities	☒		
Street cleaning and street bins	☐		-

WASTE COLLECTION

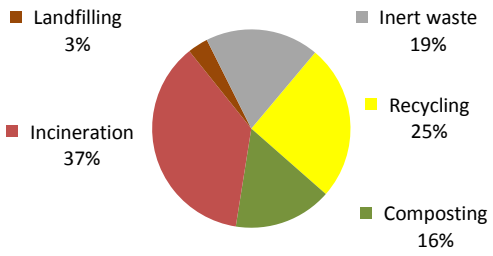
Waste fraction	Collection methods: Door-to-door	Collection methods: Bring banks	Collection methods: Other	Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
Residual waste	☒	☐	☐	222.8	
Bio-waste	☐	☐	☐	Garden waste in CAS	
Glass packaging	☐	☒	☒	6.65	
Paper Cardboard	☒	☐	☐	45.76	
Beverage cartons	☐	☐	☒	0.78	
Metal packaging	☐	☐	☒	-	
Plastic packaging	☐	☐	☒	0.05	

Mixed bulky waste (outside of CAS)	Collection method: ☐ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (kg/cap) 10.9
Civic amenity sites	Nb. of inhabitants per CAS: 25,000 Nb. of fractions sorted for recycling: 35	Collected quantities (in kg/cap) Sorted fractions: 309.8 Mixed fractions: 101.5



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	N.A.
Recycling	174
Composting	110
Anaerobic digestion	-
Incineration	252
Landfilling	23
Inert waste treatment	127
Other	-



FINANCING SYSTEM

Financing system	Fee depending on the volume of the container for residual waste.
Other specific fee	Deposit scheme for beverage packaging (glass, metal, plastic). Fee for small companies for CAS.
Pay-as-you-throw	☒ for household waste ☒ for similar waste ☒ for other waste

THESSALONIKI – GREECE - 2015

Name of the area	City of Thessaloniki
Population	325,200
Population density	7,100 inh./km²
Operations led by	FODSA, a public company managing waste for the Association of Local Authorities of the prefecture of Thessaloniki

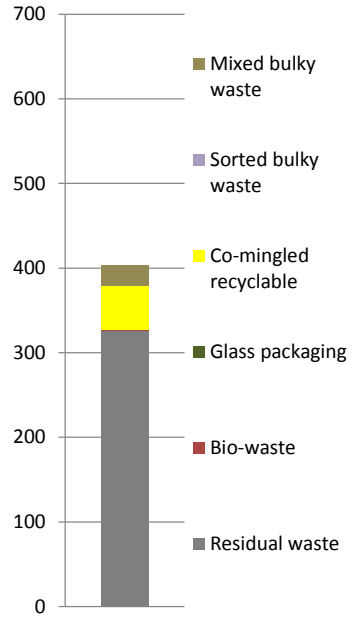
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☒ ☒ ☒	Waste from shops, offices, businesses, public institutions and schools similar in quantity and quality are regarded as municipal waste	
Waste generated by the municipalities	☐		
Street cleaning and street bins	☒	Waste collected on public space (street bins, sweepings…)	

WASTE COLLECTION

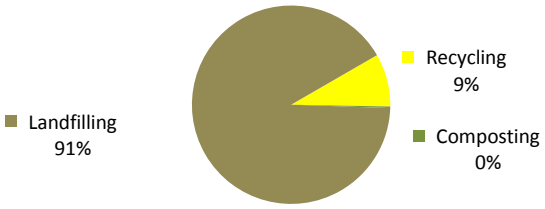
Waste fraction	Collection methods: Door-to-door	Collection methods: Bring banks	Collection methods: Other	Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
Residual waste	☐	☒	☐	325.4	342.5
Bio-waste (only garden waste)	☐	☐	☒	1	1
Glass packaging	☐	☒	☐	1.2	1.2
Paper	☐	☒	☐	51.5	28
Cardboard					
Beverage cartons					-
Metal packaging					1.6
Plastic packaging					4.8

Mixed bulky waste (outside of CAS)	Collection method: ☐ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) 24.3
Civic amenity sites	Nb. of inhabitants per CAS: 325,200 Nb. of fractions sorted for recycling: -	Collected quantities (in kg/cap) -



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	-
Recycling	35
Composting	1
Anaerobic digestion	-
Incineration	-
Landfilling	370
Inert waste treatment	-
Other	-



FINANCING SYSTEM

Financing system	Based on property value
Other specific fee	Fee for bulky waste collection on demand
Pay-as-you-throw	☐ for household waste ☐ for similar waste ☐ for other waste

BARCELONA – SPAIN - 2015

Name of the area	City of Barcelona
Population	1,604,555
Population density	16,000 inh./km²
Operations led by	Collection organised by the City Council, treatment organised by the Metropolitan Area

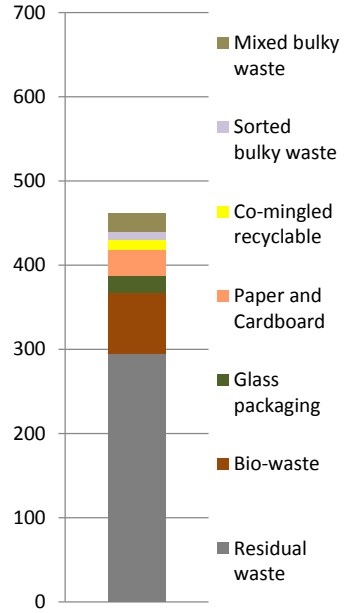
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☒ ☒ ☒	Bars and restaurants (glass, food waste…), retailers (paper and cardboard), offices, schools and hospitals. Big producers (residual waste + bio-waste > 900 l/day) must have separated waste containers on their premises. CAS open to SMEs.	
Waste generated by the municipalities	☒	Park and garden	
Street cleaning and street bins	☒	Including illegal dumping (collected in streets and beaches)	

WASTE COLLECTION

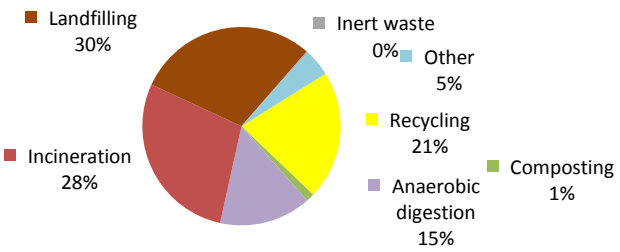
Waste fraction	Collection methods: Door-to-door	Bring banks	Other	Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
Residual waste	☒	☒	☐	295	270
Bio-waste (incl. garden waste)	☒	☒	☐	Food: 68.1 Green: 4.1	72
Glass packaging	☐	☒	☐	20.8	20.8
Paper	☐	☒	☐	30.3	38.8
Cardboard	☐				
Beverage cartons	☐	☒	☐	12.3	2.0
Metal packaging	☐				8.8
Plastic packaging	☐				17.1

Mixed bulky waste (outside of CAS)	Collection method: ☒ On kerbside (with periodical collection) ☐ On demand ☒ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (kg/cap) 22.3 kg/cap
Civic amenity sites	Nb. of inhabitants per CAS: 230,000 for traditional CAS 70,000 for "green collection points" + 90 locations for mobile CAS Nb. of fractions sorted for recycling: 37 in CAS / 28 in other collection points	Collected quantities (in kg/cap) *Traditional CAS:* Sorted fractions: 9.4 Mixed fractions: 0.4



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	N.A.
Recycling	94
Composting	6
Anaerobic digestion	67
Incineration	127
Landfilling	132
Inert waste treatment	1
Other	20



FINANCING SYSTEM

Financing system	Annual fixed fee for household / For commercial activities regarded as "small producers", fee according to the surface of the premises and the type of activity. For commercial activities considered as "large producers", fee according to the volume of the residual waste container.
Other specific fee	Fee for commercial waste in CAS or for specific collection for commercial waste.
Pay-as-you-throw	☐ for household waste ☒ for similar waste ☒ for other waste

PAMPLONA – SPAIN - 2016

Name of the area	Mancomunidad de la Comarca de Pamplona, group of municipalities around Pamplona
Population	329,531
Population density	255.7 inh./km²
Operations led by	Mancomunidad de la Comarca de Pamplona

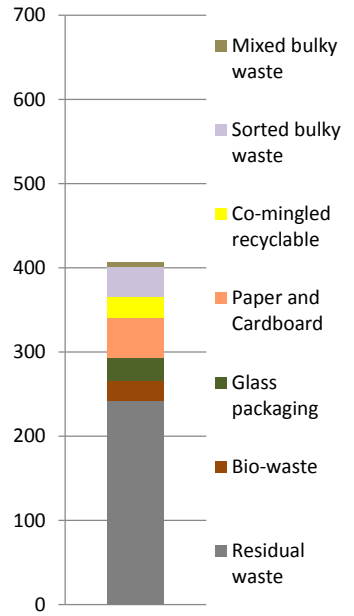
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☒ ☒ ☒	Defined as **non-hazardous** waste similar in nature and composition to household waste and generated by various commercial activities and offices, as well as schools and public establishments. A list of waste fractions included and excluded is provided by the local regulation	
Waste generated by the municipalities	☒	Waste from green areas	
Street cleaning and street bins	☒	Waste from street cleaning and generated in public spaces	

WASTE COLLECTION

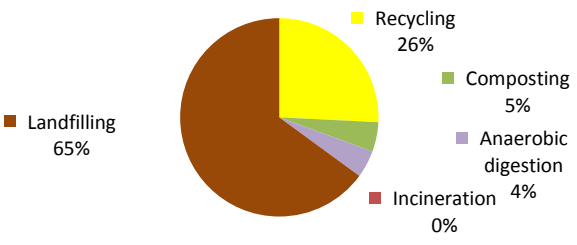
Waste fraction	Collection methods			Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
	Door-to-door	Bring banks	Other		
Residual waste	☐	☒	☐	242.3	251.5
Bio-waste (garden waste in other containers)	☐	☒	☒	24.1	24.1
Glass packaging	☒	☒	☐	26.4	26.4
Paper	☒	☒	☐	48.8	49.1
Cardboard					
Beverage cartons	☐	☒	☐	23.9	2.0
Metal packaging					2.9
Plastic packaging					9.5

Mixed bulky waste (outside of CAS)	Collection method: ☐ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) Sorted fractions: 36.0 Mixed fractions: 5.5
Civic amenity sites	Nb. of inhabitants per CAS: 329,531 Nb. of fractions sorted for recycling: 35 Small fixed and mobile collection points also available for hazardous waste and several other fractions (small appliances, clothes, toys…) Public containers are available for green waste	



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	N.A.
Recycling	139.3
Composting	26
Anaerobic digestion	24.1
Incineration	-
Landfilling	350.9
Inert waste treatment	-
Other	-



FINANCING SYSTEM

Financing system	Tax, rate according to the producer (household, commercial activity) with a minimum and a maximum amount
Other specific fee	Additional fee are applied for big producers for each m³ above 12 m³/week. Above certain quantities per day or delivery, fees are applied on the waste brought to the CAS (especially for C&D waste)
Pay-as-you-throw	☐ for household waste ☐ for similar waste ☒ for other waste

MARSEILLE – FRANCE - 2015

Name of the area	Marseille Provence Métropole, 18 communes
Population	1,045,823
Population density	1 729 inh./km²
Operations led by	Partly by municipal services and partly by subcontracting waste companies

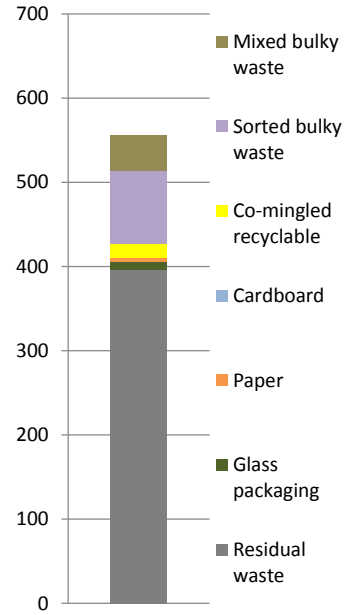
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☒ ☒ ☒	Businesses and small companies, administrations	
Waste generated by the municipalities	☒	Waste from municipal technical services	
Street cleaning and street bins	☒	Street bins and waste	

WASTE COLLECTION

Waste fraction	Collection methods: Door-to-door	Collection methods: Bring banks	Collection methods: Other	Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
Residual waste	☒	☒	☐	396	400
Bio-waste	☐	☐	☐	-	-
Glass packaging	☐	☒	☐	10.1	10.1
Paper (newspaper and magazines)	☒	☒ *	☒	10.9	4	12.1
Cardboard			☐		2.2
Beverage cartons			☐		0.2
Metal packaging			☐	5.3	0.4
Plastic packaging			☐		1.4

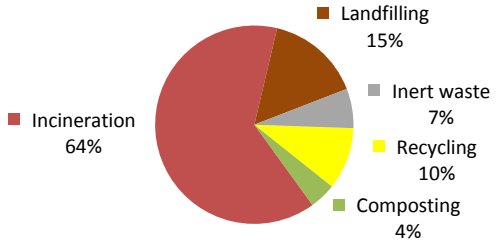
Mixed bulky waste (outside of CAS)	Collection method: ☐ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) 19.4 (mixed)
Civic amenity sites	Nb. of inhabitants per CAS: 61,500 Nb. of fractions sorted for recycling: 12	Collected quantities (in kg/cap) Sorted fractions: 87.7 Mixed fractions: 22.3



* There are two different systems for the collection of dry recyclables in bring banks: one with source separation of newspapers and magazine and one co-mingling them with packaging waste

WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	-
Recycling	66.4
Composting	30.7
Anaerobic digestion	-
Incineration	355.3
Landfilling	96.2
Inert waste treatment	56.5
Other	0.4



FINANCING SYSTEM

Financing system	Tax based on the property value Fee for similar waste with a waste production above 120 l/day, according to the volume of waste
Other specific fee	Fee for business waste brought on sorting platforms
Pay-as-you-throw	☐ for household waste ☒ for similar waste ☒ for other waste

RENNES – FRANCE - 2015

Name of the area	Rennes Métropole (43 communes centred around the city of Rennes)
Population	426,502
Population density	605 inh./km²
Operations led by	Managed by Rennes Métropole, operated by various subcontractors

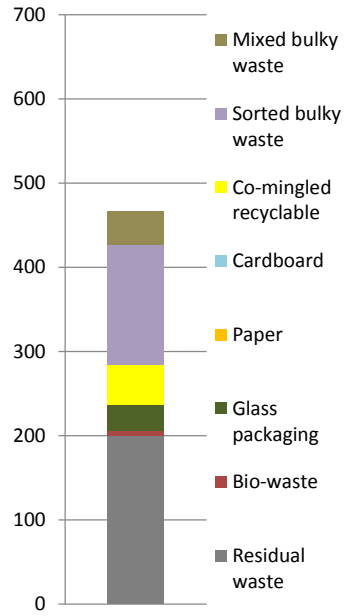
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		85 %
Similar waste: - *From commercial activities* - *From public organisations*	☒ ☒ ☒	Non-household waste below 10,000 l/week collected door-to-door or in bring banks, with a special fee for volumes above 52 m^3/yr	15 %
Waste generated by the municipalities	☐		
Street cleaning and street bins	☐		

WASTE COLLECTION

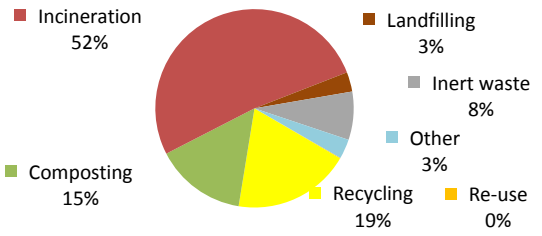
Waste fraction	Collection methods: Door-to-door	Collection methods: Bring banks	Collection methods: Other	Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
Residual waste	☒	☒	☐	200	208
Bio-waste (only garden waste)	☒	☐	☒	5.2	5.2
Glass packaging	☒	☒	☐	32	32
Paper	☒	☒	☐	47	25
Cardboard					7
Beverage cartons		☒			0.9
Metal packaging					1.8
Plastic packaging					4.7

