How to best collect bio-waste

Guidance for municipalities on the best performing methods to separately collect bio-waste

ZERO WASTE EUROPE

For EU member states, the issue of organic waste is becoming increasingly important and for most, quite alarming. Whilst capture rates for organics remain low across most of Europe, municipalities are having to identify plans and solutions due to the impending deadline for EU member states to mandatory separate and collect organic waste with municipal solid waste (MSW) management systems.

How exactly to best collect organic waste, which is both food and garden waste, given its complexity, is still being debated around much of the continent. This short paper, which predominantly focuses on food waste as the biggest challenge in the near future, aims to showcase data that proves how door-to-door collection models for separated organics provide the best results in terms of both quantity of material collected and the quality (low-contamination) of such bio-waste. **The paper will highlight the vastly better results that door-to-door delivers in comparison with other models that are increasingly seen as progressive solutions, such as open or locked street containers.** In reality, while these methods may initially be cheaper, they deliver poorer results that do not align with required targets and lead to greater costs in the mid to long term.

This guide will help answer one of the most problematic and recurring questions that European municipalities have - how to improve and maintain their bio-waste collection system to ensure it aligns with the mandatory targets set out in EU legislation. With a required target of recycling 65% of municipal waste by 2035, EU member states know that this goal will not be achieved without an effective collection system in place for bio-waste. This guide will provide key details and evidence on how to establish such high-performing systems in a range of contexts.

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Context

The main policy driver for management of bio-waste at the EU level is the revised Waste Framework Directive (WFD) which mandates bio-waste collection from 1 January 2024 onwards.[1] Article 22 of the WFD also determines that member states shall take measures to "encourage the recycling of bio-waste, including composting and digestion; to encourage home composting; and to promote the use of materials produced from bio-waste".

Furthermore, another mandatory target included in the 2018 revision of the WFD is the goal of having 65% of municipal waste collected and prepared for reuse and recycling by 2035. Achieving this goal will not be possible unless bio-waste is collected effectively. Therefore, the main objective of this guide is to show which collection systems for bio-waste provide the best results, both for quality and quantity, as local and national decision-makers consider their options ahead of the 1st January deadline for mandatory collection.

Within the European Union, the proper collection and treatment of bio-waste remains at low levels, currently around 16% of the theoretical potential, while in 2021 the majority of municipal solid waste was still incinerated or landfilled.[2] Not only is this resulting in vast amounts of unnecessary waste, the combination of organics remaining in landfills is also significantly contributing to climate change via methane emissions, a powerful Greenhouse Gas (GHG) that traps 82.5 times as much heat as CO_2 over a 20-year timespan. Furthermore, composting collected bio-waste is a proven methodology for tackling climate change and building healthy soils, vital for the health of our planet. At the global level, since 2018 the EU has aligned itself with the United Nations' Sustainable Development Goals, with the bloc's objective to reduce food waste by 30% by 2025 and 50% by 2030.

[1] "In order to avoid waste treatment which locks in resources at the lower levels of the waste hierarchy, to enable high-quality recycling and to boost the uptake of quality secondary raw materials, member states should ensure that bio-waste is separately collected and undergoes recycling in a way that fulfils a high level of environmental protection and the output of which meets relevant high quality standards". Directive 2008/98/EC [7]
[2] Eurostat 2021 municipal waste statistics
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Municipal_waste_statistics

What is bio-waste?

As defined in EU regulations, “bio-waste means biodegradable garden and park waste, food and kitchen waste from households, offices, restaurants, wholesale, canteens, caterers and retail premises and comparable waste from food processing plants”. It is often referred to as organic waste given its natural link to the earth through its natural creation and its ability to be given back to the soil.

When working with cities to implement bio-waste collection systems, any prior discussions should focus on prevention. Food waste prevention systems are necessary and critical at the local level given the unique role cities play within the supply chain. Municipalities can stimulate change directly - through initiatives found within public procurement tenders, public canteens or municipal markets - and they can influence the system indirectly through initiatives to support peri-urban agriculture practices and to help reduce local citizens' consumption of food.

However, there will always be some food scraps to be collected, which are unavoidable residues from food preparation - for instance, fruit and vegetable peels. Therefore, effective bio-waste collection systems are fundamental, as well as strategies for its treatment. Given the fermentability, harsh smells, and holistic consumption of food waste (not everyone has a garden but everyone eats), food waste is often the priority for municipalities within their bio-waste system.

Image 1: Food Waste, Stock Images

The benefits of bio-waste separate collection

The benefits of having a high-performing collection system for bio-waste are numerous and far-reaching. These range from a reduction in GhG emissions and improved soil health to operational improvements in the wider waste management system, and to opportunities that bring together members of the community such as community composting.

Starting with the **environmental benefits**, the most recent studies estimate that **source-separated collection and the effective treatment of organics can reduce methane emissions from landfills by 62%, even with moderate ambition.** Given the potency of methane emissions, this is a critical prevention step we can and should be taking to reduce the risks posed by climate change over the coming decade. Furthermore, once bio-waste is collected, it can then be used for composting, with the most effective collection systems producing the most effective compost. This helps bring several environmental benefits, from storing more carbon in soils and fighting desertification to making soils more resilient against floods, landslides, and eutrophication - all of which play a significant role in mitigating the risks of climate change.

However, effective bio-waste collection is not only key for environmental matters and to achieve highest material recovery rates, but also for an **operational reason.** With more bio-waste separately collected, less will subsequently be found in the other waste streams, having a hugely positive impact on waste collection as a whole in two main areas. First, collecting bio-waste separately leads to a reduction in residual (i.e. mixed, non-recyclable) waste and thus opens up the possibility of collecting residual waste less often, especially as the waste will be less contaminated with food scraps and, as a consequence, less smelly. Reducing the frequency of collection rounds not only leads to better performing zero waste systems (see below), but also to cost-optimisation and smaller budget needs for municipalities. Second, there will be less contamination by food scraps in other dry recyclables streams if bio-waste is effectively collected separately. With dry recyclables (such as plastic and paper) less contaminated with food waste, materials remain at a higher quality and are much more likely to keep their value (price) on the recycling market. In turn, this can lead to greater revenues generated by the city.

The bio-waste stream is entirely manageable at all scales at the local level, from collection to treatment. It does not depend on any industry and does not involve high transport costs. Communities can be more autonomous in the management of their food waste and reduce their dependence on disposal facilities, the costs of which are always higher.[3]

There are also several social benefits from separately collecting bio-waste, predominantly through composting. Collection of bio-waste at source not only helps to increase awareness about food waste on households, but it also makes for good-quality compost material as a result - for example, there are much lower quantities of plastics and paper found in the composting process. Treatment through composting also creates new green jobs - almost 4 times as many per 10,000 tonnes of waste generated compared to incineration and landfill; whilst community compost sites help to connect the community and bring about greater local social cohesion and togetherness .

