LIFE BIOBEST

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LIFE BIOBEST

GUIDING THE MAINSTREAMING OF BEST BIO-WASTE RECYCLING PRACTICES IN EUROPE

D3.1: Guideline on the separate collection of bio-waste

WP3: Set of guidelines

T3.1: Separate collection analysis

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Public Report

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1 Document attributes

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1.1 Document Management Control Sheet

Table 1. Document Management Control Sheet

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1.2 Document Revision History

Table 2. Document Revision History

Version Number	Date	Version Type	Short Description of the Changes	Editor
0.1	19/03/24	1st Draft	Draft version to share with partners for peer review	CIC – Vera Brambilla, Alberto Confalonieri, Irina Krutova, Eva Maria Lopez, Michele Giavini, Marco Ricci
0.2	05/04/24	2nd Draft	Peer reviewers' contributions in track changes and notes	ENT & ECN
0.3	24/04/24	3rd Draft	Revision to include reviewers' contributions	CIC – Vera Brambilla, Alberto Confalonieri, Irina Krutova, Eva Maria Lopez, Michele Giavini, Marco Ricci
0.5	08/05/24	4th Draft	Final linguistic and format revision	ENT – Mike Stinavage & Gemma Nohales
0.6	29/05/24	Definitive/ Approved	Definitive and approved version to be submitted	ENT – Mike Stinavage & Gemma Nohales
0.7	18/06/24	Submitted	Submitted to Participant Portal in PDF	ENT – Gemma Nohales

1.3 Guideline Overview

Separate collection of bio-waste is of utmost importance for achieving environmental sustainability and economic efficiency of the waste management system, as well as for promoting circular economy principles. Moreover, since Decembre 2023, the diversion of bio-waste from the commingled collection with residual waste is obligatory across all EU countries according to the Waste Framework Directive (WFD). Implementing effective bio-waste management systems requires a combination of infrastructure development, education and supportive policies.

This guideline aims at summarising the key aspects that have to be considered when implementing a separate collection scheme for bio-waste and, in particular, for kitchen waste. The documents include a focus on necessary tools such as bins and containers, collection frequencies for bio-waste (and other municipal solid waste streams) and on the quality of kitchen waste collected, so that decision makers and local authorities will take a leap towards the implementation of the WFD mandates. This guideline also includes a short section on home composting, a technique where households handle their domestic bio-waste in a private space.

A set of diverse Best Practice (BP) cases identified in the framework of LIFE BIOBEST project and included in **Annex 1: Best Practice cases on bio-waste collection**, which details the aspects of collection, treatment and recycled products, illustrate the models implemented in specific areas and local contexts.

A specific reference is made to communication and engagement when requesting waste producers to sort bio-waste since successful solutions depend on high participation rates and must be cost and time effective. This topic is addressed specifically in **LIFE BIOBEST D3.4 Factsheets on the analysis of best practices in communication and engagement from various countries**.

By investing in these tools and fostering stakeholder engagement, communities can reap the myriad benefits of bio-waste diversion while advancing towards a greener future.

1.4 Table of Acronyms

To ease the reading, a number of technical terms, that are often repeated in the text, are abbreviated as listed below.

Table 3. List of Acronyms

Acronym	Term
CP	Commercial Producers
D-t-D	Door-to-door (or pick-up scheme)
f.m.	Fresh Matter
FW	Food Waste
GW	Garden Waste
Ho.Re.Ca.	Hotels, Restaurants and Cafeterias
KPI	Key Performance Indicator(s)
KW	Kitchen Waste
L	Litre
MSW	Municipal Solid Waste
PAYT	Pay-as-you-throw
RW	Residual Waste
WFD	Waste Framework Directive
wk	week
yr	year

1.5 LIFE BIOBEST Project Summary

EU obligations on the separate collection of bio-waste came into force at the end of 2023, increasing the availability of source-separated bio-waste for composting and anaerobic digestion. To ensure the development of bio-waste management best practices and the production of quality compost and digestate for soil applications, while minimizing any negative effect and effectively closing the loop, a comprehensive analysis is required regarding bio-waste management strategies, instruments and management schemes and their results given that large disparities exist among experiences in the EU.