Mixed bulky waste (outside of CAS)	Collection method: ☐ On kerbside (with periodical collection) ☒ On demand ☒ Illegal dumping ☒ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) 3.3
Civic amenity sites	Nb. of inhabitants per CAS: 23,700 Nb. of fractions sorted for recycling: 20	Collected quantities (in kg/cap) Sorted fractions: 142.4 Mixed fractions: 39.5



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	0.5
Recycling	90
Composting	70
Anaerobic digestion	--
Incineration	243
Landfilling	15
Inert waste	37
Other	-



FINANCING SYSTEM

Financing system	Tax based on the property value, special fee for commercial waste for volumes between 52 and 520 m^3/yr, based on the number of actual collection (chipped bins)
Other specific fee	Special fee for commercial waste in civic amenity sites applied to several waste fractions
Pay-as-you-throw	☐ for household waste ☒ for similar waste ☒ for other waste

TORINO – ITALY - 2015

Name of the area	City of Torino
Population	890,529
Population density	6,940 inh./km²
Operations led by	AMIAT – public waste management company in charge of waste management on the territory of the city

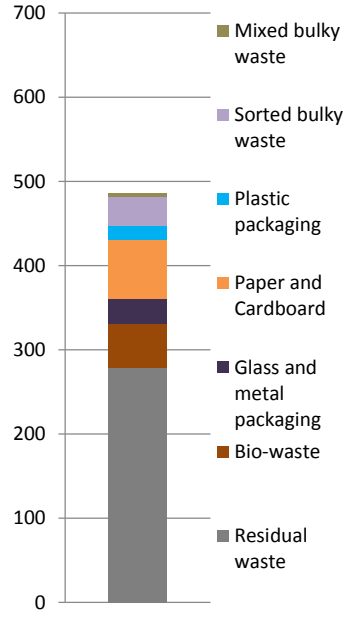
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☒ ☐ ☐	Below 150kg/m²/year, non-household waste producers can use the service by paying the waste tax. Higher threshold are available for food markets. In CAS, only non-household WEEE is accepted	
Waste generated by the municipalities	☐		
Street cleaning and street bins	☒		1%

WASTE COLLECTION

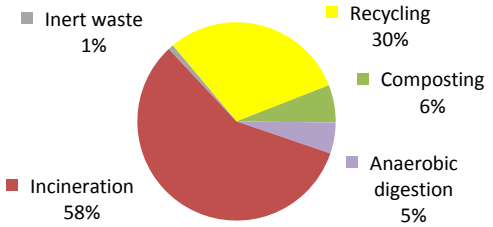
Waste fraction	Collection methods: Door-to-door	Collection methods: Bring banks	Collection methods: Other	Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
Residual waste	☒	☐	☐	278	303
Bio-waste (no garden waste)	☒	☐	☐	53	40
Glass packaging	☒	☒	☐	29	25
Metal packaging					1
Paper	☒	☒	☐	71	67.5
Cardboard					
Beverage cartons					
Plastic packaging	☒	☒	☐	16	10.5

Mixed bulky waste (outside of CAS)	Collection method: ☐ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) Sorted fractions: 35 Mixed fractions: 4
Civic amenity sites	Nb. of inhabitants per CAS: 128,900 Nb. of fractions sorted for recycling: 30	



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	-
Recycling	143
Composting	29
Anaerobic digestion	24
Incineration	274
Landfilling	-
Inert waste treatment	4
Other	-



FINANCING SYSTEM

Financing system	The waste tax is calculated according to the size of the household and the number of inhabitants. For important commercial activities, it is calculated according to the surface and the type of activity.
Other specific fee	CAS are free for inhabitants and do not accept non-household waste.
Pay-as-you-throw	☐ for household waste ☐ for similar waste ☐ for other waste

MAASTRICHT – THE NETHERLANDS - 2017

Name of the area	City of Maastricht
Population	122,753 (2017)
Population density	2,175 inh./km²
Operations led by	Maastricht Municipality and private industries

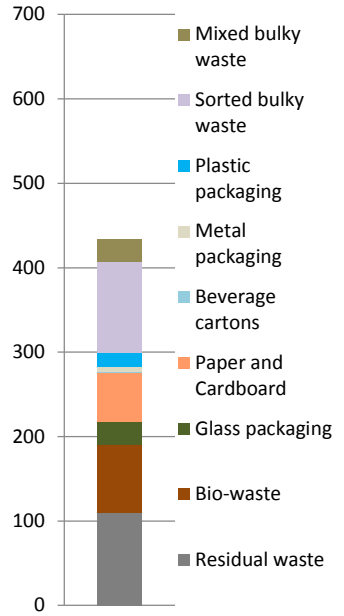
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☐ ☒ ☐	Includes similar waste from offices, stores, and services waste concerning commercial activities in the centre of Maastricht. No business waste in CAS.	
Waste generated by the municipalities	☒	Only own municipal buildings	
Street cleaning and street bins	☒		

WASTE COLLECTION

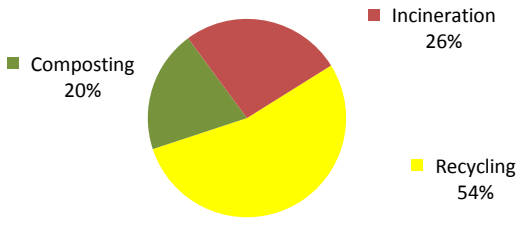
Waste fraction	Collection methods			Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
	Door-to-door	Bring banks	Other		
Residual waste	☐	☒	☐	109.7	106.7
Bio-waste (incl. garden waste)	☒	☒	☐	81.6	81.6
Glass packaging	☐	☒	☐	27.5	27.5
Paper Cardboard	☒	☒	☐	56.8	56.8
Beverage cartons	☐	☒	☐	2.3	2.2
Metal packaging	☐	☒	☐	2.4	4.8
Plastic packaging	☐	☒	☐	19.1	17.5

Mixed bulky waste (outside of CAS)	Collection method: ☐ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☒ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) Collected: 14.6 Final sorted: 7.3
Civic amenity sites	Nb. of inhabitants per CAS: 30,700 Nb. of fractions sorted for recycling: fine residual waste – 8; bulky waste – 18	Collected quantities (in kg/cap) Sorted fractions: 107 Mixed fractions: 12



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	-
Recycling	218.8
Composting	81.6
Anaerobic digestion	-
Incineration	106.7
Landfilling	-
Inert waste treatment	-
Other	-



FINANCING SYSTEM

Financing system	Uniform tariff for all households (local waste tax) + Tariff per residual waste bag
Other specific fee	Tariff per kg of m³ mixed bulky waste at the environmental parks (Civic amenity sites)
Pay-as-you-throw	☒ for household waste ☒ for similar waste ☒ for other waste

KRAKOW – POLAND - 2015

Name of the area	City of Krakow
Population	761,873
Population density	2,327.7 inh./km²
Operations led by	Miejskie Przedsiębiorstwo Oczyszczania Sp. z o.o. (Municipal Waste Company Ltd.)

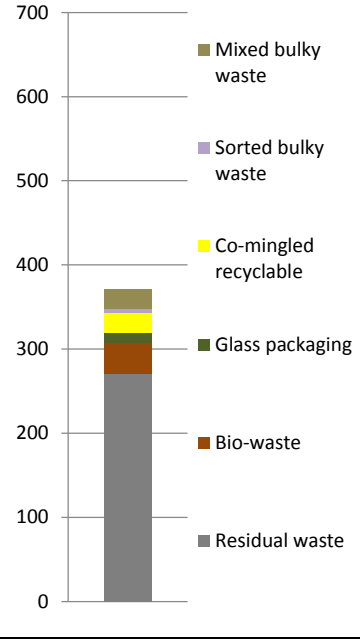
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒	This is the only fraction exactly calculated and recorded	82.8 %
Similar waste: - *From commercial activities* - *From public organisations*	☒ ☐ ☐	This waste is included in the household waste, as it is similar in composition	
Waste generated by the municipalities	☒	There is a certain amount of waste coming from the municipality's activities but this waste is not recorded. 7.2% comes from the maintenance of urban spaces (green waste from parks and other green areas)	17.2%
Street cleaning and street bins	☒	Street and squares cleaning + street bins	0.008 %

WASTE COLLECTION

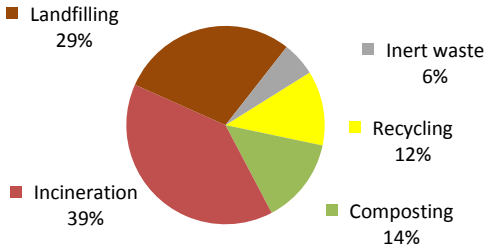
Waste fraction	Collection methods: Door-to-door	Collection methods: Bring banks	Collection methods: Other	Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
Residual waste	☒	☐	☐	270.6	270.6
Bio-waste (mainly garden waste)	☒	☒	☒	36.9	36.9
Glass packaging	☒	☒	☐	12.3	12.3
Paper	☒	☒	☐	22.7	8.2
Cardboard					
Beverage cartons					0.6
Metal packaging					2.6
Plastic packaging					5.4

Mixed bulky waste (outside of CAS)	Collection method: ☒ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (kg/cap) 19.2
Civic amenity sites	Nb. of inhabitants per CAS: 380,937 Nb. of fractions sorted for recycling: 4	Collected quantities (in kg/cap) Sorted fractions: 5.8 Mixed fractions: 3.9



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	N.A.
Recycling	29.1
Composting	33.4
Anaerobic digestion	-
Incineration	94
Landfilling	69
Inert waste treatment	13.2
Other	-



FINANCING SYSTEM

Financing system	Based on number of inhabitants of a property
Other specific fee	None
Pay-as-you-throw	☐ for household waste ☐ for similar waste ☐ for other waste

PORTO – PORTUGAL - 2016

Name of the area	City of Porto
Population	216,400
Population density	7,000 inh./km²
Operations led by	Lipor - Intermunicipal Waste Management Company of Greater Porto

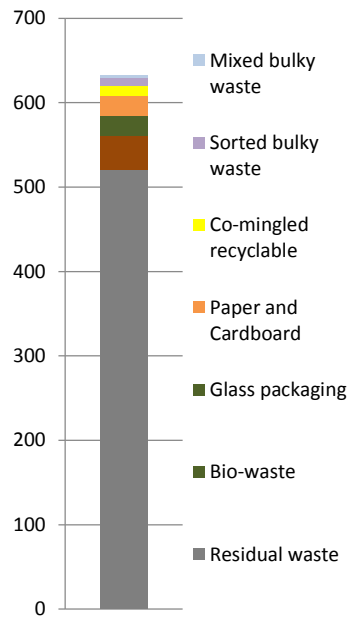
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☒ ☒ ☒	Cover similar waste producers with a production below 1,100 l/week	
Waste generated by the municipalities	☒	Park and garden waste	
Street cleaning and street bins	☐		

WASTE COLLECTION

Waste fraction	Collection methods: Door-to-door	Collection methods: Bring banks	Collection methods: Other	Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)*
Residual waste	☐	☒	☐	521	521
Bio-waste: food waste from home, restaurants, supermarkets and markets + green waste from parks, gardens and cemeteries	☒	☐	☐	39.4	32.9
Glass packaging	☐	☒	☐	24.5	24.4
Paper	☐	☒	☐	23.2	23.2
Cardboard	☐		☐		
Beverage cartons	☐	☒	☐	12.2	0.83
Metal packaging	☐		☐		0.70
Plastic packaging	☐		☐		7.3

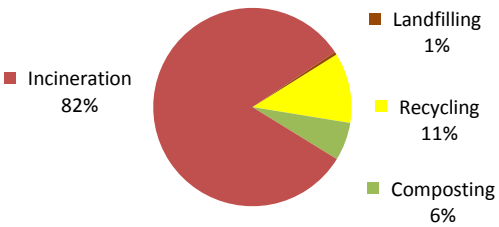
Mixed bulky waste (outside of CAS)	Collection method: ☒ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) Sorted fractions: 8.60 Mixed fractions: 3.50
Civic amenity sites	Nb. of inhabitants per CAS: 107,300	



* Assessment done with the total waste quantities treated by LIPOR

WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	N.A.
Recycling	72.58
Composting	39.38
Anaerobic digestion	-
Incineration	518.25
Landfilling	3.01
Inert waste treatment	-
Other	-



FINANCING SYSTEM

Financing system	Waste tax included in the water bill
Other specific fee	None
Pay-as-you-throw	☐ for household waste ☐ for similar waste ☐ for other waste

MALMÖ – SWEDEN - 2015

Name of the area	City of Malmö
Population	322,574
Population density	1,946 inh./km²
Operations led by	Waste collection operated by private contractors, waste treatment by public company VA SYD

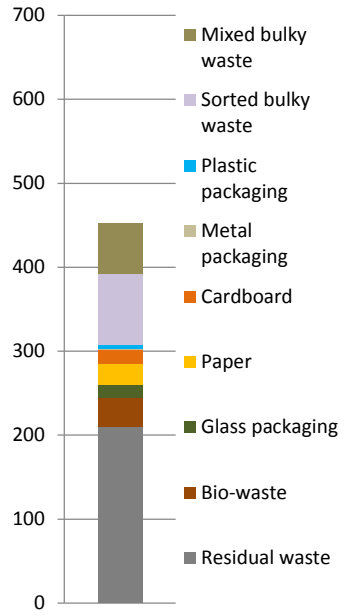
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☒ ☒ ☒	Waste similar in composition and nature are included in municipal waste (commercial activities, schools, hospitals…). CAS not accessible for vehicles > 3.5 t	
Waste generated by the municipalities	☐		
Street cleaning and street bins	☐		

WASTE COLLECTION

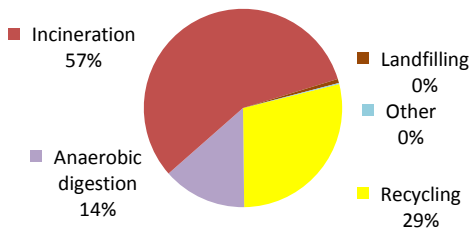
Waste fraction	Collection methods			Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
	Door-to-door	Bring banks	Other		
Residual waste	☒	☐	☐	210	
Bio-waste (no garden waste)	☒	☐	☐	34	
Glass packaging	☐	☒	☐	16.3	
Paper (newspaper only)	☐	☒	☐	25	
Cardboard (including paper packaging)	☐	☒	☐	16.1	
Beverage cartons					
Metal packaging	☐	☒	☐	1.3	
Plastic packaging	☐	☒	☐	5.4	

Mixed bulky waste (outside of CAS)	Collection method: ☐ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) Sorted fractions: 84 Mixed fractions: 60
Civic amenity sites	Nb. of inhabitants per CAS: 161,300 Nb. of fractions sorted for recycling: 20 Mobile CAS available for hazardous waste (13 locations)	



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	-
Recycling	134
Composting	-
Anaerobic digestion	64
Incineration	265
Landfilling	3.1
Inert waste treatment	-
Other	0.8



FINANCING SYSTEM

Financing system	Annual fee based on the size of the residual waste container and the frequency of collection, extra cost for additional emptying.
Other specific fee	Fee for bulky waste collection on demand. CAS are accessible for commercial activities against a fee.
Pay-as-you-throw	☒ for household waste ☒ for similar waste ☒ for other waste

GLASGOW – UNITED KINGDOM - 2015

Name of the area	Glasgow City Council
Population	606,300
Population density	3,520 inh./km²
Operations led by	Glasgow City Council

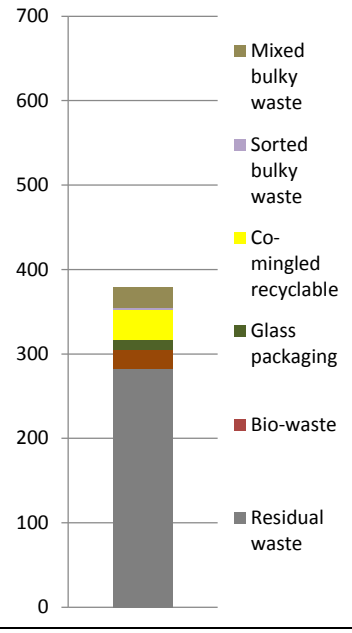
SCOPE OF THE DATA

Type of Waste	Included?	Please specify	% of the total municipal waste
Household waste	☒		N.A.
Similar waste: - *From commercial activities* - *From public organisations*	☐ ☐ ☐	While the City Council offers a commercial waste collection service, the data presented here do not include these quantities	
Waste generated by the municipalities	☒	Waste from parks and grounds included	
Street cleaning and street bins	☒	Street bins and sweeping waste included	6%