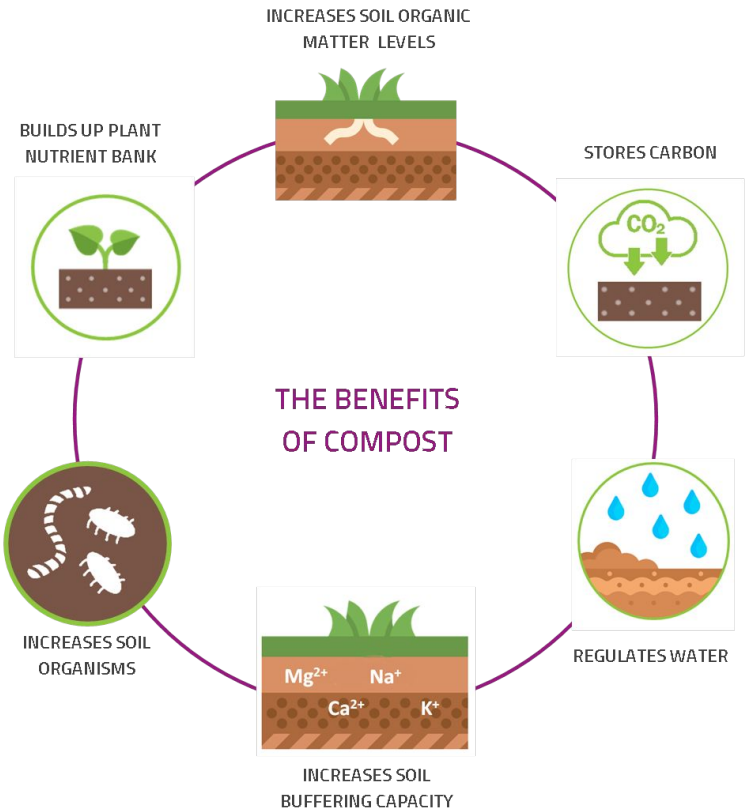

Image 2: Improving soils with compost, European Compost Network

[3] Compostplus. La Collecte Séparée Des Biodéchets, Une Solution d'avenir . http://www.compostplus.org/wp-content/uploads/2018/03/Guide-CompostPlus_200112_WEB.pdf.

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Best ways to collect bio-waste

In this section, we identify the best ways to collect bio-waste, while also pointing out what kinds of cities within the European context are best suited for each methodology. It is, however, important to first examine the intricacies of a system that effectively manages both food waste and garden waste, as these require two different approaches if a system is to be high-performing. We will then showcase some key aspects to consider when defining a collection model for food waste. The components of an effective collection model for bio-waste will be shown simultaneously with the best existing practices and their results. Finally, we will share recommendations about how to measure performance and overcome some of the most common challenges faced by municipalities.

GARDEN VERSUS FOOD WASTE

A key priority to consider when designing a local bio-waste collection system is that food waste and garden waste have different characteristics, and should thus have different collection and treatment methods. While food waste has a high density (around 0,6) and high humidity (around 70% or more), requiring a high frequency of collection, garden waste has a low density (around 0,2), requiring compaction, and it is much more seasonal.[4] For example, municipalities will have much more garden waste collected during autumn (fallen leaves) and summer (grass cuttings) than during the winter months. The system needs to accommodate such fluctuations in quantities.

The best practice model, as shown in Milan (Italy), Wales (UK), and Catalonia (Spain), is to design bio-waste collection schemes to focus mostly on food waste. In these cities and regions, garden waste is collected separately in specific collection rounds, with a much reduced frequency compared to food waste; or they require citizens to bring garden waste to ”drop-off” sites. However, in Flanders (Belgium), the Netherlands, Austria, and Germany, municipalities use wheeled bins called “biobins” (or “biotonnen”) to collect garden and food waste together. While these systems lead to good results, they still provide many opportunities for improvement.

[4] ADEME - Agence de la transition écologique (France) le Compost Plus - 2018

After analysing systems in different regions, it must be noted that there are some operational problems with collecting garden and food waste together. As already mentioned, trucks with a compaction system would be needed for collecting both types of waste at the same time, which increases costs. This is particularly the case when comparing the door-to-door collection of food waste only, which requires the use of smaller trucks with no compaction system and with workers able to manually pick up bags, reducing the time of each round. As pointed out above, food waste is the main focus of this paper given its increased complexity and therefore greater need of guidance. However, we can conclude that **models based on the individual separate collection of garden waste and food waste are the best options for municipalities looking to increase the quality and quantity of the food waste collected.**

DESIGNING AN OPTIMISED COLLECTION SYSTEM FOR BIO-WASTE

Several important factors need to be considered by a municipality or region when determining the best collection system for bio-waste. Regional, social, economic, and demographic characteristics all must be taken into account. The main ones are summarised below.

Urban characterisation

- What is the size of the population and how densely populated is the municipality/region?
- Is the population found mostly in rural, semi-rural, semi-urban, or urban areas? What percentage of the population can be found in each category?
- Does the population of the region/municipality change during the seasons (e.g. tourism) or during the week (e.g. high volume of commuter traffic)?

Building typology

- What percentage of people live in high-rise buildings (apartments), semi-detached, or detached houses?
- How many households have access to a garden?
- How many households are there in the region/municipality? What is the average number of residents per household?

Economic situation

- Does the region/municipality host a large number of private businesses that produce food waste, such as restaurants, supermarkets, or canteens?
- How densely populated are these businesses? (i.e is there a particular area in which there are lots more of such outlets in a close space?)
- What is the average income per household?
- Are there any local food sharing initiatives?

Waste generation

- What is the total volume of municipal solid waste and residual waste?
- Is bio-waste already collected? Food and garden waste, or just one?
- How much of the residual waste is actually organic waste?
- What is the broader composition of municipal waste?

ADAPT THE SYSTEM TO YOUR LOCAL CONTEXT

Lund, (Sweden), is a good example of how municipalities can best **adapt their systems** for each part of the city. A case of high performance, in Lund 63-75% of food waste is currently collected separately, with only 2-5% of impurities.[5] With approximately 125,000 inhabitants, a population density of 290/km^2, and with the local university, service sector, and high tech industries as the main economic activities, they have adopted different systems based on the urban and building typology needs.

The “Quattro select bin” system was developed for single-family households. The municipality provides two tall wheelie bins with 4 compartments each, so that these households can sort their waste in 8 fractions: food waste, residual waste, cardboard, paper, plastic, metal, coloured glass, and clear glass. They are provided also with paper bags for food waste, which are included in the fee. The first bin (the one containing food waste) is collected every second week, and the second bin of dry recyclables every fourth week. The collection truck also has 4 compartments for these different fractions.

[5] Markus Paulsson | Energy strategist & Project Manager at Lund Municipality - mai. de 2021 HOOP's Urban Circular Bioeconomy Webinar “Selective Collection of Urban Biowaste”. Online: https://www.youtube.com/watch?v=y1qTqUSyCtE

The model coexists in the city with other systems for more dense areas. In multi-family areas, waste is collected using bins of larger sizes, one for each fraction, or using an underground waste system in “islands” on public spaces, separating the waste in 4 or 8 fractions. Both the bins and the collection frequency are adapted: waste is collected weekly in multi-family areas, and 1-6 times per week in hotels and restaurants. These commercial activities pay proportionately according to the size and frequency of collection.

In addition, there are 4 recycling centres in Lund where citizens can bring their waste and sort it in 15 different fractions - including garden waste, which can be received in these centres or alternatively collected separately in a single bin with different frequency for households.