The LIFE BIOBEST project aims to identify and validate the current best practices and management instruments along the bio-waste management chain (from generation to treatment) that allow the production of quality compost and digestate and establish a series of reference Key Performance Indicators (KPI), based on the analysis of existing databases and experiences. In a policy brief about barriers and through interconnected co-creation meetings with relevant expert stakeholders of the sector, solutions will be provided to overcome the identified technical, regulatory, economic and environmental barriers to widely adopt the proposed BPs.

Four guidelines and a comprehensive EU-wide guide will be created, together with two decision-support tree guides for local and regional authorities to adapt bio-waste management models to their specific context, offering feasible BP and management instruments to promote efficient collection and subsequent recycling of bio-waste into quality compost and digestate.

By means of an analysis of the input materials, treatment practices, resulting compost and digestate quality, a proposal for premium European standards for biological waste entering composting and anaerobic digestion will be developed with the ultimate goal of promoting the certification of these materials and treatments, guaranteeing optimal management processes and a safe, beneficial return to the soil.

The outcomes of LIFE BIOBEST will promote a significant improvement of the collection and treatment systems, and consequently of the quantity and purity of the input material, reducing process rejects and favouring the conversion of bio-waste into high-quality compost and digestate.

The LIFE BIOBEST consortium is led by Fundació ENT (ENT) in partnership with Consorzio Italiano Compostatori (CIC), ACR+ (Association of Cities and Regions for Sustainable Resource Management), European Compost Network (ECN) and Zero Waste Europe (ZWE). It is a 2.5-years LIFE Preparatory Project funded by the European Commission.

Project Total Eligible Costs: € 1,664,600.07, Funding Rate: 90%, Maximum Grant Amount: € 1,498,140.05.

1.6 LIFE BIOBEST Guidelines

In conjunction with the January 2024 EU separate collection mandate, the LIFE BIOBEST project investigates various facets of bio-waste management ranging from separate collection, implementation of recycling strategies, processing systems and related management options in order to create high-quality compost and digestate products.

To support upper-level authorities and decision makers in streamlining policy measures and lower-level authorities in implementing solutions, LIFE BIOBEST presents four bio-waste management guidelines. Together, these guidelines offer a strategic vision and practical approaches crucial to effective bio-waste management.

The goal is to provide guidance and support for optimising implementation of the EU obligation with evidence from high performing schemes and with the definition of performance indicators. This guidance may be applied to all the involved actors in the system to maximise the potential contribution of bio-waste to circular economy and related EU targets. Whether municipalities are in the initial stages of bio-waste implementation design or an advanced state of management, these guidelines provide a point of reference for policy and decision-makers, local authorities, waste haulers, recycling entities, and technical practitioners.

This work is crucial to promote the collection of large quantities of high-quality bio-waste in order to produce quality outputs such as compost, digestate, and biogas. Given the diversity of local contexts, these guidelines provide a comprehensive outlook on bio-waste management as well as existing best practices from a number of EU countries where management instruments are successfully applied.

The four LIFE BIOBEST guidelines are:

- **D3.1 Guideline on separate collection** provides an overview of the different bio-waste separate collection schemes and assesses the pros/cons. This guideline includes a set of Best Practices that focus on collection from households and other producers in various contexts.
- **D3.2 Guideline on governance and economic incentives** discusses the governance tools and economic instruments needed to improve management schemes. The guideline presents these instruments alongside examples of their application and includes an analysis of the economic viability of Best Practices in bio-waste management from separate collection to treatment.
- **D3.3 Guideline on quality compost and digestate** breaks down the treatment technologies and resources that support the production of compost and digestate. The guideline provides insights about the processing options, analysis of product characteristics, quality assurance systems as well as related EU legislation and the ECN quality assurance scheme.
- **D3.4 Factsheets on the analysis of best practices in communication and engagement from various countries** delves into the topic of public

communication and education. Public participation and awareness are key complementary issues to management schemes. This guideline includes an analysis of experiences from frontrunners and gives insight about impacts of communication activities.

The backbone of these guidelines is the empirical knowledge of the LIFE BIOBEST consortium and the successful experiences and instruments provided in each document. Taken individually or as one, these guidelines contain information key for institutions and stakeholders in the bio-waste value chain.