WASTE COLLECTION

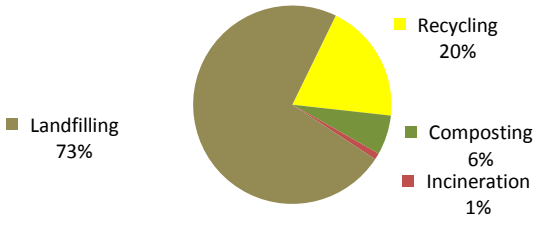
Waste fraction	Collection methods: Door-to-door	Collection methods: Bring banks	Collection methods: Other	Collected Quantities (kg/cap)	Final sorted quantities (kg/cap)
Residual waste	☒	☐	☐	282.4	288.0
Bio-waste (incl. garden waste)	☒	☐	☐	22.05	22.05
Glass packaging	☒	☒	☐	12.6	12.6
Paper	☒	☒	☐	35.2	20.7
Cardboard					2.6
Metal packaging					1.4
Plastic packaging					3.2
Beverage cartons	No separate collection				

Mixed bulky waste (outside of CAS)	Collection method: ☒ On kerbside (with periodical collection) ☒ On demand ☐ Collection of illegal dumping ☐ Other specific schemes ☐ Only in (mobile) civic amenity sites	Collected quantities (in kg/cap) 24.3
Civic amenity sites	Nb. of inhabitants per CAS: 153,800 Nb. of fractions sorted for recycling: 15	Collected quantities (in kg/cap) Sorted fractions: 2.9



WASTE TREATMENT

Treatment	Quantities (kg/cap)
Re-use	-
Recycling	71.5
Composting	23.6
Anaerobic digestion	-
Incineration	3.9
Landfilling	267.1
Inert waste treatment	-
Other	-



FINANCING SYSTEM

Financing system	Tax based on property value and number of inhabitants in the household.
Other specific fee	There is a charge for the bulky waste collection on demand for several types of waste. Specific charges apply in CAS for specific waste fractions and above certain quantities or number of visits.
Pay-as-you-throw	☐ for household waste ☐ for similar waste ☒ for other waste

4. Analysis

The data presented in the factsheets show important differences between the cities. The general reasons were mentioned previously: different scope of data, different contexts impacting waste generation and management, different local strategies with various effects.

Considering the size of the panel and the fact both waste generation and sorting performances are the results of many different parameters, the conclusions that can be drawn from the analysis of data have to be formulated with caution. The report will mainly try to answer the following points:

- Are there proper correlations between waste production / sorting performances and external factors / local instruments?
- Are there any similarities and discrepancies when comparing front runners and cities with lower performances?

By comparing the common practices among the best-performing cities and the common practices in less well-performing cities, effective practices will be highlighted.

4.1 Waste generation and collected quantities

4.1.1 General observations

One of the most challenging figures to analyse is waste generation. When comparing different datasets presenting collected quantities per inhabitant, it can be tempting to explain differences by consumption pattern, standard of living, or prevention efforts. However local waste generation is the outcome of various parameters, among which the living conditions (e.g. size of housing, presence of gardens…), tourism, and the economic activity also play a role. But most importantly, waste generation is affected by two other parameters:

- **How it is calculated**: waste generation is generally assessed by collected quantities, which do not generally include illegal practices (illegal dumping, backyard burning) or prevention practices such as home or decentralised composting;
- **The scope of municipal waste data:** as seen previously, the scope of municipal waste can differ greatly from one place to another. If a share of commercial waste is included, then the local economic activity impact waste generation. If street bins are included in the calculation, then the impact of non-residents (tourists, commuters…) might be significant.

As mentioned previously, this study distinguishes two types of waste:

- "**Common waste**", e.g. all the waste that is produced by citizens on a regular basis and handled via traditional collection schemes (door-to-door, bring banks, vacuum systems…). It is mostly composed of bio-waste, dry recyclables (paper, packaging waste) and residual waste;
- "**Other waste**", e.g. all the waste that is not "common waste", meaning that it is not collected with common waste for various reason (bulkiness, hazardousness…). It includes bulky waste, hazardous waste, and in general all waste collected in civic amenity sites and within bulky waste collection schemes.

The data on quantities of waste collected per capita are presented in the following graph:

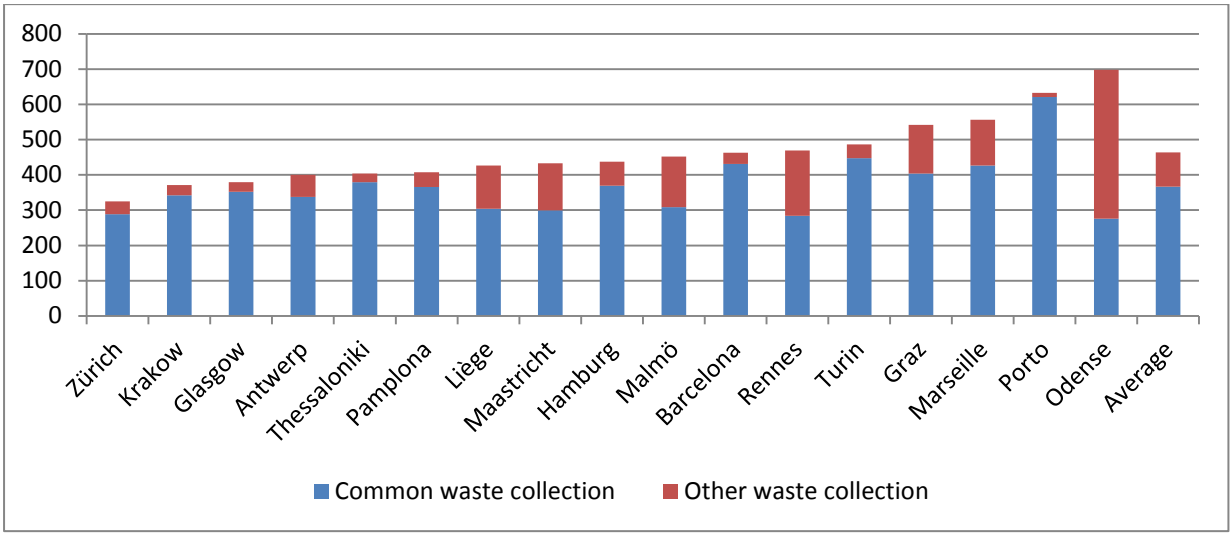


Figure 9: quantities of municipal waste collected per inhabitant (in kg/cap)

The graph shows important differences among the quantities collected, from about 300 kg/cap in Zürich to 700 kg/cap in Odense. There are also important differences in the proportion of "common waste" (residual waste, bio-waste, paper and packaging waste) and "other waste" (bulky waste and waste collected in CAS). "Other waste" represents a very small fraction of municipal waste in many cities, yet it represents 60% of the total municipal waste in Odense.

The average collected quantities are 465 kg/cap, among which there are 367 kg/cap of common waste and 97 kg/cap of other waste. The standard deviation is much more significant for other waste. The collected quantities for both common waste and other waste are presented on the following graphs:

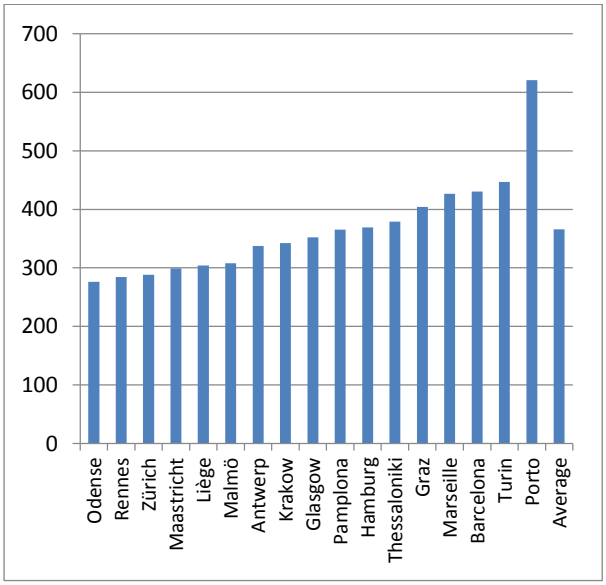


Figure 10: common waste collected quantities per capita (kg/cap)

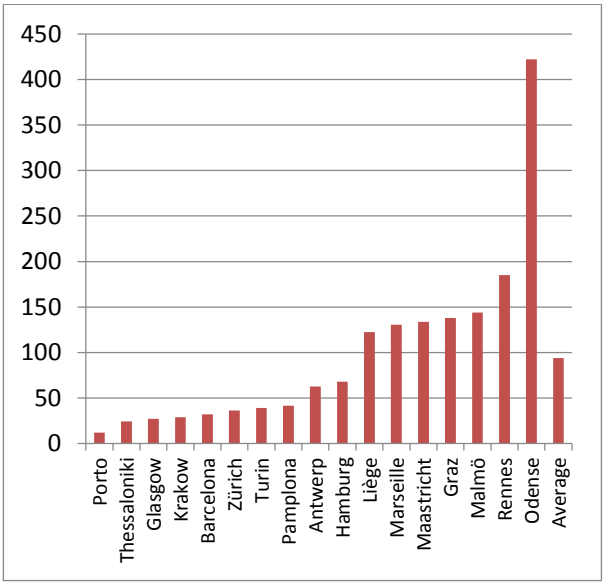


Figure 11: other waste collected quantities per capita (kg/cap)

Figure 10 shows that most common waste quantities per capita are actually quite homogeneous, except for Porto, which also has the smallest collected quantities for other waste. Other waste quantities are more heterogeneous, even if Odense is put aside. Odense's other waste quantities are much more significant than the other cities' quantities, while its quantities of common waste collected are among the lowest.

Generally speaking, it is important to state that "common waste" and "other waste" are operational indicators: their exact scope depends on the practical organisation of local waste management. For instance:

- **Green waste** can be collected door-to-door (e.g. within a bio-waste stream mixing food waste and green waste) or in civic amenity sites. Therefore, green waste quantities can be reported as either common or other waste;
- **Bulky waste** is included in the other waste quantities, however it is generally defined as waste whose volume or size make it impossible to be collected with common waste. The precise conditions for waste to be regarded as "bulky waste" depends on the common waste collection system, on the rules set by the local authority and how inhabitants comply with these rules;
- **"Other waste"** includes waste collected in civic amenity sites, therefore the associated collected quantities will also depend on the civic amenity site system: what waste is accepted there (e.g. similar waste), how convenient they are, and how much the inhabitants are using them.

Data on the composition of residual waste could be collected for several cities. These data have to be considered with care since they are generally assessments based on a panel of measures, thus bearing a share of uncertainties. Moreover, the methods used to perform the composition analyses are likely to be different for every city, which can limit their comparability. Therefore, the data presented below have to be regarded as rough estimates.

The following graph presents the composition of "common waste" for several cities. It includes selectively collected quantities to which the different fractions within residual waste are added (based on the composition analysis data and the residual waste quantities):

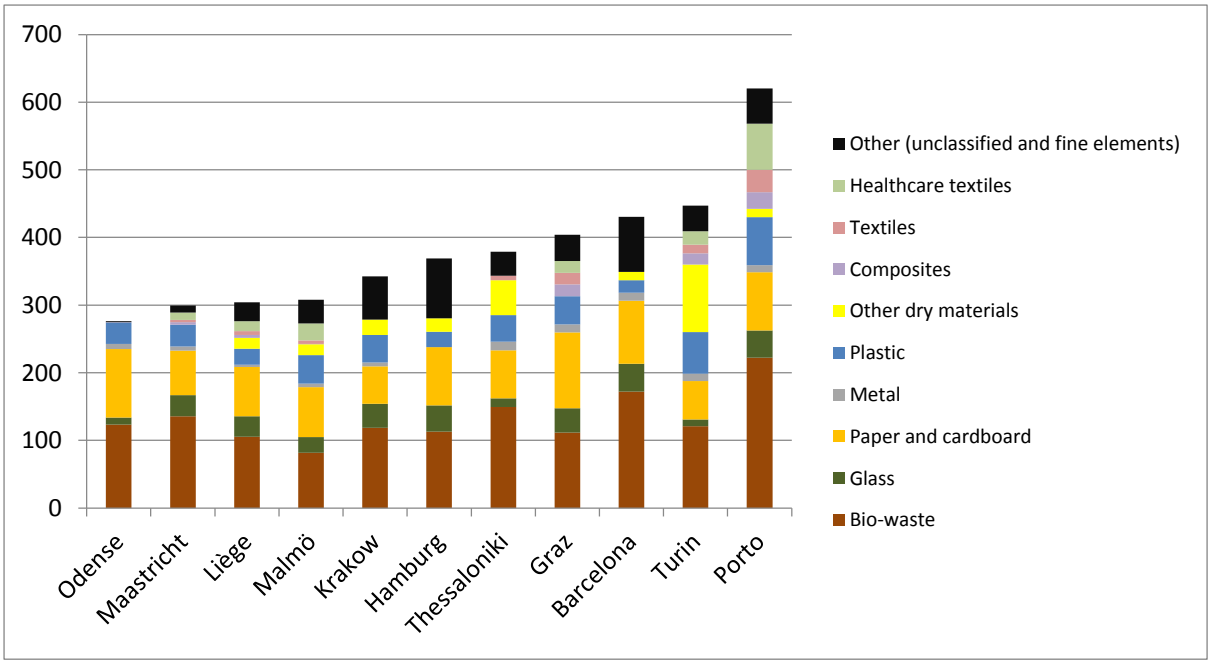


Figure 12: composition of common waste (residual waste, bio-waste and dry recyclables streams) in kg/cap

Porto presents a more important arising for three fractions:

- **Bio-waste**: this difference can be attributed to garden waste (more than 70 kg/cap/yr are collected within the residual fraction, whereas this stream is generally collected as "other waste"), but also to food waste, which could be linked to tourism and specific consumption patterns;

- **Plastic waste**: this is both due to packaging and non-packaging materials. Part of it might be collected as bulky waste in other cities. Tourism and climate could also partly explain an overproduction of plastic packaging;
- **Healthcare textiles**: no clear explanation could be found for this overproduction and no details on the exact content of this fraction were available. Comparisons of the composition of the population (especially very young children and old people) among the studied cities could not allow the identification of clear explanations.

Odense's significant "other waste" quantities are collected in its civic amenity sites. It can be assumed that Odense collects part of what other cities consider as common waste there. On the contrary, Porto might be collecting "other waste" as common waste, as explained above.

4.1.2 Collected quantities and scope

As highlighted previously, one reason behind the differences in collected quantities might come from the scope of municipal waste, e.g. the types of waste regarded, collected and reported as municipal waste. Some of the cities also have separated data reporting for household and commercial waste.

For instance, the five cities presenting the most important collected quantities collect similar waste and waste generated by the municipalities, while the cities presenting lower collected quantities all exclude part of the categories. For instance, Glasgow does not include similar waste and Zürich does not include any commercial waste in the presented data.

Otherwise for other cities, no explanation can be correlated to the scope of municipal waste: for instance, Krakow presents relatively low quantities compared to others, yet both similar waste and waste generated by municipalities are included. The absence of precise data on the share of commercial waste in municipal waste does not allow a clear identification of its impact on the total collected quantities.

4.1.3 The impact of context on collected quantities

In order to identify possible explanations behind the differences of waste quantities, contextual data related to the cities were collected. To do so, Eurostat's Urban Audit database[3] including various data on population, living conditions, economy, and tourism was used. It is possible that local data are not entirely comparable (different calculation methods and scope), therefore the results have to be considered with caution.

The following parameters were investigated:

- **Tourism**: total nights spent in tourist accommodation establishments per resident population;
- **Population**: population density;
- **Living conditions**:
  - Average area of living accommodation;
  - Average size of household;
  - Proportion of households that are 1-person households;
- **Economy**:
  - GDP per inhabitant;
  - All companies per inhabitant.