Image 3: The “Quattro select bin” system in Sweden, PWS

GRADUALLY BEGIN ROLLING OUT THE NEW SYSTEM ACROSS THE CITY

To start a new collection system, there is a recommended policy of implementing it first in **pilot districts or neighbourhoods**, as it provides the city with a strong opportunity to test and validate the assumptions made to determine the optimal system while at a smaller scale. These could include size of bins, frequency of collection, use of certain bags, etc. It is possible to test different systems to compare results, although the lack of a constant variable may lead to inferior or inaccurate results. Within this testing phase, a large amount of effort must also be made to properly integrate all the users of the future system, and to create feedback opportunities to ensure future success of the full roll-out.

In the table below, we see, for example, seven different pilots in **Slovakia**. Their success can be compared in terms of food waste collection per inhabitant/year. These pilots show how different parameters like free compostable bags, collection frequency, and communication campaigns come into play in delivering the best results.

Activity / tools	S1	S2	S3	S4	S5	S6	S7
Waste Analysis	✓	✓	✓		✓		
Roadmap / project, external consultancy	✓	✓					
Free vented caddies for residents	✓	✓	✓	✓		✓	
Free compostable bags for residents	✓	✓	✓	✓	✓	✓	
Bin max. 240 l for bio waste	✓	✓		✓			
Short delivery distance	✓	✓	✓	✓	✓		
Optimal capacity (250 l / resident per year)	✓	✓		✓	✓		
D2D collection	✓						
Collection frequency 2 times a week	✓		✓	✓	✓	✓	✓
Passportization, monitoring	✓				✓		
Financial motivation - PAYT							
Communication campaign	✓	✓	✓	✓	✓	✓	✓
Flyers	✓	✓	✓			✓	✓
Caddy and bag labels/printing			✓			✓	
Special web			✓				
Social media	✓	✓	✓	✓	✓	✓	✓
Extended campaign	✓						
Education D2D	✓	✓					
Communication of benefits	✓	✓	✓	✓	✓		
Free compost	✓				✓	✓	
Local activists and groups	✓		✓				
Collected food waste / inhab. / year	**81,80**	**46,00**	**36,80**	**36,00**	**32,50**	**2,20**	**8,80**

Image 4: Comparison of pilots with different strategies of waste collection in Slovakia, JRK Slovensko

DOOR-TO-DOOR COLLECTION

Door-to-door collection for households, also commonly referred to as kerbside collection (due to the fact that waste is picked up from the kerb of the pavement), is proven to be the system yielding the best results - much better than, for example, open or locked road containers. With road containers, participation tends to be voluntary; whereas in kerbside systems, households are encouraged to separate each fraction and participate. Municipalities with a door-to-door system have the highest separate collection rate because these systems focus on **individual responsibility**.

In door-to-door collection models, the waste management company comes on a specific day and picks up one or several specific waste streams, which each citizen or group of residents (depending on the requirement) leaves in front of their building or house. Most often, the waste streams which are separately collected from households include food and garden waste, paper and cardboard, lightweight packaging (plastics and metal), glass, and residual waste.

The objects (bins or caddies) used for food waste collection must be unique to this specific waste fraction. The size of the bin/caddy must be defined according to the aspects already listed above (urban typology, density, seasonality, building typology, the number of dwellings, and the presence of internal open or community spaces). The capacity of the bins and the frequency of collection must also be determined according to both the volume of waste generated by a household/apartment, and to embed zero waste principles within the system. We will discuss this later, showcasing how more frequent and bigger bins for food waste lead to higher capture rates compared to residual waste. In some cases, as shown by Milan, a dedicated service by caretakers in multi-family buildings is needed to set out the bins and bags before the collection and to retrieve them after.

Regarding the bins for collection, cities with the best performance are using one **10-litre vented kitchen bin** for collection at the source (kitchen), and then provide a secondary bin (35-litre for single-family households or 120-litre for a building complex) which is filled up by waste from the smaller bin and then put out for collection each time. This helps save space in the kitchen whilst also ensuring maximum capture rates.

The use of vented/aerated kitchen caddies is important as they improve the user-friendliness of the system - they are small enough to fit inside a household kitchen whilst allowing for air to get in and for moisture to escape, helping to avoid potential bad odours. Specific attention must be paid to the **optimal size of these bins** as, if they are too large, for example, due to the high density of food waste, manual transport by users becomes impractical. The 10-litre bin is proving to be well-suited to kitchen spaces, while allowing for a larger second storage bin (typically 120-litres) for several residents in a multi-apartment building or for a larger family.

Bratislava (Slovakia) has one of the best practice systems in place. With about 425.000 inhabitants, this capital city now has only **0,98% of impurities** in its collected food waste. They are distributing 10-litre vented kitchen bins (inspired by the Italian model) and 1 year's worth of certified compostable bags to households. This is complemented by a high frequency of food waste collection of 2 times a week, and a low frequency of residuals collection (one time every 2 or 3 weeks).

BRATISLAVA, Slovakia

Communication campaigns

- Meetings with residents, newspaper, TV, radio, social media

Households:

- Door-to-door collection or very short delivery distance to a container on the street
- Objects used: 10-litre vented kitchen bins + 35-litre or 120-litre secondary bins
- Compostable bags sufficient quantity for 1 year

High collection frequency for food waste and low frequency for residuals

Image 5: Waste Collection Slovakia, JRK Slovensko

BIOWASTE COLLECTION IS ALSO VIABLE ALSO IN DENSELY POPULATED AREAS

With almost 1.4 million inhabitants, **Milan (Italy)** is the largest city in Europe to cover 100% of the population with a food waste collection scheme, capturing 105 kg per capita per year of food waste according to the latest data (2019). Considering that the total generation of food waste is around 120 kg per capita per year, the city is reaching an 87.5% rate - an amazing mark. With more than 80% of the residents living in multi-family buildings, and with a population density of more than 7,000 people/km^2, Milan is an example of good implementation of a food waste collection scheme in a large and densely populated city.[6]

In 2011, the municipal government decided to adopt an ambitious separate collection scheme for the metropolitan area focused on bio-waste. At that time, Milan was only collecting 28 kg of food waste per inhabitant. Food waste collection for households started in Milan between 2012-2014 with a holistic and effective information campaign. **Households** were provided with a 10-litre vented kitchen bin and 25 compostable bags. A 35-litre secondary bin for single-family households or a 120-litre secondary bin for multi-family buildings are also part of the scheme, which are collected twice a week.

[6] Bio-Waste Generation in the EU: Current Capture Levels and Future Potential'. Zero Waste Europe, https://zerowasteeurope.eu/library/bio-waste-generation-in-the-eu-current-capture-levels-and-future-potential/. Accessed 27 Oct. 2022.

Image 6: Bins used for door-to-door collection in Milan, AMSA

The above graphic translates as:
"Brown bin - grey bin with brown cover
Organic domestic waste
Scraps from fruits, vegetables, domestic scraps of meat and fish, kitchen scraps, leftovers, rice, bread, biscuits, pasta and farinaceous foods
Emptying: twice-weekly"

Complementary to bio-waste collection is a door-to-door scheme with transparent bags also for residual waste and lightweight packaging: this allows visual inspections by waste collectors or other dedicated professionals, who can issue fines to a building for improper sorting. Therefore, the quality of bio-waste collected, assessed quarterly, is showing good results with a low level of contamination, around 5%. [7]

For **commercial activities**, such as bars and restaurants, food waste collection was implemented in Milan back in 1997, with daily door-to-door collection and the provision of 120-litre bins. For **open markets,** identified by the city as large producers of food waste and therefore key targets**,** food waste collection started in 2017 and in 2019 the system resulted in a total of 2000 tons of food waste being collected and subsequently composted. The collection takes place every time the market occurs and is made with special compostable bags with a bag holder (see Image 5). It is also key to highlight here that the success of the open markets collection is also the convenience for users and market stall owners. The large bins are situated directly in the market and can be found in several locations, making it easier to separate food waste than to dump it in the residuals.