2 Focus of the Guideline

The aim of this guideline is to address local authorities at the municipal or district level and provide the basic technical information about how to establish a separate collection scheme for bio-waste.

Among the wide range of different feedstock composing bio-waste, this document is intended specifically to focus on kitchen waste (KW), as it is defined below in section 2.2, generated at households. The guideline also includes information - elaborated in less detail - about how to collect other bio-waste such as garden waste (GW) generated at households or about how to sort kitchen waste generated at commercial producers (CP) located in municipalities and cities. The guideline also refers to a number of best practice examples about kitchen waste collection, collection and recycling, which have been investigated in detail during LIFE BIOBEST project and described in the **Annex 1: Best Practice cases on bio-waste collection**.

2.1 Bio-waste, a range of different feedstocks

Bio-waste is defined by the EU legislation in Waste Framework Directive [1] (WFD) as "biodegradable garden and park waste; food and kitchen waste from households, restaurants, caterers and retail premises; and comparable waste from food-processing plants". According to the type of Municipal Solid Waste (MSW) collection scheme realised locally, bio-waste collected can be a mixture of four main different types of streams as shown in the figure below.

Figure 1. Main producers of bio-waste included in the MSW collection

Source: Own elaboration

[1] Waste Framework Directive

Commercial activities generating bio-waste such as hotels, restaurants, cafeterias and others can be included into the public or municipal scheme for separate collection; this depends sharply on the boundaries of the public MSW service defined by national legislation or local regulation. This guideline primarily focuses on collection from residential users and only secondarily on collection from non-residential users.

There are additional types of bio-waste producers that may (or may not) be served by local or municipal waste services, such as marketplaces or companies being responsible for the maintenance of public green areas or spaces. This depends on the local legislation or how collection services are set-up locally. These types of producers are not addressed in this guideline.

In general, the collection of bio-waste being realised in EU Member States can be divided into four groups as detailed in Table 4, depending on the types of bio-waste "flows" that are included in each scheme.

Table 4. The four main types of bio-waste collection found in EU Member States

A. KW only scheme	B. KW scheme with some exclusions	C. KW and GW scheme	D. GW only
Schemes that allow all types of KW including cooked food, food leftovers, etc.	Schemes excluding some types of KW such as meat, fish and other putrescible proteins such as cooked, fatty residues	Schemes collecting both KW and GW streams commingled in the same bin. The scheme may exclude some types of KW (see type B)	Scheme collecting all range of waste generated in private gardens. These schemes may also include the amounts from public areas.

These four collection schemes differ in several ways, such as their potential to reduce bio-waste inside the collected residual waste, the effectiveness of tackling food/kitchen waste (a topic that is specifically addressed in EU policies regarding waste prevention and waste recycling), the contribution to reach general recycling targets of MSW as well as the possibilities to be implemented in different types of urban settings, from decentralised rural areas up to high density city centres. This applies for example when comparing schemes A and B. The latter allows for a limited range of kitchen waste to be collected, by excluding for example, cooked or animal-based foods; hence this inevitably and structurally leads to a limited interception of food leftovers and therefore scheme B results in lower per capita collection rates than scheme A.

2.2 The wording used in this guideline

This document includes guidance on two main types of collection schemes, based on the "origin" of the bio-waste as defined in Table 5; the two main "origins" of the bio-waste addressed in the following chapters are kitchens (both private or from commercial producers) and gardens (from household only).

The term bio-waste will be only used if referring to general aspects of both kitchen waste and garden waste or if the scheme collects both of them.

Table 5. Origin of bio-waste

KW	GW
Bio-waste sorted within schemes aiming to collect KW generated at households and (in some cases) at commercial companies. It can include minor quotas of GW – depending on the set up of the scheme → see Chapter 6 Type of collection schemes	Bio-waste sorted within schemes aiming to collect the waste generated in private gardens or vegetable garden, consisting mainly of grass clipping, brunches, leaves, pruning, etc. KW is not accepted in this scheme

This guideline considers kitchen waste to be collected from households, commercial producers (i.e. Ho.Re.Ca. sector and other large producers) or both, depending on the set-up of the local collection. Garden waste is considered to be collected only at households.