[3] Eurostat, 2017 (http://ec.europa.eu/eurostat/web/cities/data/database#)

Overall, no clear correlation could be observed between one of these parameters and "total municipal waste" quantities, "common waste" quantities, and "other waste" quantities. It is likely that these external factors might have combined effects on collected quantities, along with the scope of municipal waste and the actual criteria for handling similar waste. Moreover, the panel of cities studied here is not big enough to make significant statistical analyses. However, several parameters might explain part of the differences:

- **Tourism** is comparably high in both Barcelona (11.4 nights spent in tourist accommodation per inhabitant) and in Porto (13.2 nights per inhabitant), compared to the other cities (average of 5.3 nights per inhabitants), which might partly explain higher common waste quantities;
- Moreover, Porto has one of the highest figures of **companies** per inhabitant (0.17, compared to an average of 0.08 in the panel). Considering the fact commercial waste is included in municipal waste, it might also explain the high collected quantities

As an example of the unclear correlation between external parameters and collected quantities, the following graphs present total waste and other waste quantities, in parallel with GDP per inhabitant. The graphs show a sort of correlation between GDP and "other waste" collection.

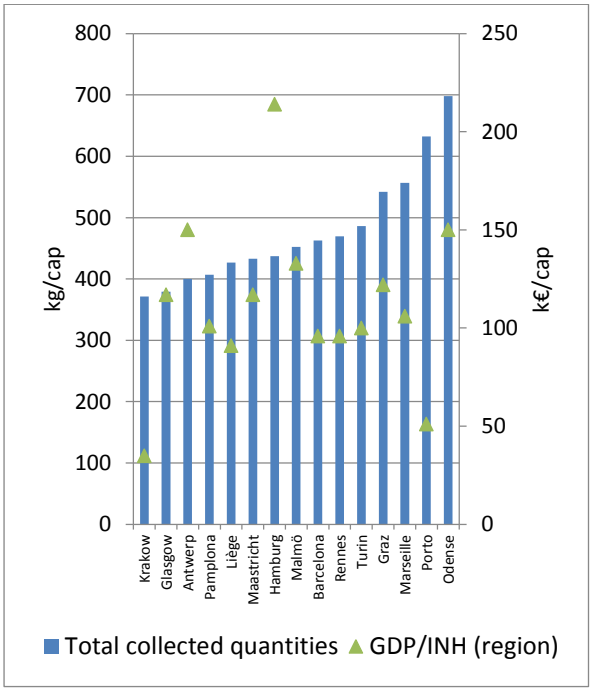


Figure 13: total municipal waste quantities (in kg/cap/yr) and GDP (in k€/inh.)

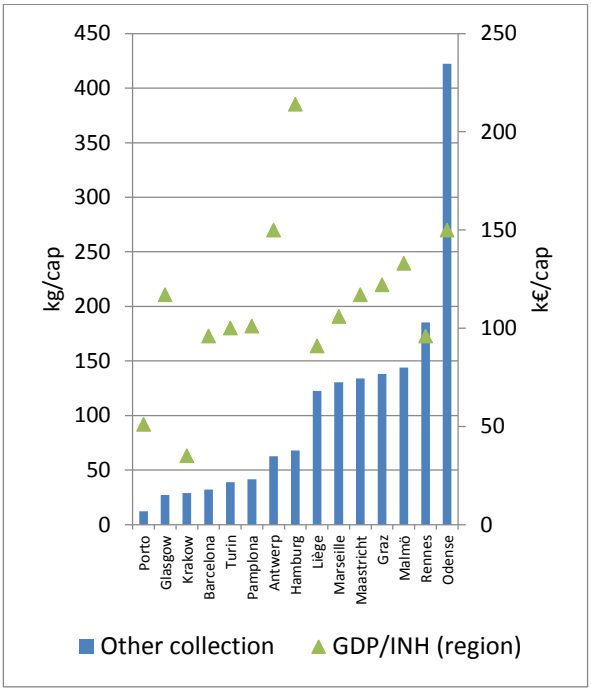


Figure 14: : other waste quantities (in kg/cap/yr) and GDP (in k€/inh.)

The impact of external parameters is dependent on the organisation of waste collection. The impact of tourism will be more important if street bins are included in the figures. Likewise, the impact of economic activities will depend on the inclusion of similar waste in municipal waste.

Therefore, and as explained above, there is no single explanation behind the differences of collected quantities. Both the scope of data and external factors play a role but it is not possible to assess their concrete impact based on such a small panel of cities. Yet, it is possible to partly explain highest or lowest quantities by highlighting specificities in the organisation of municipal waste management (e.g. the acceptance of commercial waste in CAS or tourism). More details on the content of these different fractions will be provided in the following parts, which will provide further explanation for the most notable situations.

4.2 Common waste management

As explained above, "common waste" refers to waste that is commonly produced by households and collected by common collection methods (door-to-door, bring banks…). They mainly consist in:

- **Bio-waste** collection (including kitchen waste and/or garden waste);
- **Dry recyclable** collection (paper and packaging);
- **Residual waste** collection.

4.2.1 Separation at source

The first observation that can be made on common waste collection is that there is a great diversity in how it is organised: both on the sorted fractions (how inhabitants are invited to sort their waste) and the collection methods (door-to-door, bring banks…). The following table presents the number of separated streams for each city:

Table 2: separation systems for dry recyclables in the 17 cities (bio-waste not included here)

Collection of dry recyclables	Number of cities using this system		Combinations	Cities
2 streams	4	1 (2-stream and 4-stream systems in parallel)*	Glass / Paper and packaging	Glasgow, Rennes, Krakow, Marseille*, Thessaloniki
3 streams	7		Glass / Paper and cardboard / Mixed packaging Glass and metal packaging / Paper and Cardboard / Plastic packaging	Liège, Antwerp, Hamburg, Barcelona, Pamplona, Porto Turin
4 streams	2		Glass / Paper and cardboard / Plastic and metal packaging / Beverage cartons Glass / Paper and cardboard / Metal packaging / Plastic packaging Glass / Paper / Cardboard / Mixed packaging	Odense Graz Marseille*
5 streams	0		Glass / Paper and Cardboard / Metal packaging / Plastic packaging / Beverage cartons Glass / Paper / Cardboard / Metal packaging / Plastic packaging Glass / Paper / Paper and cardboard packaging + beverage cartons / Metal packaging / Plastic packaging	Maastricht Zürich Malmö

** As mentioned previously, Marseille propose two different sorting systems for inhabitants depending on the areas*

Nine different separation systems can be identified for the seventeen cities. The number of different streams ranges from two (glass and co-mingled paper and packaging) to five (with almost all fractions separated at source). The most common system among the panel is the three-stream system, separating glass, paper and cardboard, and mixed packaging ('PMC': plastic packaging, metal, and beverage cartons).

It is also possible to highlight the practices for separation for the different waste fractions:

Table 3: method of separation of the main material fractions (one city has set two different sorting systems in parallel for dry recyclables, making the total sum of collection systems either 17 or 18)

Waste fraction	Source separation	Co-mingled	Not separated	Most common system
Food waste	3	10 (Garden waste at least partly included with food waste collection)	4	Garden waste (partly) accepted in food waste container
Garden waste (excl. CAS)	2		5*	
Glass packaging	16	1 (with metal packaging)	0	Source separation
Metal packaging	4	1 (with plastic packaging) + 1 (with glass packaging) + 5 (with paper + other packaging) + 7 (with plastic packaging and beverage cartons)	0	Collected with plastic packaging and beverage cartons
Paper	3	9 (with cardboard) + 4 (with cardboard and other packaging) + 2 (with cardboard and beverage cartons - only for paper packaging)	0	All papers (packaging and non-packaging) collected with cardboard packaging
Cardboard	2	9 (with paper) +5 (with other packaging) + 2 (with paper packaging and beverage cartons)	0	Collected with paper
Beverage cartons	2	7 with plastic and metal packaging + 5 with P&C** and packaging + 2 with paper and cardboard packaging	1	Collected with plastic and metal packaging
Plastic packaging	5	7 with metal packaging and beverage cartons + 5 with P&C* and other packaging + 1 with metal packaging	0	Collected with metal packaging and beverage cartons

** For these cities, garden waste is collected in CAS*

***P&C: Paper and Cardboard*

For bio-waste, the most common system is to collect garden waste and food waste. However, the accepted garden waste differs and ranges from small plants to all types of garden waste that can fit the container. The material fraction the most commonly separated at source is glass, with only one city collecting it comingled with metal. Two other popular combinations are paper and cardboard, as well as plastic packaging, metal packaging, and beverage cartons (PMC).

The following graph shows the collected quantities per capita for common waste along with the number of streams collected for dry recyclables and the type of bio-waste collection ("bio-waste" means here that food waste and green waste are collected together). The cities are sorted according to their sorting rates, i.e. the sum of collected bio-waste and dry recyclables compared to the total quantities of common waste:

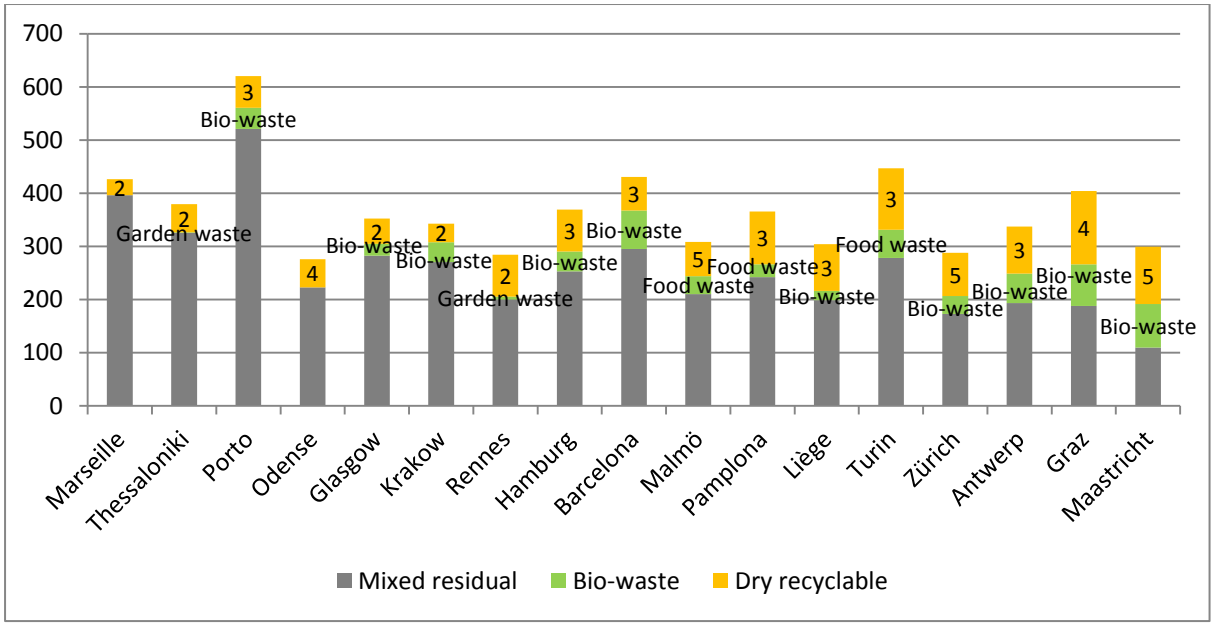


Figure 15: collected quantities of common waste per capita, with indications on the accepted bio-waste and the number of collected streams for dry recyclables

Unsurprisingly, the cities with the highest sorting rates all sort their bio-waste. The cities with the lowest sorting rates tend to also have the lowest number of sorted streams, while the cities with more streams sorted at the source tend to have higher sorting rates. One exception is the City of Odense, yet part of the dry recyclables and all garden waste are collected in civic amenity sites or through a deposit scheme (for beverage packaging), making comparisons challenging with other cities. Moreover, a deposit system is widely used in Denmark for glass, plastic, and metal beverage packaging, whose associated quantities are not reported here.

4.2.2 Collection modes

The collection modes used in the different cities are also very different from one to another. The following graph shows the number of cities using the various collection modes for the main waste stream categories:

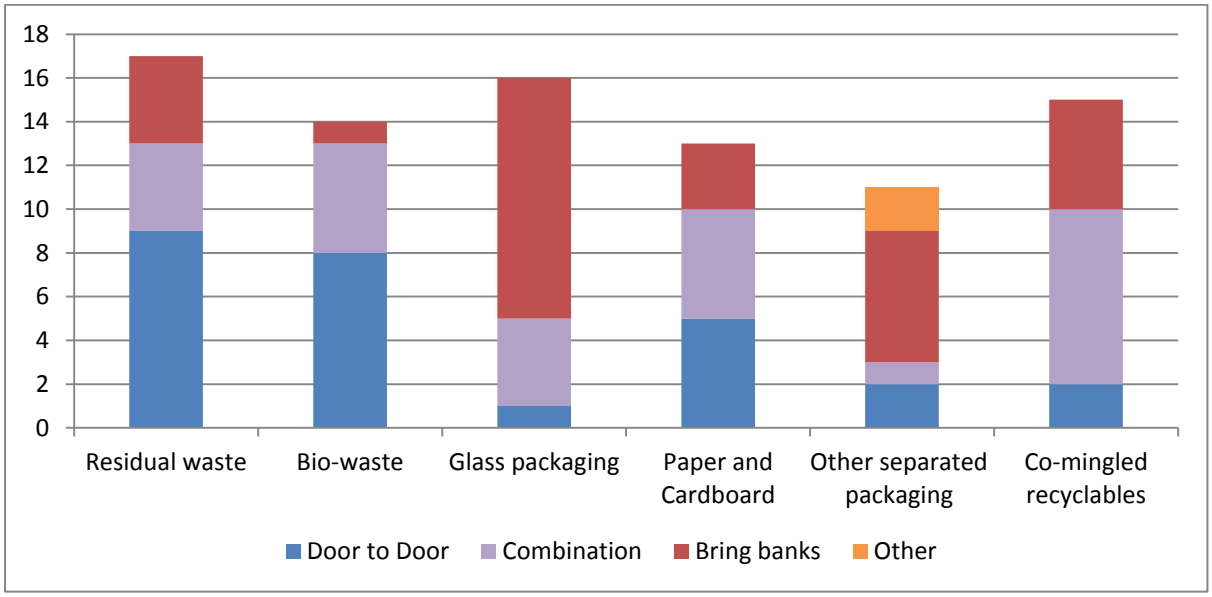


Figure 16: number of cities using the different collection modes per waste stream

Here "combination" refers to situations where several collection modes are used for the same waste stream. It usually consists in different collection modes depending on the location in the city, e.g. an underground container system in the dense part of the city and a door-to-door system in less dense areas. The "other separated packaging" refers to packaging waste separated at source (e.g. plastic bottles), while co-mingled recyclables refers to a mix of various material waste collected together (e.g. PMC systems).

Several observations can be drawn from this graph:

- **Residual waste** and **bio-waste** are mainly collected through **door-to-door** schemes;
- **Glass packaging** and **other separated packaging** are mainly collected through **bring systems** (the "other" collection modes refers here to the collection of recyclable fractions in civic amenity sites as done in the city of Odense).
- For **paper/cardboard** and **co-mingled recyclable** materials, the situations are more **diverse** and no dominant system can be identified.