[7] Bio-Waste Generation in the EU: Current Capture Levels and Future Potential'. Zero Waste Europe, https://zerowasteeurope.eu/library/bio-waste-generation-in-the-eu-current-capture-levels-and-future-potential/. Accessed 27 Oct. 2022.

Image 7: Food waste collection in Milan open market, La Repubblica

Image 8: Biowaste collection of multi-family households in Milan, La Repubblica

MILAN, Italy

Communication campaigns

- In several languages, because of the different nationalities of the inhabitants

Households:

- Door-to-door collection
- Objects used: 10-litre vented kitchen bins + 35-litre or 120-litre secondary bins
- Compostable bags

Commercial activities:

- Daily door-to-door collection
- Objects used: 120-litre cards
- Compostable bags

Open markets:

- Collection in the place at the end of functioning hours
- Objects used: special bag holder in steel
- Compostable bags

Treatment:

- Anaerobic digestion plant + Composting of the digestate

Statistical Highlights

- 1.4 million inhabitants
- 800k daily commuters
- 21 million visitors per year
- 100% of the population is serviced by door-to-door collection of biowaste (garden and food)
- 103 kgs/person/year of food waste collected
- 87,5% of total bio-waste generated by the city is captured and sent for composting

Compostable bags or biodegradable liners

It is highly recommended that cities mandate the use of compostable / biodegradable bags within the bins for the collection of food waste. To ensure the quality of bio-waste captured for composting through low levels of contamination by traditional plastic bag scraps, the bags alone (if no bin is provided) or those placed inside bins **must be biodegradable**. This means bags that meet the European Union's **EN-13432 standard that certifies compostable bags**. [8]

Compostable bags are made to be able to break down in controlled composting conditions. The EN-13432 certified compostable bags are legally certified and are always guaranteed to decompose entirely during composting, without producing any toxic elements. All marks that certify the compostability of these bags are accompanied by a code or a number of reference so the customer can check their validity.

As well as the aerated kitchen bins, the use of compostable bags or biodegradable liners within the bins improves the **user friendliness of the system.** Unlike traditional plastic, they allow air to circulate inside, facilitating the transpiration of the food waste. And therefore, as already mentioned, any potential odours generated by anaerobic fermentation are reduced, and "this also reduces the production of leachate, the weight of the waste (around 6-7%) and optimises the strength of the compostable bag." [9]

Furthermore, if non-compostable bags are used to collect food waste, this will ultimately lead to an unwanted amount of plastic (or the other material used) found in the resulting compost, whether done at home, in a community or in a centralised plant. Plastic or other items found in the compost that come from the non-compostable bags degrade the value and quality of the resulting compost, limiting municipalities' options for what they can do with this product - whether it is to use on public lands, sell to nearby farmers or give back to local residents.

[8] European Standards. 'BS EN 13432:2000 Packaging. Requirements for Packaging Recoverable through Composting and Biodegradation. Test Scheme and Evaluation Criteria for the Final Acceptance of Packaging'. https://www.en-standard.eu/bs-en-13432-2000-packaging.-requirements-for-packaging-recoverable-through-composting-and-biodegradation.-test-scheme-and-evaluation-criteria-for-the-final-acceptance-of-packaging/. Accessed 28 Oct. 2022.

[9] Guide and Experiences of Reference for Implementing the Selective Collection of Municipal Waste. Catalonia. Ministry of Territory and Sustainability, June 2018. Online : https://residus.gencat.cat/web/.content/home/lagencia/publicacions/prevencio/guia_experiencies_implantacio_rsrm_en.pdf

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Visual inspections become possible in a door-to-door scheme with **transparent bags**, and this is important (even for residual waste or packaging). It allows collectors or dedicated staff to give fines to households or businesses for improper sorting or excessive contamination within the food waste fraction, for example. A best practice approach used by Welsh municipalities is that waste collectors leave notes and guidance for households that do not recycle correctly. If the error is repeated, then collectors do not collect bags with the wrong items in, before issuing fines to non-complying households as a last resort.

It is recommended that municipalities consider the distribution of compostable bags for households. In France, for instance, the free distribution of biodegradable bags only represents less than 1% of the waste budget. [10] In Wales, in the United Kingdom, participation in food waste collection from households has doubled since 2015 largely due to the local council's decision to provide free compostable liners to the residents, as previously they had been asked to either use newspaper or to purchase biodegradable caddy liners from local authority buildings. [11]

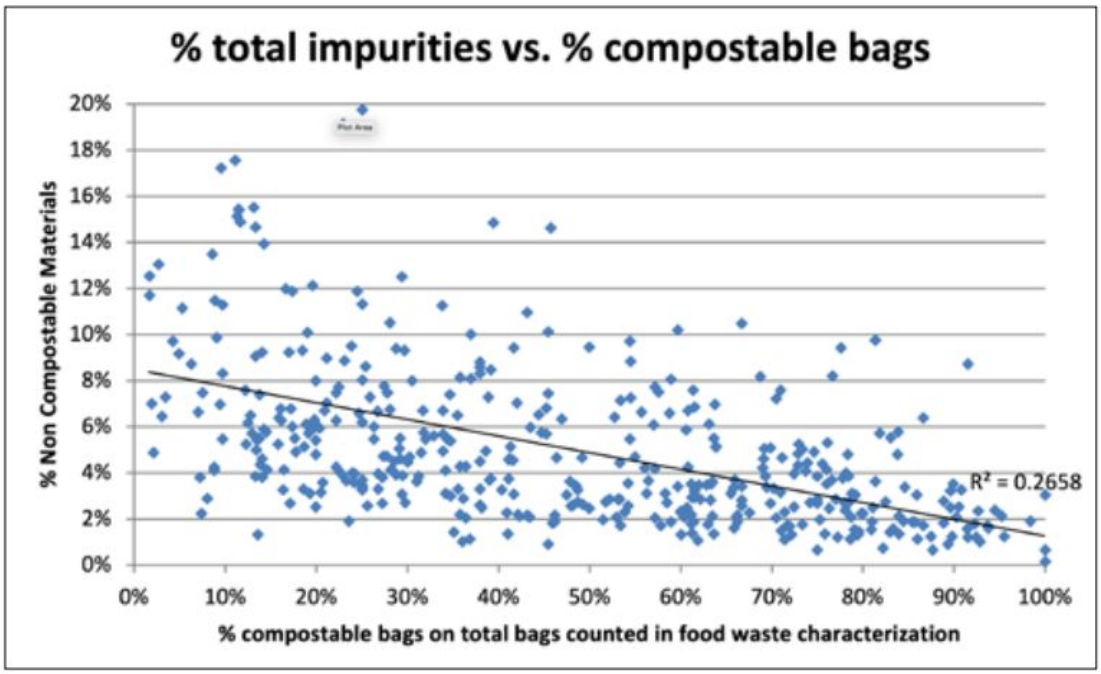

Image 9: Correlation between the purity/type of bag, as assessed by CIC: average purity in the municipality vs. percentage of compostable bags in the municipality,
ECBPI 'Unwrapping the bio-waste potential' report, 2022

[10] Compostplus. La Collecte Séparée Des Biodéchets, Une Solution d'avenir . http://www.compostplus.org/wp-content/uploads/2018/03/Guide-CompostPlus_200112_WEB.pdf.
[11] McQuibban, Jack 'The State of Zero Waste Municipalities Report 2021'. Zero Waste Europe, 8 Dec. 2021, https://zerowasteeurope.eu/2021/12/the-state-of-zero-waste-municipalities-report-2021/.