3 Type of collection schemes

3.1 Factors to be considered

There are a number of factors that local authorities need to consider when deciding how to set up a collection scheme for bio-waste:

- The composition of MSW, specifically the relative amount of kitchen and garden waste generated and the amount collected and the seasonality of the garden waste generated. For information on specific requirements for flows considered as animal by-product, see **LIFE BIOBEST D3.3 Guideline on quality compost and digestate.**
- The type of waste producers addressed by the scheme: in an urban area these can be broadly grouped into households and commercial producers such as restaurants, canteens, hotels, schools and others besides the amount generated by the urban areas itself (i.e. green waste from public areas). Regarding the expected results in diversion and recycling of MSW, it is of uttermost importance that collection schemes are addressed to the households, which represent, generally, the largest group of kitchen waste producers in a municipality.
- The type of urbanisation - where bio-waste is collected - influences the availability of (private and public) spaces to locate the waste bins. At single, detached households, there is more space to place the bins. High-rise buildings may have difficulties stationing bins.
- The possibility of decentralised and rural areas to involve waste producers (mostly households) to recycle bio-waste locally by means of home/community composting.
- The expected results of a specific type of bio-waste collection scheme in terms of quantities collected (i.e. the diversion rate) and of quality (i.e. the content of physical contaminants); the latter factor may become critical for some collection schemes and limit the recycling process and reduce its effectiveness and efficiency.
- The type, size and location of the bio-waste recycling plants that are already available or that are planned to be built; some type of facility will have a limited acceptance of specific bio-waste categories such as bulky garden waste or liquid food waste.
- The distance between the areas of collection and the location of the recycling plants should also be considered when designing a specific collection scheme for bio-waste.

The main factors are further detailed and described in the next chapters of this section.

3.2 Pros and cons of the different collection schemes

Independently if a specific scheme collects kitchen waste only, garden waste only or if waste receptables allow a mixture of both, all types of schemes currently applied in different EU countries can be grouped into three main approaches, related to how the waste producer delivers the waste to the collection service; these are grouped into: door-to-door (D-t-D) schemes, bring schemes or collection centres.

As a general rule, while door-to-door and bring schemes can be applied for both kitchen waste or garden waste collections, collection centres usually only accept garden waste.

Table 6. Type of collection schemes for bio-waste

D-t-D scheme	Bring scheme	Collection centres
The approach aims to equip each building or waste producer with a receptable for bio-waste collection	Collection of bio-waste is done with wheeled bins or road containers located permanently in public, accessible spaces (preferred with sized or reduced entry openings)	Collection centres, also called drop-off points, are supervised places where waste producers are identified during access and delivery
Number of households per collection bin: **from single up to 10**	Number of households per collection bin: **from 10 to 70**	Number of households per collection bin: **up to hundreds**
Location: **at or next to** the waste producer's premise	Location: **within walking distance** from waste producer (optimal 50-100m, always less than 250m)	Location: within driving distance
Logistics for collection: **complex**	Logistics for collection: **simple**	Logistics for collection: **basic**

There are a number of advantages and disadvantages for each type of scheme, considering which type of bio-waste is specifically going to be collected. Table 7 and Table 8 present a range of schemes for collecting kitchen waste, garden waste or both, including a qualitative comparison of the main pros/cons in terms of:

- Possibilities to identify single waste producer during the step of collecting waste or emptying the waste bin.
- The quality of the bio-waste (in terms of its physical contamination by means of plastics, metal, glass and others), this factor stems from **LIFE BIOBEST KPI05**, "Contaminants inside bio-waste/food waste collected (% of total bio-waste)", and the capacity of the waste collection service to provide feedback to single waste producers (compliance monitoring).
- The diversion or separate collection rate expected, intending the amount of bio-waste that is collected separately compared to the potential generated; this

relates to **LIFE BIOBEST KPI11**, "Diversion rate of bio-waste/food waste (% of bio-waste generated)".

- The influence of a fluctuant production of bio-waste, following the seasonality of garden waste in the scheme.

The cases and the qualitative comparison shown in Table 7 demonstrate that door-to-door schemes are preferable for collecting kitchen waste, leading to larger amounts collected separately, lower contamination and improved identification of waste producers during the phase of collecting waste. Door-to-door schemes also allow – if designed properly - to split bio-waste into two schemes: one scheme tackling specifically kitchen waste and another scheme, not necessarily a door-to-door scheme for garden waste.