The impact of the collection systems on sorting performances is difficult to measure on this panel, as presented on the following graph:

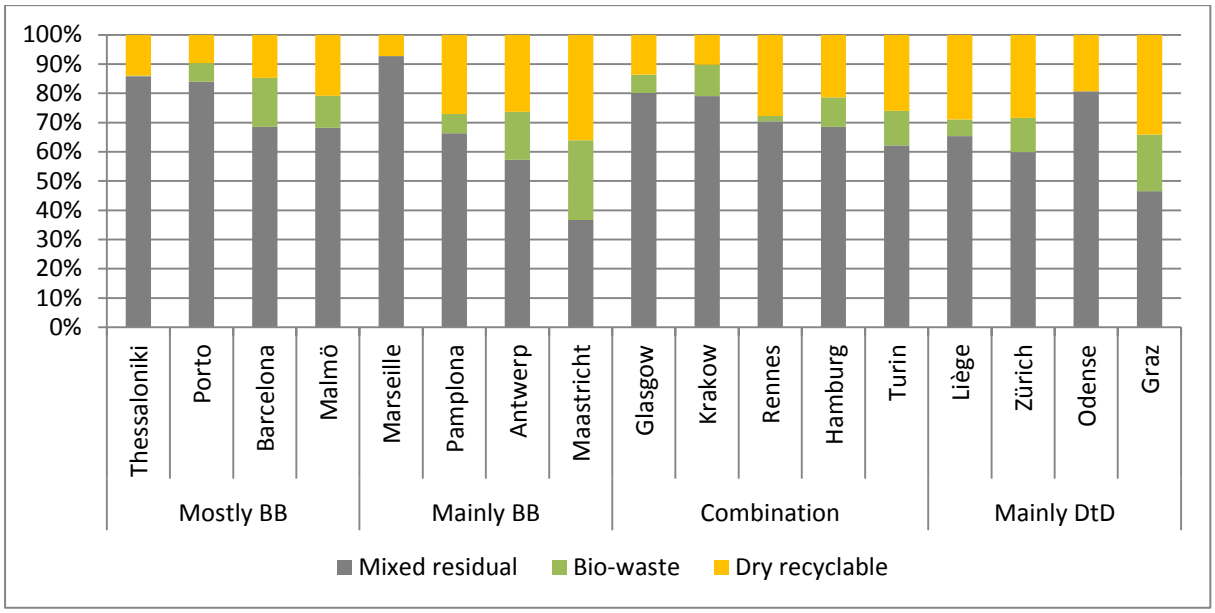


Figure 17: share of collected quantities for residual waste, bio-waste, and dry recyclables in cities sorted by collection methods (in %)

The data collected do not allow the identification of a clear link between sorting rates and collection modes. Well-performing cities can be found among cities resorting to bring banks and to door-to-door systems.

4.2.3 Bio-waste collection

This part will only focus on bio-waste collected with the "common waste", excluding collection in civic amenity sites, which is commonly used. However, this data collection did not focus on the sorted fractions in CAS (which would have required many more resources). Therefore, the quantities presented here have to be analysed with caution. Two cities out of the 17 only collect garden waste in civic amenity sites (Marseille and Odense).

The following graph shows the collected quantities of bio-waste in the 15 cities collecting bio-waste as common waste:

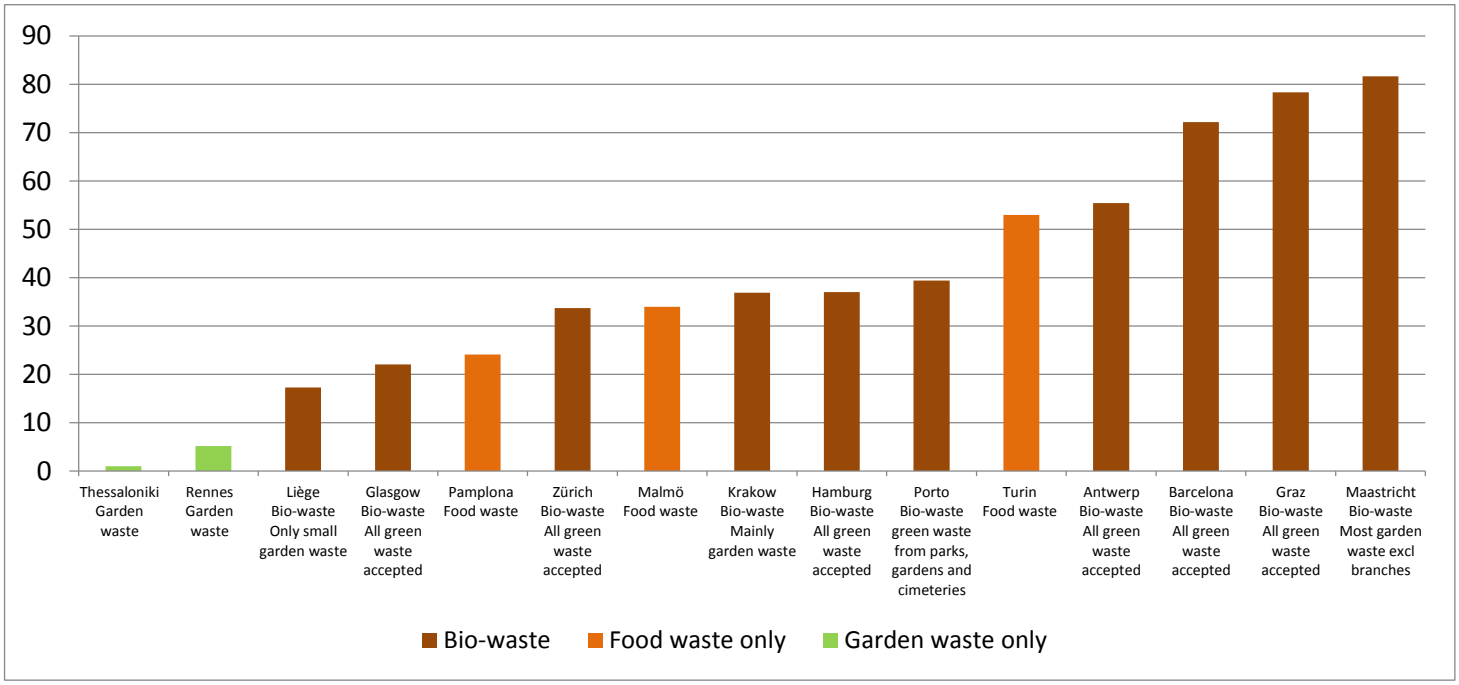


Figure 18: collected quantities of bio-waste per inhabitant (in kg/inh.)

The lower collected quantities can be found for cities organising a collection for green waste only, however it must be noted that the service is rather limited in both cities: for instance in Rennes, the service is only available to the inner city area where people have limited access to civic amenity sites. The data presented are broken down to the total population, making the quantities per capita rather small.

The cities collecting the most important quantities include garden waste in the bio-waste collection; however, Turin does reach significant collected quantities for food waste only (over 50 kg/cap/yr). It is interesting to note that collected quantities are rather heterogeneous among the panel: from 17 to over 80 kg/cap/yr. While it is difficult to provide clear reasons behind these differences, several factors might impact the quantities collected: the incentives set to promote bio-waste collection (in Liège, the bio-waste collection is voluntary, while Maastricht has set a tax on residual waste bags making bio-waste separation financially relevant to inhabitants), the inclusion of green waste, or the collection of non-household bio-waste along with household waste (in Barcelona, commercial bio-waste accounts for about 30% of the collected bio-waste).

Data on the composition of residual waste could be collected for several of the cities studied. These data consists in assessment of the average content of the residual bin based on a sample of residual waste. As explained previously, It is important to note that these data include a share of uncertainty and might not be completely comparable for several reasons: different sampling methods in use giving different levels of precision (e.g. the fine elements might be considered apart or not), different sampling categories in use, lack of data on the precise definition of these categories making it difficult to establish their exact scope… Therefore, the data presented below have to be regarded as rough estimate.

Using these data on composition analysis, it is possible to assess the collection rate of bio-waste in several cities. The results are presented below:

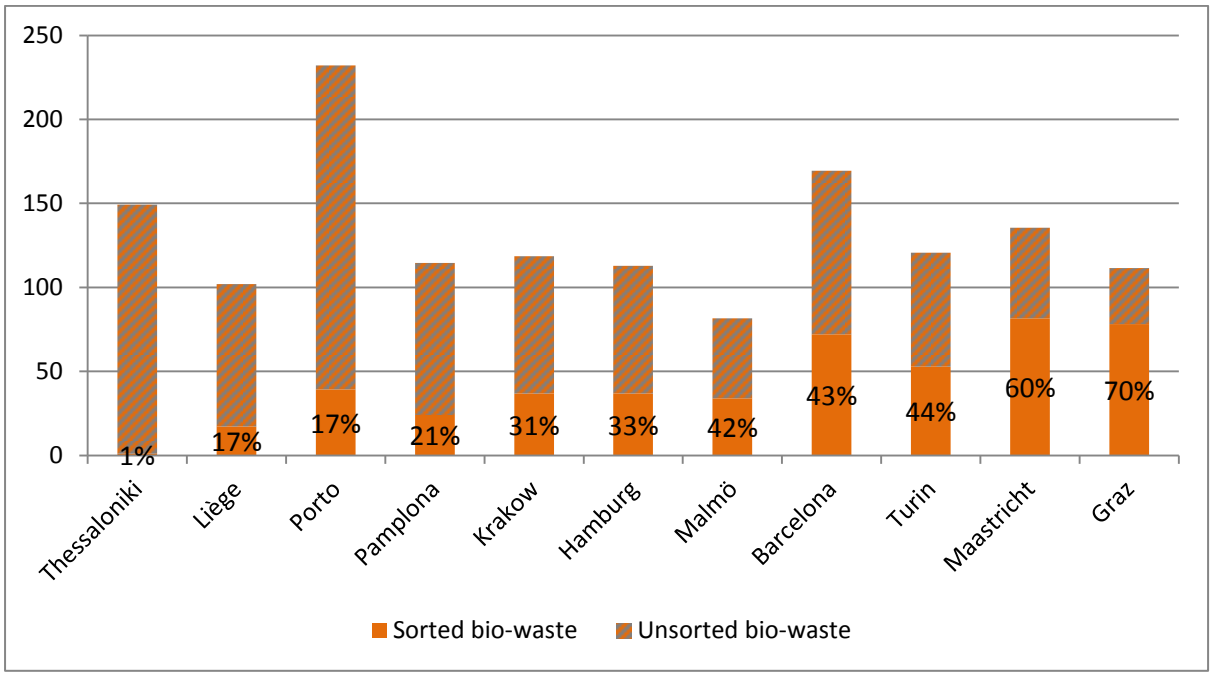


Figure 19: sorted and unsorted bio-waste in different cities in kg/cap/yr, and sorting rates. ***Unsorted quantities are assessed based on the composition analysis of residual waste and residual waste collected quantities***

There are important differences regarding the total arising of bio-waste among the cities, which can be explained by various parameters: scope of the municipal waste (e.g. share of commercial waste), different consumption patterns, presence of garden waste… The sorting performances are very diverse, ranging from 1% to 70%. It is interesting to note that cities presenting very different performances in Figure 18 like Malmö and Barcelona actually share very close sorting rates, due to a

very different total arising. Moreover, while Graz collects smaller quantities per capita than Maastricht, it actually achieves a higher sorting rate.

4.2.4 Dry recyclables

"Dry recyclables" refers to recyclable materials collected as common waste, mainly: paper, cardboard, plastic packaging, metal packaging, and beverage cartons. A seen previously, there are almost as many different sorting systems for dry recyclables as there are cities in the panel studied. The following graph shows the collected quantities per inhabitant for the dry recyclables only, stating on the considered quantities whether the fractions are collected together in one stream (co-mingled) or separately. More specifically:

- The "paper and cardboard" sections are labelled as "co-mingled" if collected together as one stream and "separated" if there is one stream for paper and one for cardboard;
- "Other packaging" mainly refers to PMC. The corresponding sections in the graph are labelled as "co-mingled" if PMC is collected as one single fraction and as "separated" if they are collected in different streams.
- The yellow sections refer to streams including paper, cardboard and other packaging waste collected all together.

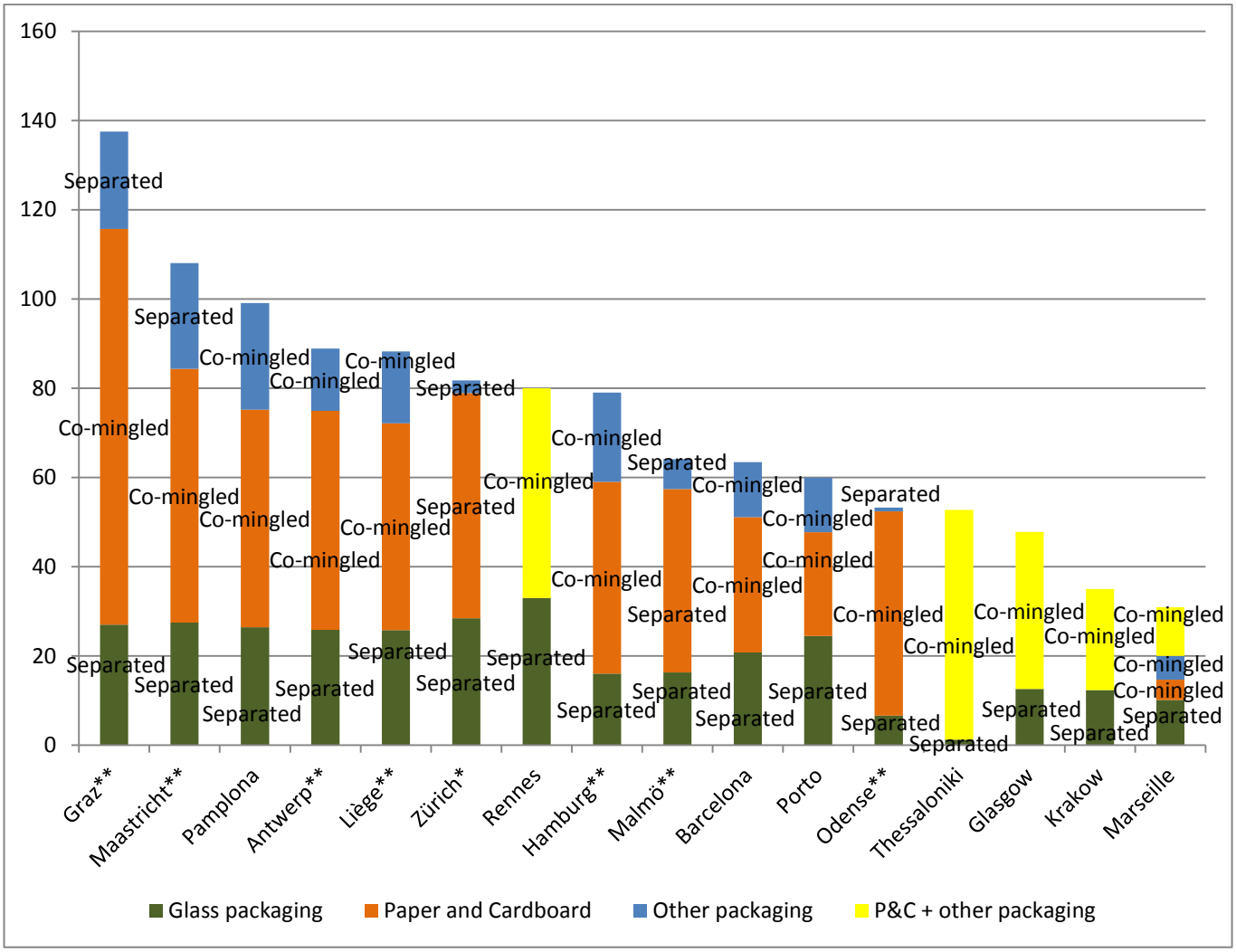


Figure 20: collected quantities per inhabitant for dry recyclables (in kg/cap/yr)

Existing deposit systems for beverage packaging

The first observation is that for most cities, paper and cardboard is the most significant stream in terms of quantities, followed by glass packaging. It is interesting to note that the cities collecting the most significant quantities of dry recyclables all separate paper and cardboard from other packaging materials. The two cities with the highest collected quantities (Graz, Maastricht) also separate other packaging at source, yet their performances are quite close to other cities collecting them co-mingled (Pamplona, Liège…). On the contrary, the cities with the lowest sorted quantities mainly operate co-mingled collection systems. Rennes is the exception here, yet it must be noted that its context might be more favourable (comparably lower population density).