Performance indicators for bio-waste collection

When designing a bio-waste collection system, it is incredibly important to embed the regular capture of data, both at the start (to set the baseline from where progress can be measured from) and throughout, in order to effectively map progress. These are some crucial indicators that any city wishing to implement a high-performing system should be collecting data on:

1. **Capture rate and quantity**
   The quantity of food and garden waste being collected (important to measure these separately). Break this down further into kgs/person/year and also compare as a % to the total municipal solid waste that is generated.

2. **Quality**
   This refers to the percentage of impurities found in food waste, which can be measured by calculating the discards from the total food waste collected. Key data also includes what these impurities are, (plastic or paper for example) as this information will help inform future policies to reduce contamination and improve quality.

3. **Percentage of bio-waste in residual waste**
   This is probably the best way to measure the efficiency of the system. Measuring separate collection rates do not account, for example, for food waste reduction. Capture rates may also be inflated with bulky garden waste in some cases. Therefore, systems that have low volumes of bio-waste in the residual waste and other waste streams show their efficacy and should be highly desired by cities.

It is important to reference here that the EU Waste Framework Directive also mandates for Member States establish annual reports on food waste generation. The first year of this is 2020 and must have been submitted to Eurostat by July 2022. An explanation of this decision and the methodology can be found here.

Comparison of systems

Regarding bio-waste separate collection, and with all that has already been said, the first important thing to consider is that **quality matters as much as, if not more than quantity.** Therefore, sometimes solutions that seem to be cheaper and/or easier to install and manage should be looked at with caution, because in several cases such systems are proving to deliver lower quality results.

The following examples of Catalonia and Emilia Romagna are great case studies because in these cities there are, or were, two or more systems co-existing. This allows us to compare situations comparable under all influencing factors as culture and behaviour, economic characteristics, regulatory framework, consumption habits, etc.

Catalonia, Spain

Throughout Catalonia, 286 municipalities are operating door-to-door collection for several waste streams (which they aim to increase to 451 municipalities in the near future). Furthermore, all Catalan municipalities have implemented the separate collection of bio-waste, serving 95% of Catalonia's inhabitants (the other 5% treating bio-waste through home-composting). The reason Catalonia makes a great case study though is that the collection of bio-waste in the region has been done using different collection schemes, leading to varied results.

For bio-waste, the systems in use range from door-to door collection, underground or semi-underground and surface containers; and, finally, open containers on streets with unrestricted access or locked containers with restricted access.

Despite the wide variety of existing models, they are trying to progressively switch to a door-to-door separate collection model in many cities, as regional officials recognise this as the best performing system. **Municipalities with door-to-door system have the highest rate of separate collection in Catalonia, ranging from 60 to 85%.**[12] *"We now know that moving the deposit point away from the entry to dwellings and buildings to the container areas did not help maintain awareness and co-responsibility of waste generators as regards the responsible administration of waste management".* (SPORA: Environmental Consultancy for Waste Agency of Catalonia , 2020)

[12] SPORA Environmental Consultancy for Waste Agency of Catalonia - July 2020.

Because some municipalities still use different kinds of containers, others use different kinds of door-to-door collection models and some locations still mix the two models, there is a lot of information and data to analyse from Catalonia, which we can use to compare the results of each of these systems.

Image 10 is sourced from recent presentations given by the Waste Agency of Catalonia. It is a comparison for bio-waste separate collection using either 1) containers in street areas, 2) door-to-door collection and 3) a combined system of the two. **The data showcases that door-to-door is the vastly better performing model, collecting over twice as much bio-waste per inhabitant per year.** Furthermore, **the contamination rate is also reduced by half** when using door-to-door models compared to large containers in the street.

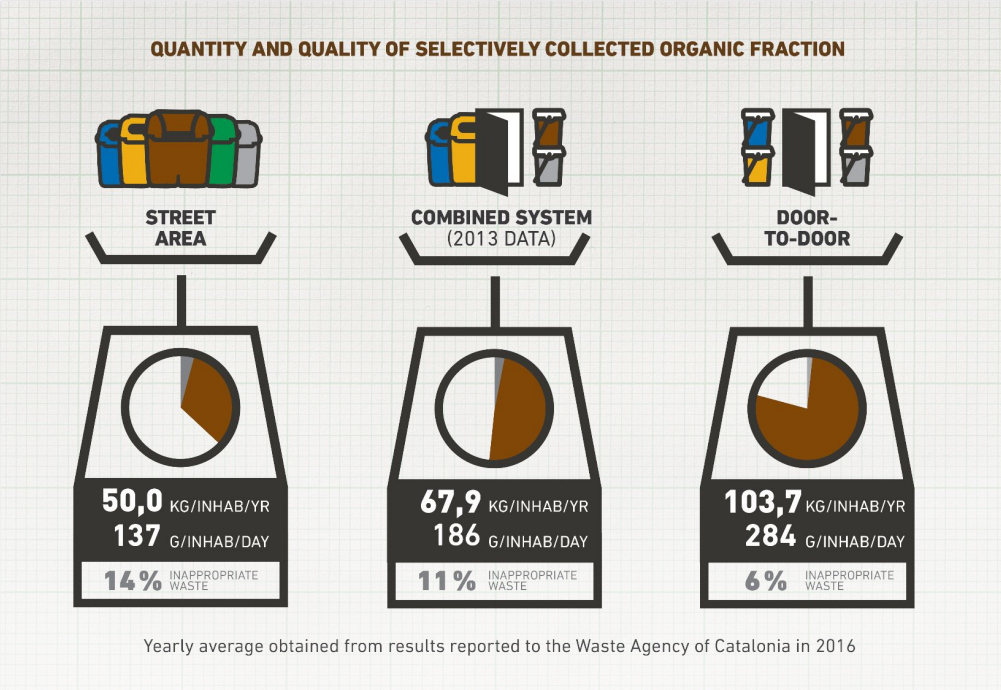

Image 10: Comparison of 3 different systems regarding quantity and quality results of bio-waste separate collection, Waste Agency of Catalonia

Images 11 and 12 further elaborate on the performance of these three models using data from 2020. The data from Catalonia clearly illustrates that total door-to-door collection provides the best results for the entire waste system, but that this is most noticeable for bio-waste in particular, with **nearly 3x as much bio-waste collected compared with road containers**.

Road containers also delivered 3x as much impurities than door-to-door models. Furthermore, the high performance of door-to-door collection can also be seen by the impact it has on residual waste. **Residual waste per capita is 2.4x less** in municipalities using door-to-door compared to road containers.