An assessment of the sorting rates for dry recyclables could be identified for various cities for which a composition analysis could be identified. Considering the uncertainties on the scope of the composition analysis data for plastics (which in many cases includes all types of plastics), no data can be presented for PMC. The results are presented for glass and paper/cardboard in the following graph:

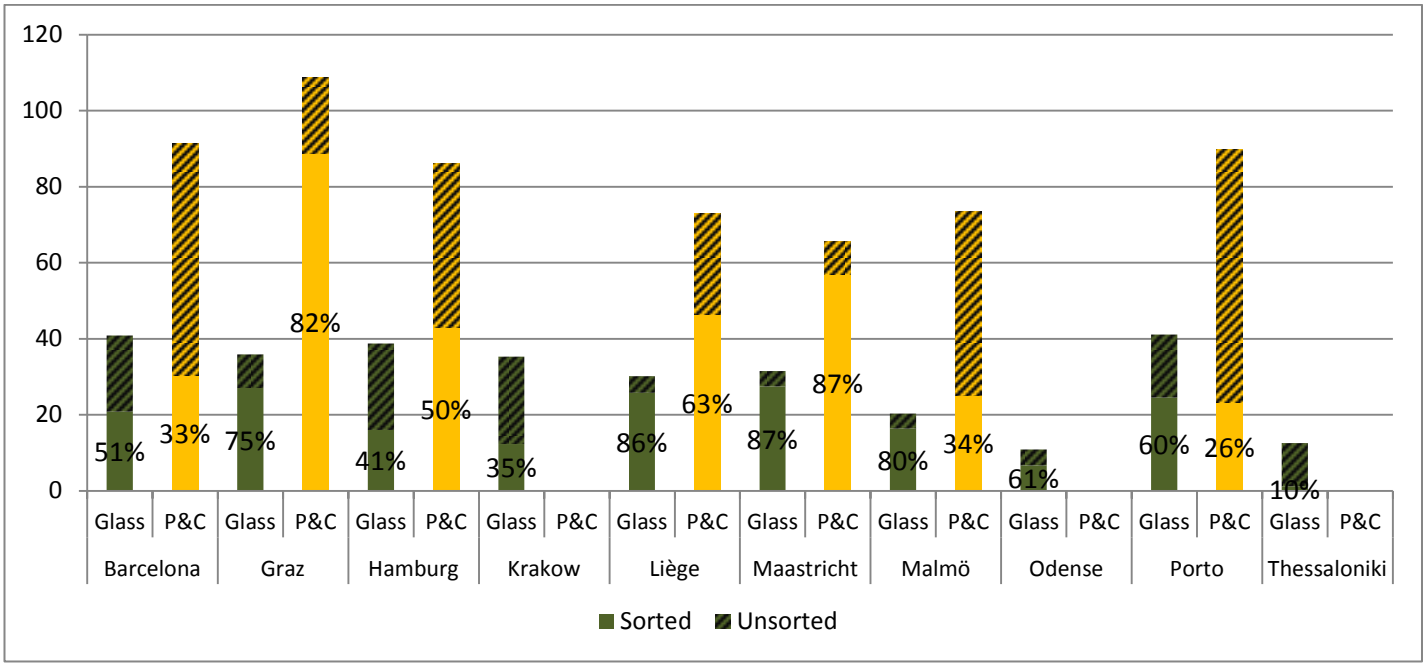


Figure 21: unsorted and sorted quantities for glass and paper/cardboard in kg/cap/yr

As it was observed with bio-waste, there are also differences when it comes to total arising. Besides differences in consumption pattern, the extent of deposit systems for beverage packaging can also explain these differences, for instance the low quantities of glass in Malmö and Odense. In many territories, the sorting rates are consistent for both material fractions. In several cities (Liège, Malmö, and Porto), sorting rates for paper and cardboard are much lower, yet part of the cardboard might be collected in civic amenity sites, so the actual sorting rates could, in fact, be more important.

Data were collected on the **sorted quantities**, including both material fractions separated at source and outputs of sorting centres, which is equivalent to the "**DREC** quantities". These sorted quantities differ from the collected quantities since all sorting operations lead to a certain loss, due to both impurities in the comingled streams and technical limitations of the sorting plants. In sorting centre, these impurities are designed as "sorting residues" and sent to incineration or disposal. Several limitations linked with the quality of the collected data must be stated before presenting the data:

- Several cities were unable to provide data on sorted quantities, e.g. on the division of co-mingled fractions into sorted materials, or on the sorting residues;
- Impurity rates for fractions collected at the source were not always available or reported as small. In many cases, the final sorted quantities of paper and cardboard were reported as identical to the collected quantities due to a lack of information.

The comparison of collected and sorted quantities for each city is presented on the following graph:

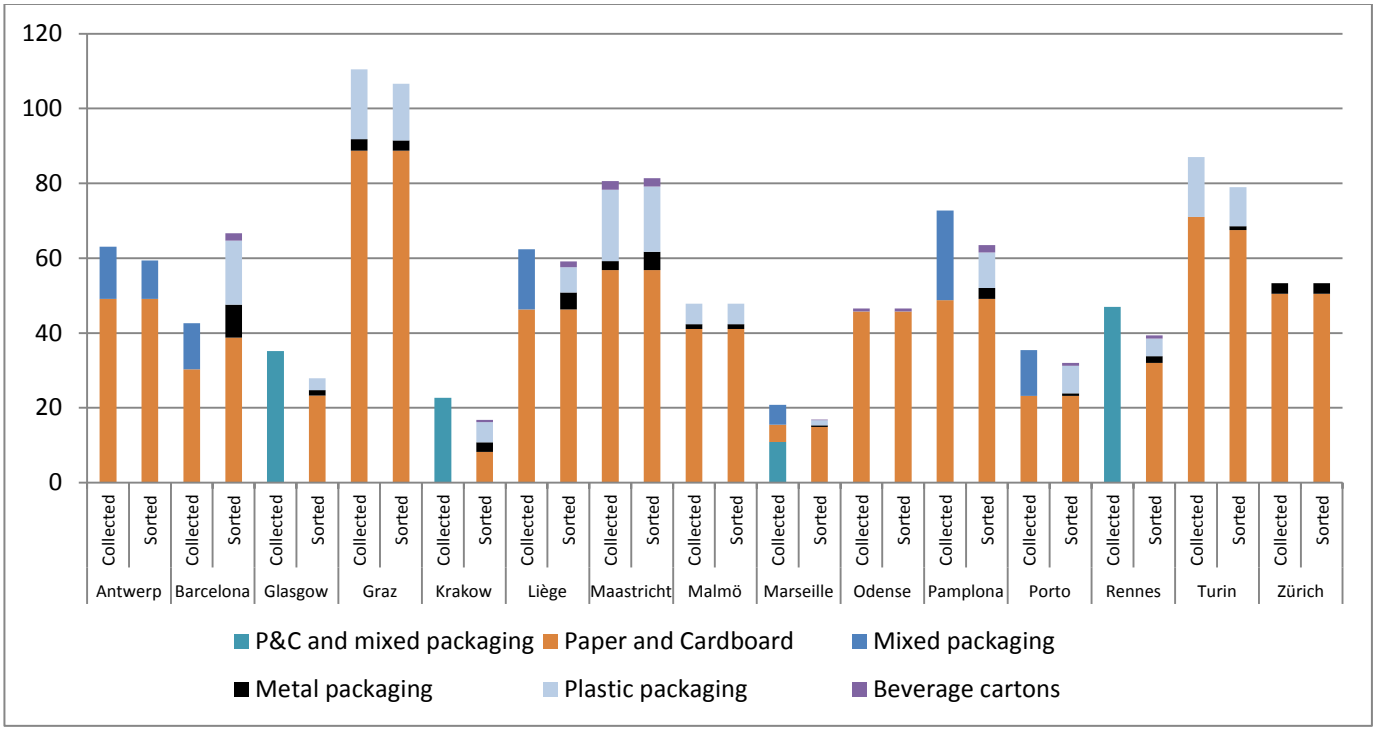


Figure 22: collected and sorted quantities for P&C and PMC for the different cities, in kg/cap/yr

The graph leads to several observations:

- "Paper and cardboard" represent a significant fraction of the sorted materials from co-mingled collection systems;
- Plastic is the most significant fraction from PMC for most cities. For Zürich, no data is available for plastics, since their collection is a national scheme;
- While sorting losses can be observed for almost every city, it is not the case for Barcelona. The reason behind the increased quantities after sorting comes from the treatment of residual waste in MBT units extracting materials, as well as the pre-treatment of bio-waste prior to anaerobic digestion, during which recyclable materials are also extracted.

It is possible to compare loss rates for all dry recyclables (excluding glass, which is mostly separated at source). The following graph shows the different loss rates according to the level of source separation:

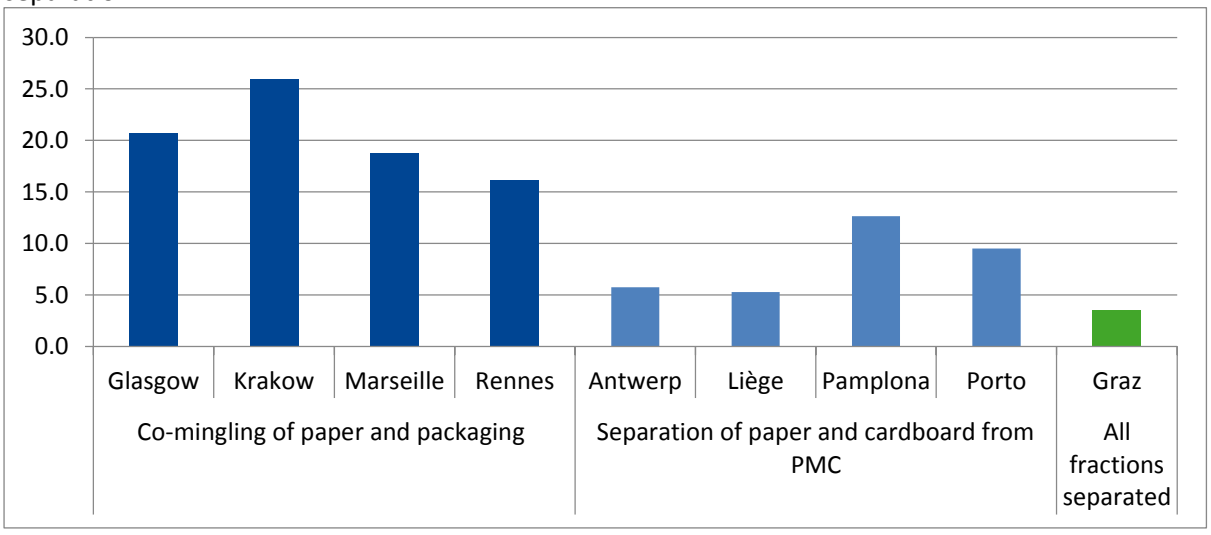


Figure 23: loss rate for dry recyclables (excl. glass) in %, according to separation systems

Unsurprisingly, more separation at source leads to lower loss rates. This is mainly linked to the fact that the reported loss rate for paper and cardboard is generally low, coupled to the fact that P&C accounts to most of the dry recyclables quantities. The comparison of loss rates and mode of collection tends to show better results for cities with door-to-door systems, yet the panel of cities for which workable data are available is not sufficient to make this observation statistically relevant. Besides, one city (Antwerp) achieves a rather overall low loss rate while resorting partly to bring banks. It seems that the method of separation and especially the separation of P&C from PMC is the main parameter impacting the general loss rate.

It is also interesting to note that the loss rate for PMC is quite significant for the cities for which this data is available and quite comparable to the loss rates for co-mingled systems, as presented in the following graph:

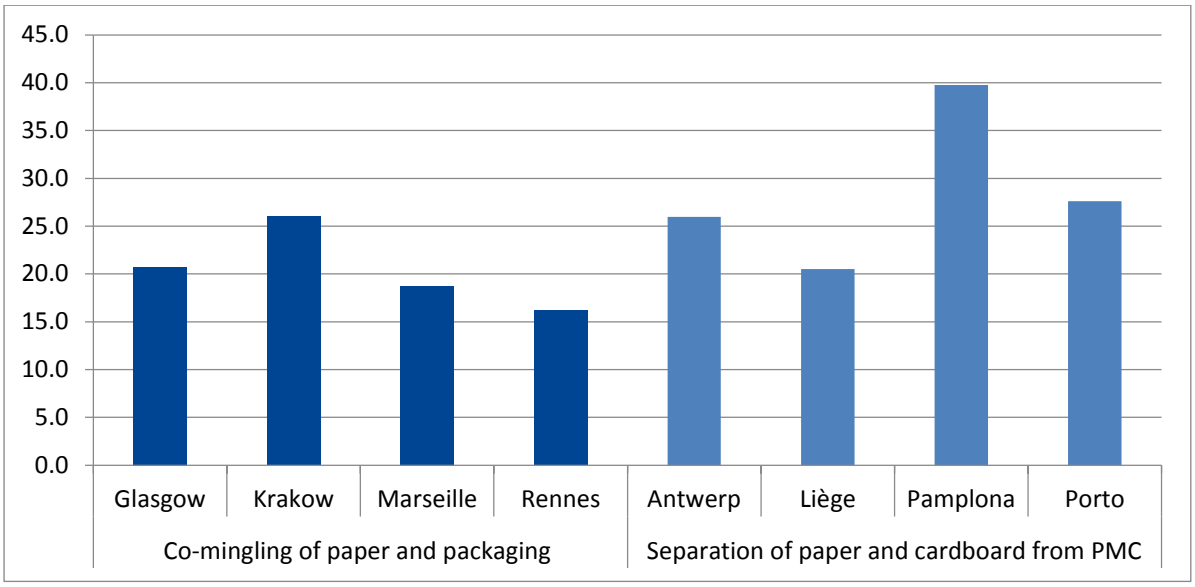


Figure 24: loss rates for PMC and for P&C+PMC (in %)

In average, the loss rates for PMC collection streams for which data are available are actually higher than the ones for co-mingled collection streams.

4.2.5 Sorting performances and external factors

Sorting performances were compared in parallel with several parameters, such as population density, average household size, or tourism. No clear link between the observed sorting rates for common waste and these contextual factors could be identified. It is likely that the panel is too small to observe relevant trends.

4.3 Other waste management

Data were collected on "other waste" management, i.e. all waste which, due to its property (hazardousness, bulkiness…) is not managed with common waste. To facilitate the process of data collection, only a limited list of data was collected from cities:

- **Collection of bulky waste** outside of civic amenity sites (e.g. collection on the kerbside or on demand): type of collection and associated collected quantities;
- **Civic amenity sites**: number of inhabitant per CAS, number of sorted fractions, collected quantities for sorted fractions (regardless of whether they are sent to recycling or not) and mixed fractions (i.e. mixed bulky waste, mixed combustible, and/or mixed incombustible).

It is important to keep in mind that part of the "other waste" is not included in this study, e.g. WEEE collected in shops or textiles collected in specific bring banks.

4.3.1 Collection systems for other waste

All cities studied here resort to civic amenity sites, to various extents: from one civic amenity site per 23,700 inhabitants in Odense to one per 381,000 inhabitants in Krakow. All cities also resort to other collection systems for bulky waste: the most commonly used is “collection on demand”, used by all cities but one. This consists in giving the possibility for inhabitants to request a specific collection (by phone or through a web portal), for which they might be charged. Five cities also propose kerbside collection with a periodical collection. Finally, four cities also propose other specific collection systems (small collection points, specific containers for areas with no CAS, punctual collection points set near housings for people to dispose of their stored other waste…).

Mobile civic amenity sites are also used by several cities. These collection points are implemented in several areas during a short timeslot (half a day to a full day) and on regular basis (e.g. once a month). One unusual practice is the Cargo-Tram set in Zürich, which consists in a Tram carrying containers where inhabitants can dispose of their waste for free. The Tram makes 18 round trips every month with 9 stops.

4.3.2 Collected quantities

The data collected on other waste collection are presented below:

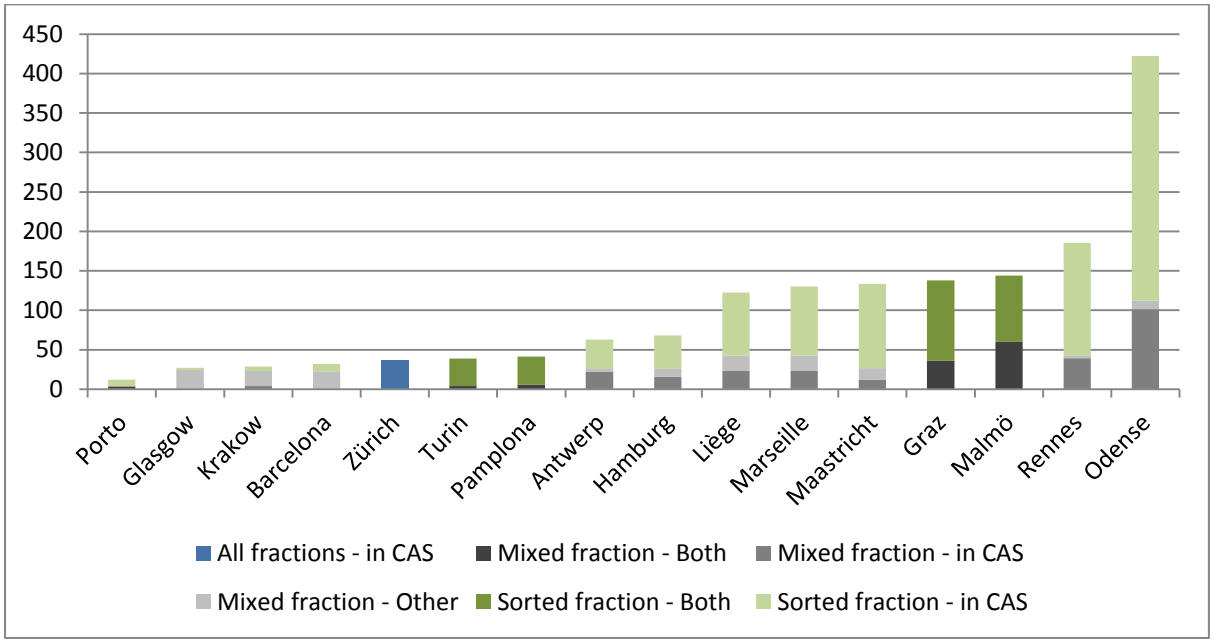


Figure 25: collected quantities of other waste in kg/cap/yr

The detail of information is different from one city to another. For some of them, it was not possible to have a distinction between other waste collected in CAS or through other means. For others, the share of mixed waste and sorted waste could not be reported.

There are important differences between the collected quantities of other waste in the cities, ranging from 20 to over 400 kg/cap/yr. The most significant quantities are collected in civic amenity sites, with important sorting rates. The cities collecting smaller amounts per inhabitant mainly resort to bulky waste collection, with smaller sorting rates.

4.3.3 Civic amenity sites

Civic amenity sites are an effective way to improve waste sorting. The following graph shows the total mixed quantities and the total sorted quantities in parallel with the number of CAS per inhabitant as well as the share of other waste collected in CAS.

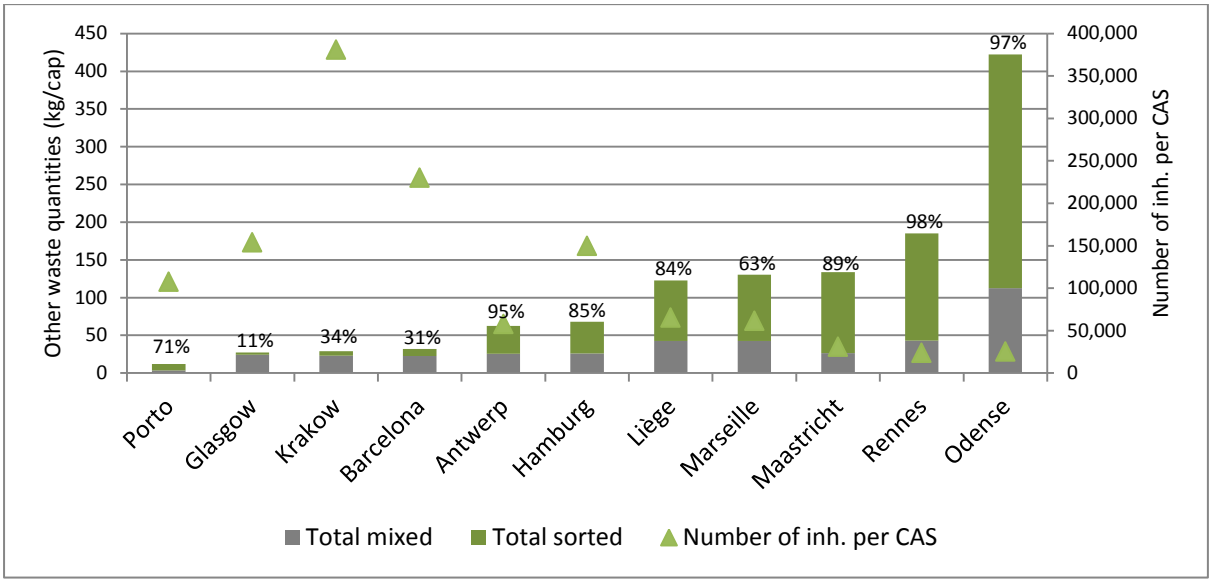


Figure 26: sorted and mixed other waste quantities (in kg/cap/yr), the number of CAS per inhabitant, and the share of other waste collected in CAS compared to the total quantities of other waste (in %)

The cities collecting the most significant quantities of other waste also achieve the most significant sorted quantities; it is interesting to see that they share two main elements compared to the cities where quantities and sorting rates are lower:

- An important number of CAS per inhabitant;
- A significant share of other waste collected in CAS (i.e. a very little share of "other waste" is collected on demand or on the kerbside).

However, it is important to state that the cities presenting the better performances for other waste are generally less dense (both Odense and Rennes have a population density below 700 inh./km²) while some of the cities performing less well present a comparatively high density (Porto: 7,000 inh./km², Barcelona: 16,000 inh./km²), thus limiting the possibility to implement a CAS network.

Data were collected on the sorted fractions for the cities among the ones with the most significant quantities. They are presented in the graph below:

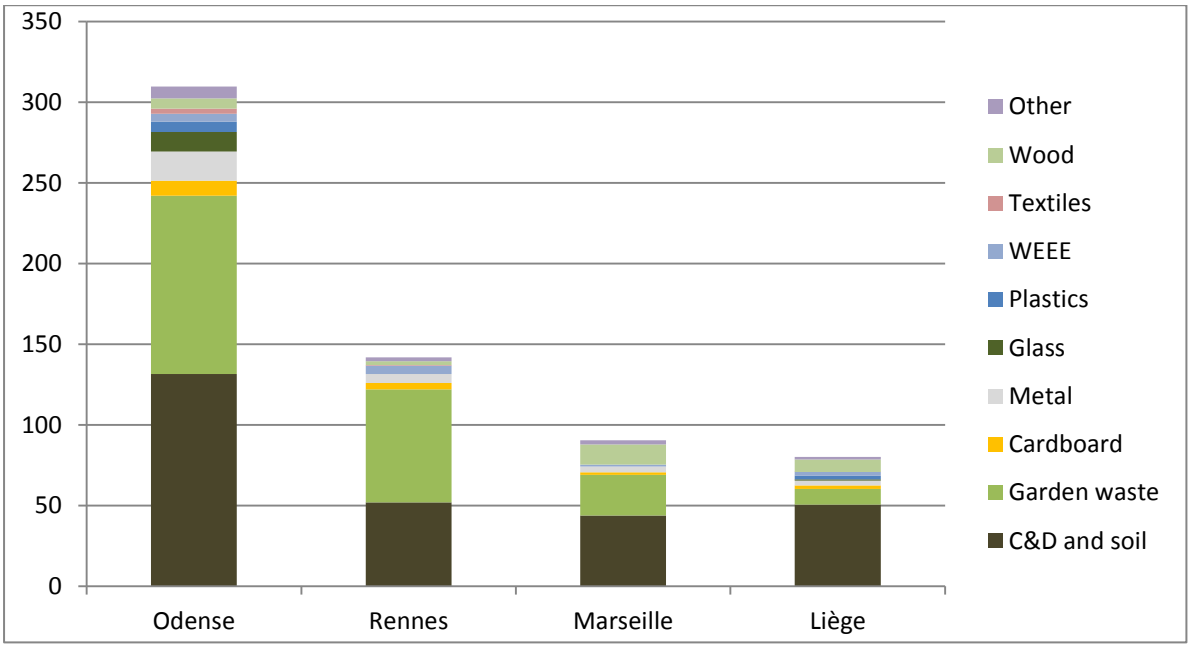


Figure 27: main sorted fractions in the CAS of 4 cities (in kg/cap/yr)

It is interesting to note that the most significant fractions are common for these 4 cities: construction and demolition waste and garden waste. Both Odense and Rennes have no or a very limited collection scheme for bio-waste as "common waste", which partly explains the differences with other cities. As for C&D waste, the possible share of commercial waste might explain some differences: for instance, Odense accepts waste from small companies in its CAS, which might not be the case in other cities.

No detailed data could be identified regarding the share of commercial waste in other waste; it could partly explain the differences in collected quantities. Marseille provides specific collection points of business "other waste" and reports the associated quantities in its annual report. These quantities are not included in the data presented in this report, yet they provide an assessment of the potential share of commercial other waste. About 47 kg/cap/yr of commercial waste were collected on these platforms, representing 30% of the total "other waste". The main fractions are also C&D waste and garden waste.

4.3.4 Bulky waste collection

The various bulky waste collection methods were previously mentioned. Few data were collected on bulky waste collection beside the modes of collection and the collected quantities. These quantities are presented in the graph below, along with other information:

- The collection systems: is kerbside collection available or is there only the collection on demand?
- The number of CAS per inhabitant (green triangles);
- Existing fee for bulky waste collection (yes/no). The fee can be applied for any type of waste or only for specific fractions.

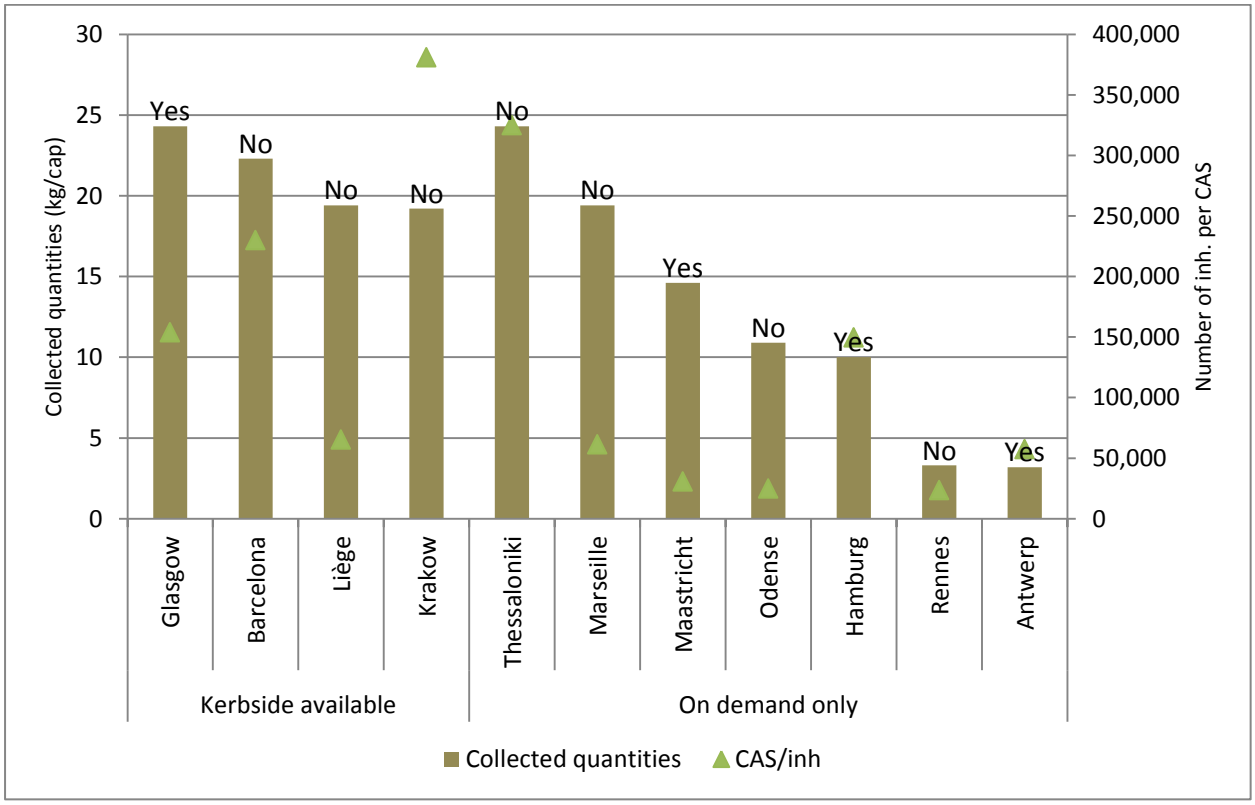


Figure 28: collected quantities of bulky waste outside of CAS (in kg/cap/yr), number of CAS per inhabitant and presence of a charging system for bulky waste collection (yes/no)

There seems to be a correlation between the collected quantities and these different parameters. The cities with the lowest collected quantities either propose a high density of CAS, have no periodic, kerbside collection for bulky waste, and/or dispose of a paying collection system.

4.4 Waste separation and financing systems

The cities have set very different systems to charge for the collection service. Usually, different systems apply for household and non-household waste; in some cases commercial activities can use the municipal service with the same financing system if their waste generation is below a given limit. In other cases, commercial activities have to contract a waste collection service and can either choose the public waste company or another private company.

To compare the sorting performances with the financing system, the cities were sorted depending on how incentivising their system is for waste producers:

- **None**: waste fees are not related with waste production (neither for household nor for commercial activities). It is either a fixed tax or a fee based on the size of the household or of the housing;
- **Only on other waste**: there is no PAYT for common waste. Part of "other waste" collection is covered by a PAYT system (either the bulky waste collection on demand or the acceptance of specific fractions in CAS);
- **Commercial waste**: the PAYT system is only applied to non-household producers using the municipal system;
- **All**: all waste producers are subject to a PAYT system for common and other waste.

The share of unsorted and sorted fractions for the different cities is presented on the following graph, with the cities sorted according to the degree of incentive of their financing system:

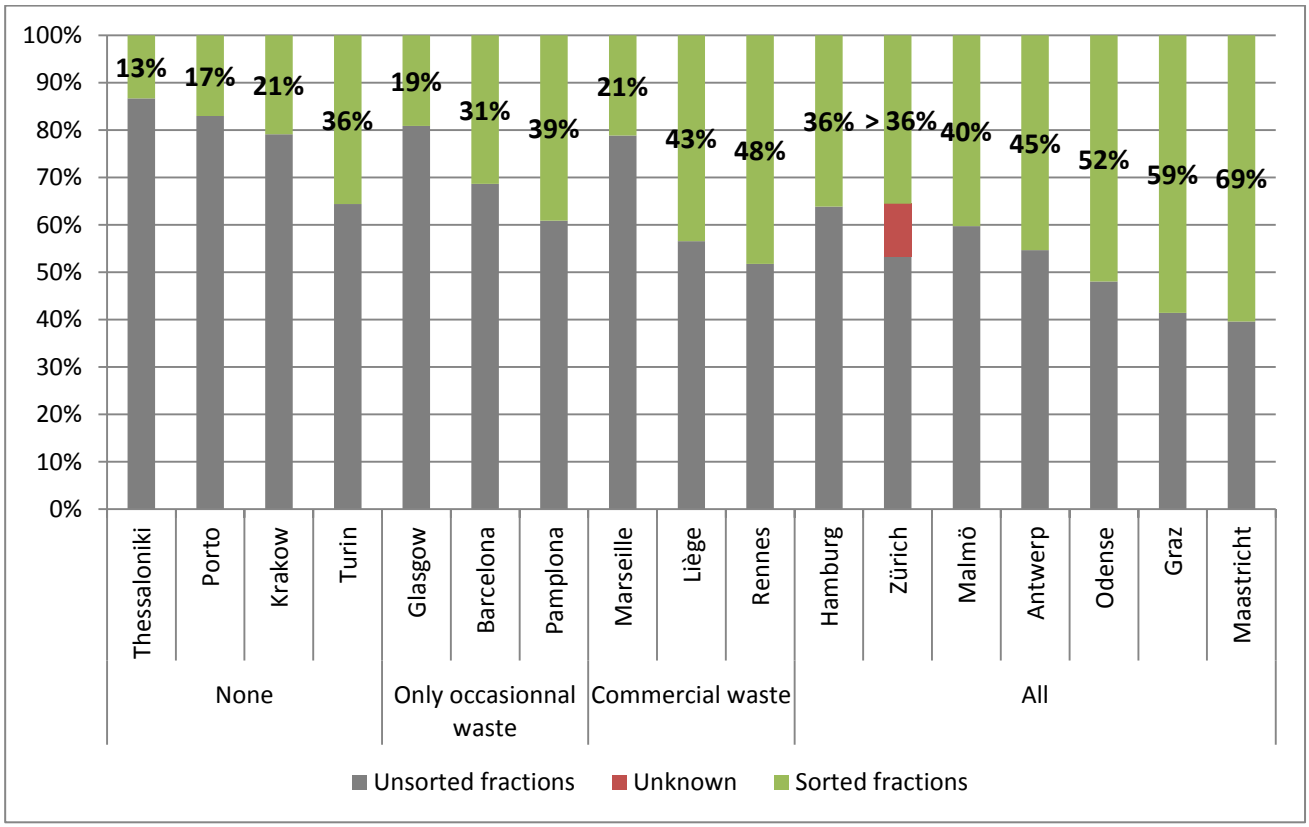


Figure 29: sorting rates (total municipal waste) according to the financing system (%)

The graph shows that the cities with the highest sorting rates all resort to a PAYT system. However, it must be noted that several cities achieve significant sorting rates without a full PAYT system, such as Rennes.