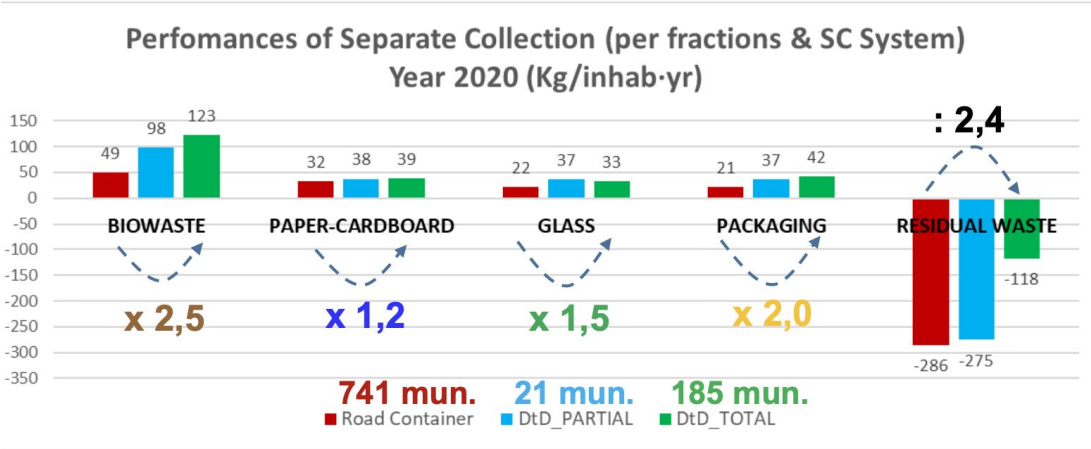

Image 11: Comparing the performance of door-to-door or road container collection systems , Francesc Giró i Fontanals, Director of Strategic Planning of the Waste Agency of Catalonia

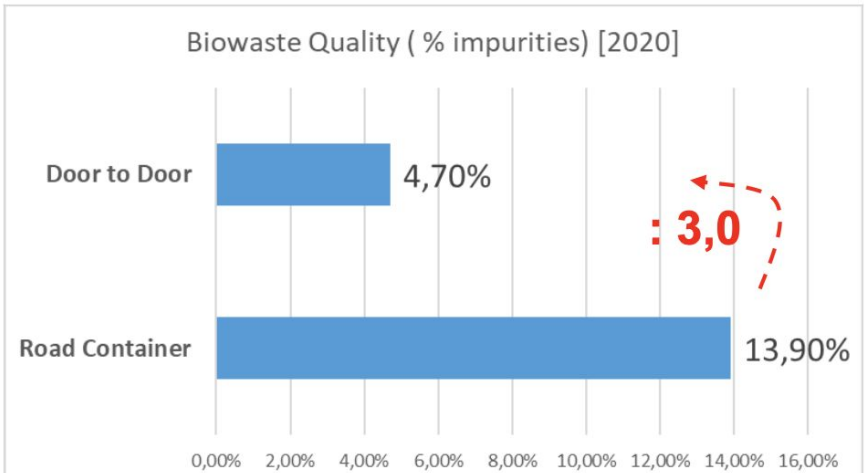

Image 12: Comparing the performance of door-to-door or road container collection systems, Francesc Giró i Fontanals, Director of Strategic Planning of the Waste Agency of Catalonia

Emilia-Romagna, Italy

Municipalities in the Emilia-Romagna region of Italy have several waste collection schemes in operation: door-to-door separate collection with or without PAYT (Pay As You Throw), lockable road containers with or without PAYT, a mixed system with road containers in part of the territory and door-to-door in another part, road containers, and some locations have waste management systems without bio-waste separate collection.

As different organisations in this region, such as the regional agency on water and waste services ATERSIR, and the Italian Composting Association (CIC), collect and analyse data related to waste collection periodically, we are able to compare the performance of these various systems. What we see again is higher captures and better quality of the food waste collected in the door-to-door collection systems, as well as lower amounts of residual waste and total waste generated. There are also differences regarding operational costs, **with door-to-door collection not only the best performing model but also the cheapest**.

Regarding quantity, the graph below compares the amount of residual waste and total waste generated (kg/person) per system. **The door-to-door system with PAYT shows the best performance, with only 125 kg/person of residual waste,** while mixed systems, road containers, and systems without bio-waste separate collection are the least performers, with 306, 343, 374 kg/person of residual waste, respectively. [13]

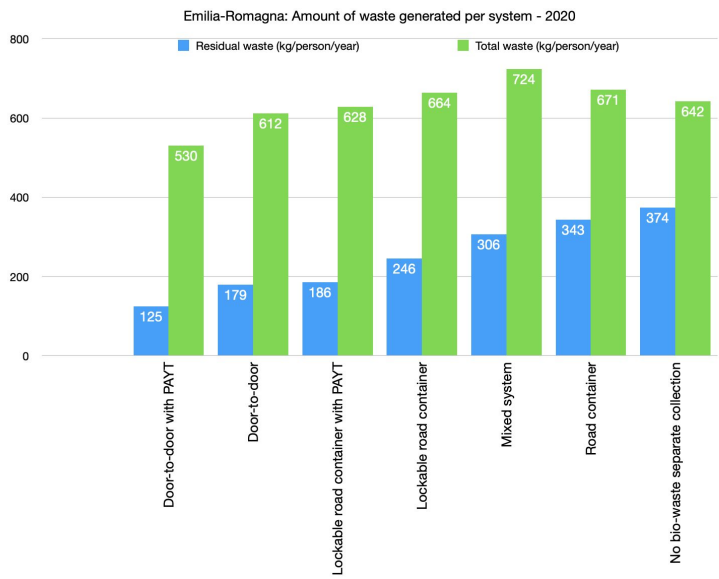

Image 13:Comparing the performance of different collection systems in Emilia-Romagna ATERSIR, CIC published by Ecodallecittà

[13] Ecodallecittà, 2020. Online: https://www.ecodallecitta.it

Regarding quality, data from 2017 shows **4,5% level of impurities in bio-waste collected with door-to-door systems, compared to 6,9% contamination with mixed systems, and 10,3% with road containers .** [14]

MODEL	% contamination w/w
Door to door	4.5
Hybrid	6.9
Road containers	10.3

Image 14: Average contamination rates under different types of schemes in Italy in 2017, European Circular Bioeconomy Policy Initiative (ECBPI), 2022

One possible issue regarding containers is that, even those that can be locked do not allow control over the quality of what is collected, and end up stimulating littering (abandonment on bags around the bin)

The total unit cost of waste management includes collection, transportation, recycling, composting and disposal. The main reason door-to-door and PAYT systems are more cost-effective is that the much smaller amount of residuals incurs savings on disposal, which then balances off the initial higher costs of collection infrastructure. Also, municipalities can receive higher revenues from the dry recyclables they collect and sell on.