4.5 Waste treatment

Data were collected on the final destination of municipal waste. The level of details obtained is different depending on the cities, thus making comparisons challenging. For instance, the quantities of inert waste treatment are sometimes available while for other cities they are not, and these quantities might be reported as “landfilled” or “recycled” depending on the local reporting system. The data used here are either provided by the city or assessed based on the available data on sorted material and on civic amenity sites.

The collected data are presented on the following graph, where inert waste treatment quantities are excluded:

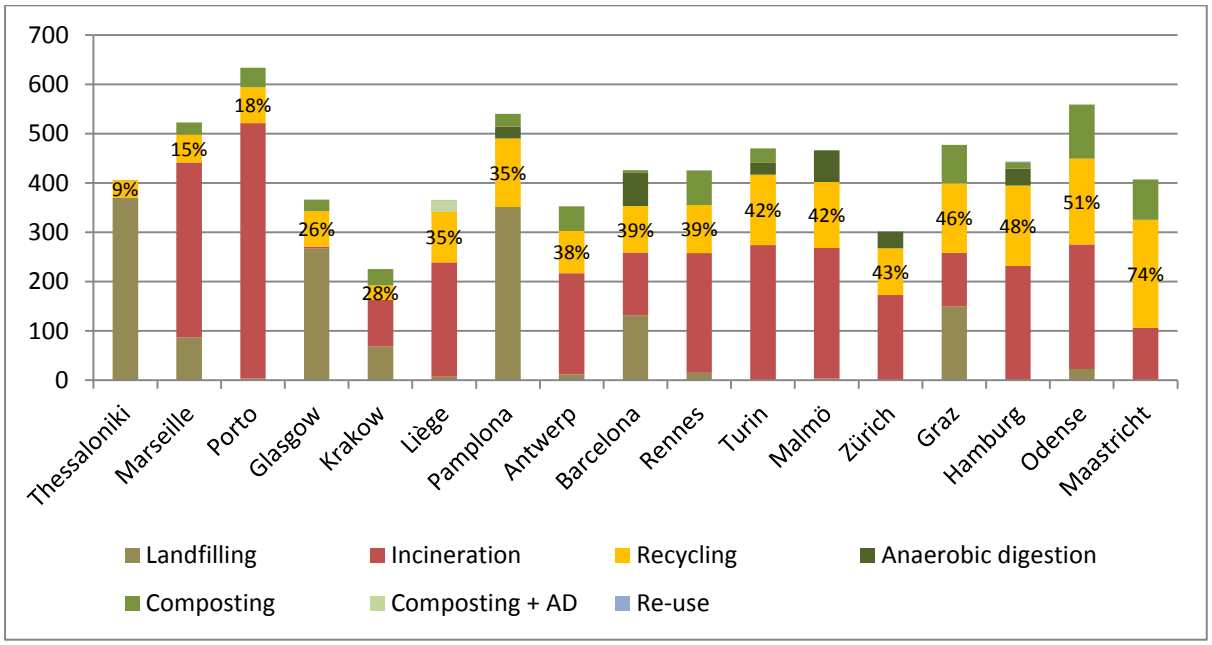


Figure 30: treated quantities of municipal in kg/cap (excluding inert waste treatment), sorted by recycling rate

The figure shows that most of the cities recycle between 35 and 50% of their municipal waste. Maastricht displays quite impressive performances compared to the rest of the panel, mainly due to its material recycling quantities. However, it is likely that parts of the recycled quantities are inert waste recycling, which is not included in the data presented in Odense. Considering Odense’s inert waste treatment as recycling would increase its recycling rate to 60%. There is no clear trend for disposal options. Landfilling tends to be very limited in the cities with high recycling rates while landfilling is more commonly found in cities with lower performances, but exceptions can be found in both cases.

It is interesting to compare sorted quantities with recycled quantities. Since significant parts of the sorted quantities can also be sent to inert waste treatment, the associated quantities are also displayed. The following graph presents the quantities sorted as common waste and in CAS in parallel with the recycled quantities (including organic recovery) and inert waste treatment:

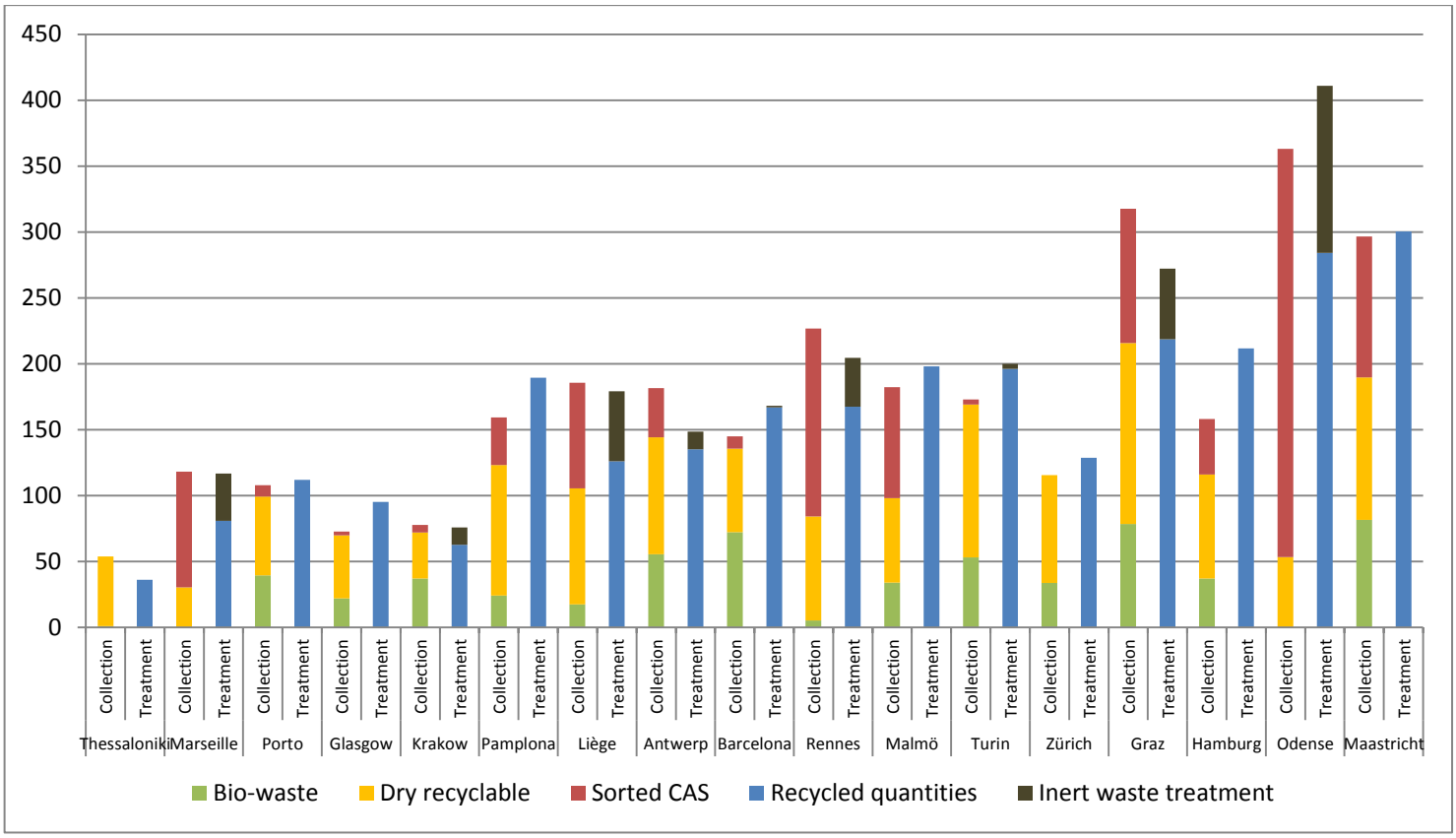


Figure 31: sorted and recycled quantities in kg/cap/yr. The cities are sorted according to the recycling rates as presented in the previous graph.

Unsurprisingly, recycled quantities and sorted quantities are closely linked. The differences between "sorted" and "treated" quantities can be explained by various reasons:

- Co-mingled materials are then sorted in sorting centres where part of them is discarded as sorting residues (due to impurities in the collected fraction or limitation of the sorting processes);
- The sorted quantities does not include fractions collected outside of "common waste "or civic amenity sites, i.e. recyclable materials extracted from mixed bulky waste in bulky waste sorting centres as well as specific collection schemes (textile bring banks, collection in shops…);
- Some cities resort to MBT for residual waste, where further quantities can be extracted and sent to recycling.

The reasons behind high recycled quantities vary for each city. For some of them, civic amenity sites play a significant role compared to common waste collection (Odense, Rennes). For other, high performances are achieved thanks to the combination of collection of dry recyclables, bio-waste, and in civic amenity sites (Maastricht, Hamburg, Graz, Malmö).

Finally, data were collected regarding the cost of landfilling and the landfill taxes in the different Member States[4]. While these data might not reflect the actual price at local level, it can give hints regarding the costs of waste disposal. The share of recycling, incineration and landfilling is presented on the following graph along with the average landfill tax and landfilling cost and the existence of a landfill ban (y/n):

[4] CEWEP, 2017

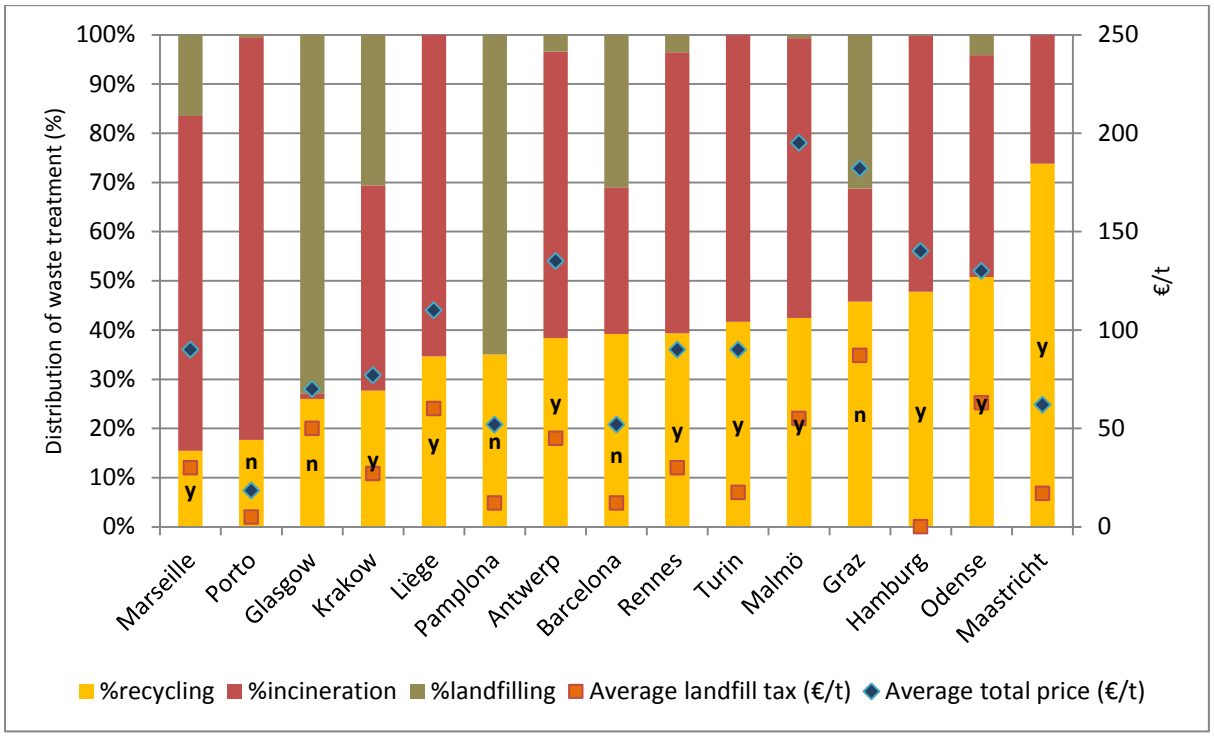


Figure 32: percentage of recycling, incineration and landfilling and national landfill tax and cost (in €/t)

The cities with higher recycling rates are generally located in countries with a high landfill tax/cost and/or a landfill ban.

4.6 Similarities and differences

Despite the very heterogeneous practices identified in the different cities and the difficulty to ensure consistent comparisons, it is possible to find some common good practices shared by the cities with the highest recycling performances:

- **Source separation** seems to be the key to high recycling performances. The most advanced cities all rely on the following systems:
  - Selective collection of **paper and cardboard**, separated from the other fractions;
  - Effective separation of other waste in **civic amenity sites**, allowed by a dense network of CAS and a limited collection of bulky waste on demand;
  - Effective source separation of **bio-waste**.
- A PAYT system for part or all of the waste.

On the contrary, the cities with lowest performances mostly use comingled collection for paper, cardboard and packaging, have a limited bio-waste separation system and a limited civic amenity site network, limiting the possibilities of source separation.

When it comes to common waste separation, high performances can be attributed to mainly 3 fractions: paper and cardboard, glass, and bio-waste. Bio-waste is generally collected in door-to-door systems. For dry recyclables, it is interesting to note that there is no clear correlation between sorting rates and the collection mode (door-to-door or bring banks), well-performing cities resorting either to door-to-door or to bring bank systems.

Many other parameters can explain the performance differences, which could not be investigated for this study: communication, coverage of the different selective collection systems, quality of the collection service provided, frequency of collection, etc.

Conclusions

The report confirms previous observations made during the R4R project: high recycling performances are closely linked with an effective collection of bio-waste and paper/cardboard, as well as a dense network of civic amenity sites and pay-as-you-throw schemes. The cities presenting high performances all rely on source separation and at least partly to financial incentives, while the cities with lower performances generally resort to co-mingled collection and have set little to no economic instruments.

Other factors are known to be essential but could not be covered here: communication, coverage and convenience of collection schemes, collection frequencies… These factors could also explain some of the differences.

The report also highlights the fact that consistent and meaningful comparisons can only be achieved if there is a proper understanding of:

- The **local context**, especially any external factor that can affect waste generation and composition (tourism, typology of housing…);
- The **exact scope of data** and the associated waste management practices, especially the inclusion of commercial waste in common waste collection and in civic amenity sites;
- The **total arising** of the different fractions thanks to composition analyses, allowing to put collected quantities into perspective;
- The different steps from collection to the sorting of materials in homogeneous fractions, allowing the exclusion of sorting residues from recycled quantities.

ACR+' waste database will be continuously improved with new datasets and more detailed data, so that the analyses presented here can be fine-tuned and expanded to more territories, following this general approach.

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