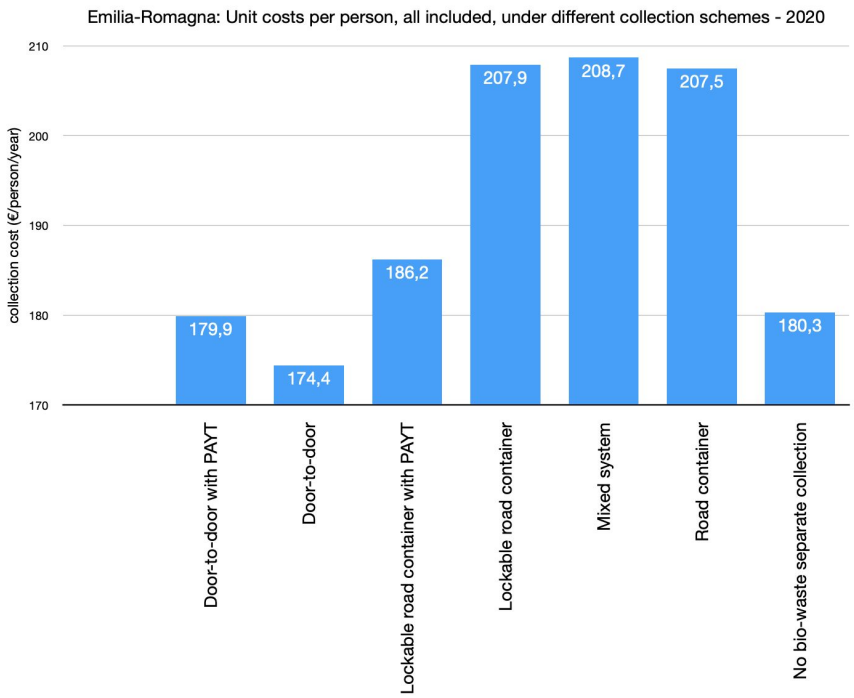

Image 15: Figure comparing the cost of different collection systems in Emilia-Romagna Source: ATERSIR, CIC published by Ecodallecittà

[14] European Circular Bioeconomy Policy Initiative (ECBPI), 2022. Online: https://bbia.org.uk/wp-content/uploads/2022/09/Unwrapping-the-biowaste-potential.pdf

Key policy recommendations

This final chapter will look at some of the most important policy recommendations that we can provide to cities looking to implement high-performing, cost-optimal bio-waste collection systems. While not exhaustive, this list covers the most important aspects to consider when looking to introduce bio-waste collection models which collect large quantities with low impurities, crucial for creating good compost which can lead to several environmental or economic benefits for a municipality.

1. User-friendliness

Life in cities demands practicality, and waste collection should try to be as user-friendly and convenient as possible. To increase citizen outreach and participation, local characteristics must be taken into account to develop models that are specifically adapted to the local context. For example, the type of bins provided to households, the collection frequency and how information is provided to citizens available must all be part of this tailored approach. Systems should ultimately make it easier for citizens and businesses to separate food waste than to put it in the residual (mixed) waste bin.

A good example of supporting citizens to do the right thing comes from Hernani in Spain, which operates four “emergency centres” where residents can leave their waste in case they miss the door-to-door collection on a given day. There is also a drop-off site that takes bulky waste, electric and electronic devices, and other waste which is not covered by the door-to-door collection, free of charge.

2. Financial incentives

High-performing systems are often those which have created the right conditions that means the costs of bio-waste collection and treatment are **cheaper than disposal into landfill or incineration**. This means higher taxes and gate fees should be mandated for residual waste treatment by municipalities or regional authorities, where possible. The running of bio-waste treatment plants, such as composting sites and anaerobic digestion, must also be economically viable. This can be achieved in several ways, ranging from savings by using biogas created to feed into the local energy systems or by selling on the produced compost.

For citizens, financial **penalties** could also be introduced to improve compliance with the system. The staff responsible for the collection could inspect bags and bins, giving fines to households or businesses when there is too much impurities and contamination within the food waste fraction. Likewise, financial incentives can be given to compliant citizens or those who compost at home / in the community. These can be offered in the form of a reduction in the annual waste fees or by the provision of vouchers that get participating individuals discounted offers at local businesses, helping also to support local businesses and keep money within the local economy.

A recent study found that the implementation of financial incentives positively encourages citizens to sort their waste. In focus groups, respondents specifically emphasised that systems like **pay-as-you-throw (PAYT)** are highly motivating to trigger or maintain the sorting habits. [15] **PAYT models are important additional policies to supplement door-to-door collection schemes that help keep the system cost-efficient, deliver optimal environmental and social results and increase** environmental awareness among participants.

Several municipalities that successfully implemented a PAYT system include

- ➔ **Salacea**
- ➔ **Newport**
- ➔ **Parma**
- ➔ **Besançon**

Furthermore, in Ghent, a PAYT waste collection system was introduced in 1998 anda continuous downward trend of collected residual waste has been recorded ever since. [16] PAYT systems can vary and therefore apply different strategies, depending on what best suits the local context. These strategies range from charging for the size of container chosen by the household, the frequency of collection of a given container, the application of a fee per sack that is used; the weight of waste set out for collection, or a combination of the above. [17]

The most effective PAYT systems set a fixed fee for every household, business, or individual, covering the core operational costs of waste collection and treatment. This is normally around 60-70% of the previous existing waste fee. **The remaining 30-40% is therefore variable and is calculated depending on the volume of waste generated by a user**, with those who generate below average consequently paying less than the average household fee. PAYT systems should be flexible and continue to be updated with the goal of reducing waste generation.

[15] H2020 Collectors project (2021). Deliverable 2.5 Report on implemented solutions and key elements in selected cases for societal acceptance. Online: www.collectors2020.eu/wp-content/uploads/2021/02/Collectors-Deliverable2.5.pdf

[16] H2020 Collectors project (2020). Work package 3 Quantification of costs and benefits, ASSESSMENT OF SOCIO ECONOMIC AND FINANCIAL PERFORMANCE OF 12 SELECTED CASE STUDIES. Online: www.collectors2020.eu/wp-content/uploads/2020/04/Deliverable3.2_COLLECTORS-project-1.pdf

[17] H2020 Collectors project (2020).D4.6 – *Policy recommendations & development needs related to the waste framework conditions*. Online: www.collectors2020.eu/wp-content/uploads/2020/12/COLLECTORS-D4.6_Policy-recommendations-final.pdf

Hernani, in Gipuzkoa, in the Basque Region of Spain, is another good performance example, where households composting their bio-waste receive a discount on their annual waste fee, and where there is a PAYT criteria for businesses. Hernani has implemented a door-to-door separate collection system prioritising bio-waste since 2010, when the municipality removed large containers from the streets. In 2020, the results achieved included a separate collection rate of 80.6% in urban areas, and 88.70% in industrial areas. The quality of the bio-waste collected is impressively high, the results for 2019 showing "a **0.14% contamination rate**, resulting in the subsequent compost being of high value and, therefore, incredibly useful to aid local soils."

HERNANI, Gipuzkoa, Basque Region, Spain

Communication campaigns

- For waste separate collection, but also to largely promote home and community composting, including courses and technical advice from experts.

Households:

- Door-to-door collection
- Objects used: small bins + hooks to hang the bins at the front of houses and buildings

Commercial activities:

- Door-to-door collection
- PAYT policy

Treatment:

- 49 community composting centres in operation + anaerobic digestion plant + Composting of the digestate

3. Frequency of collection

Higher frequency of food waste collection = lower frequency of residual waste collection.
Another way to stimulate participation and therefore better results, in addition to tax incentives and penalties, is collecting food waste at least twice a week in households. Like this, the beginning of fermentation processes and possible discomfort to the residents is avoided. With a higher frequency for food waste, there will be less possibility of residents depositing this fraction with the residual one. This is already happening in cities in Slovakia, Italy, Spain. Hernani, Spain, for example, collects bio-waste 3 times a week during the summer months, showcasing another important adaptation to the local context which all cities in warmer climates should follow.

4. Communication and awareness-raising activities

Communication campaigns must start before the new collection system is introduced, clearly informing all citizens about the days and hours of collection, as well as what can and can't be included for each waste stream. For this purpose, in addition to websites, **apps** form an important tool for information provision in today's digital world. An example from Milan is the free app *Puliamo*, in which citizens can enter their addresses and know the waste collection days in the area and all the information necessary for proper separate collection. Besides, they can also request the collection of bulky waste, and report abnormal situations such as illegal landfills, full bins, etc. In France, the *Reseau CompostPlus* is a network of municipalities promoting separate collection of bio-waste. Since 2007, they have organised "Territories & Bio-waste Days" with the aim of bringing together members of the network and communities wishing to join, to exchange and share best practices.

However, it is not only websites and apps that can help, but more traditional communications should be considered - such as letters sent to residents, newspaper, TV or radio advertisements, leaflets, stickers, posters in bus stops and streets. These all form critical parts of a city's holistic communication strategy. In the case of Wales, **it was estimated that nearly 25% of the waste budget was protected for spending on communication and educational activities.**

Again, it's incredibly important to always **adapt communication strategies to the local context.** In Milan, for example, you can find information about waste collection in 10 different languages, as it is a multicultural city, with people from several different nationalities and origins. But the same thought should be considered for a city / neighbourhood with a predominant subset of demographics (for example more elderly people, tourists, or students).

The case of **Merthyr Tydfil, in Wales, United Kingdom, is a best practice for communications and awareness-raising.** Wales ranks third in the world for overall household recycling rates because of the performance of municipalities like Merthyr Tydfil. Households are provided with a 5-litre kitchen bin, and also a 23-litre lockable outdoor bin to empty the food scraps into, with garden waste being separately collected. This larger food waste bin is then collected weekly from the kerbside, at the same time of the collection of dry recyclables. To supplement this effective system, stickers are left on bins to encourage food waste prevention and discourage waste being put in the residual waste bag, as part of a multi-million euro national campaign to increase food waste collection results.

MERTHYR TYDFIL, Wales, United Kingdom

Communication and education are priority

- Stickers on each household's residual waste bin saying "no food waste"
- Recent £1 million 'Be Mighty. Recycle' national campaign

Households:

- Weekly door-to-door collection
- Food waste separately, but at the same time of dry recyclables collection. Garden waste is collected separately
- Objects used: 5-litre kitchen bin, and 23-litre lockable outdoor bin
- Compostable bags (provided for free by the government)

Financial support and incentives

- 'Municipal Food Waste Procurement Programme': £50m programme organised through public private partnerships, with the aim of supporting local authorities to build sufficient food waste treatment capacity.

Treatment:

- Anaerobic digestion plant + composting of the digestate

5. Use of technology

Not only for educational and awareness-raising activities and communication, websites and **other technologies** should be considered in order to optimise waste management systems. Vehicles with GPS tracking devices, for example, allow greater knowledge of collection operations which can then be used to make the collection rounds more efficient, producing less emissions from fuel usage too.

The *Re-Think Waste* project, with different pilot areas, for instance in the city of **Bitetto, in Italy,** uses a **Radio Frequency Identification (RFID)** system to implement a PAYT policy through what they call a "Know-as-you-throw" (KAYT) approach. The main objective is to provide guidance to implement the PAYT policy and clear information about separate collection. Basically, in this pilot areas, bags and bins provided to each household have a unique QR code which is scanned by the waste collectors. The corresponding data, centralised by the municipality, is used to determine the amount of annual waste fees each household should pay. According to their official website, through Re-Think Waste they also give individual, detailed and frequent feedback to citizens, promoting one-to-one meetings with those interested.

Another good example is WasteApp, which is part of the European "Urban-waste" project. WasteApp is an application-game seeking to inform the correct disposal of waste by users in tourist destinations. A system of points and prizes is proposed, and, through QR codes in waste containers across the city, tourists and inhabitants can interact in social networks.

CONCLUSION

The purpose of this paper was to showcase an analysis of the different collection models available to municipalities for bio-waste. With the upcoming deadline to mandate bio-waste be separately collected starting from the 1st January 2024, this paper comes at a crucial time when cities must decide what model they wish to continue with or start implementing.

After analysing the data from European municipalities, **it is clear that door-to-door collection of bio-waste provides the best results, both in terms of quality and quantity.** We can see that municipalities already operating door-to-door models not only have the best performance for bio-waste, but that this has positive knock-on effects for the wider system as a whole. In most cases, residual waste is much lower and higher quantities of clean, dry recyclables are collected when bio-waste is separated effectively. One of the possible reasons is that door-to-door systems emphasise individual responsibility of citizens.

This paper concludes that the best objects for cities to provide to households include a combination of a small vented kitchen bin (5-10 litre) found in the home, with a secondary deposit with a shared larger bin (20-120 litre) for multi-story apartment buildings. In all models, **compostable bags** or biodegradable liners within the bins are extremely important to improve user-friendliness and participation, and to decrease contamination in bio-waste collected by plastic bags. **More regular collection of food waste and less of residual waste** is also another conclusion after analysing our best performance examples.

The cost-feasibility of the system is also an incredibly important factor for cities. It is the cost argument which often wins when municipalities and waste companies decide on which system to implement. Street bins, for example, are the cheapest model to introduce which is why we are seeing a rise in such initiatives across Europe, despite the obvious evidence that these produce far worse results compared to door-to-door models.

There are many strategies to help optimise waste collection systems, such as the use of technology for more control and identification, the implementation of tax incentives to encourage separation of bio-waste and PAYT policies that help improve results once a door-to-door model has been implemented.

It is most important to end by adding that within the decision-making process taken by cities in the coming months, **context specificities** must be taken into account. The most effective bio-waste system for a city will depend on the local needs and context. Door-to-door models provide the framework, yet the frequency of collection, size of bins and choice of compostable bags must all reflect what best serves the needs of the community based on key indicators we identified earlier. Furthermore, educational awareness-raising activities and communications with the community are absolutely fundamental to any system's success, and should be a priority no matter what collection system will be implemented.

Although there is significant room for improvement in all the models presented, and there are still some challenges to be overcome, such as the reliance on landfilling and incineration, **we see in concrete cases how some simple actions can have extraordinary results in a short time**. If the EU is to achieve its circular economy goals, then bio-waste being effectively separated from households and businesses is an incredibly important first step, as this will result in stronger nutrient cycles, with higher volumes and qualities of compost being generated. Furthermore, **if we are to achieve the goal of recycling at least 65% of municipal solid waste by 2035, this cannot be done without the effective collection and composting of bio-waste.**

This is why we have published this paper at this specific moment in time. As many European municipalities consider which bio-waste collection system to introduce, it is imperative that municipal officials are aware of the data which clearly proves the systems which should be preferred. For any city wishing to collect large quantities of quality food waste for composting, to vastly reduce the residual waste its citizens collect and to improve the wider recycling system as a whole, then door-to-door collection of bio-waste is a must.

Visit the Zero Waste Cities website to find out more information about zero waste and how to implement successful waste prevention & reduction policies at the local level.

Zero Waste Cities

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Zero Waste Europe is the European network of communities, local leaders, experts and change agents working towards the elimination of waste in our society. We empower communities to redesign their relationship with resources, and to adopt smarter lifestyles and sustainable consumption patterns in line with a circular economy.

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