Table 7. Pros and cons of different collection schemes for kitchen waste

D-t-D scheme at single household	D-t-D scheme at single households	D-t-D scheme at multi-unit buildings
KW	**KW & GW**	**KW**
		
Identification of waste producer: **high**	Identification of waste producer: **high**	Identification of waste producer: **medium**
Quality and compliance monitoring: **high**	Quality and compliance monitoring: **high**	Quality and compliance monitoring: **medium**
Diversion rate: **high**	Diversion rate: **medium**	Diversion rate: **high**
Influences by season: **low**	Influences by season: **high**	Influences by season: **low**
Bring scheme with road containers	**Bring scheme with road containers & identification system**	**Bring scheme with road bins**
KW	**KW**	**KW**
		
Identification of waste producer: **none**	Identification of waste producer: **high***	Identification of waste producer: **none**
Quality and compliance monitoring: **low**	Quality and compliance monitoring: **medium**	Quality and compliance monitoring: **low**
Diversion rate: **medium****	Diversion rate: **medium**	Diversion rate: **medium****
Influences by season: **high*****	Influences by season: **medium**	Influences by season: **low**

Source: Pictures by © Marco Ricci

** The user accesses the bin by providing identification, but the system does not allow direct control of the quantity and quality of the bagged contents.*
***The "Diversion rate" can be conditioned by the complementary instruments applied. Since the participation is voluntary, for some experiences the rates can be even lower.*
**** Even though the model only collects KW, open road containers enable users to deliver other types of waste such as garden waste, especially when the entry aperture is not sized or reduced.*

All schemes for kitchen waste collection mentioned in Table 7 can be applied to a range of different urbanisation types; generally, in urbanised areas all schemes are applicable to households, including door-to-door schemes (see in **Annex 1** the cases of **Parma (IT)** and **Milan (IT)**). Compared to urbanised situations, in rural areas, lower frequencies of collection or bring schemes are often applied by local authorities to simplify the logistics of collection and transport. This approach also limits the collection of excessive amount of garden waste, for schemes that collect both kitchen waste and garden waste commingled. Examples referring to cases collecting kitchen waste in less-urbanised areas can be found in **Annex 1** (see examples from **Berguedà (ES)** and **Straubing-Bogen (DE)**).

The following Table 8 shows the main aspects regarding the collection of garden waste from households only. Among the three options considered, preference should be given to schemes allowing to control the quality of the waste delivered to recycling, hence bring schemes may lead to large amounts of contaminants, difficult to sort from the actual waste type intended to be collected separately. The first example with single-use paper bags allows for seasonal deliveries of garden waste, limiting excessive amounts of waste and guiding households to deliver further amounts to collection centres (or by means of home composting).

Table 8. Pros and cons of different collection schemes for garden waste

D-t-D scheme at single household	Bring scheme for households	Collection Centre
GW	**GW**	**GW**
		
Identification of waste producer: **high**	Identification of waste producer: **none**	Identification of waste producer: **high**
Quality and compliance monitoring: **high**	Quality and compliance monitoring: **low**	Quality and compliance monitoring: **high**
Diversion rate: **high**	Diversion rate: **medium**	Diversion rate: **medium**
Influences by season: **high**	Influences by season: **high**	Influences by season: **low**

Source: Picture left, Creative Commons; centre and right, Marco Ricci

A further factor to be considered is the cost for cleaning and rinsing the receptacles for bio-waste and especially for kitchen waste collection. While bins and containers for bring schemes need regular cleaning by waste collection services, collection tools provided to households in door-to-door schemes are managed directly by waste producers; in the latter case, this is further simplified if waste producers are provided with bags and liners by local authorities of waste management services.

Complexity of logistics and the costs for collection and transportation increase when moving from bring-schemes to door-to-door scheme at single household. There are instruments to compensate these additional costs in order to favour the schemes where quantity and quality of the bio-waste collected are enhanced, e.g., increasing the cost of disposal of the residual waste, considering the larger revenues for the products (i.e. compost, digestate or biogas), besides the lower amounts of rejects generated during the recycling process. Economic drivers and instruments are addressed in **LIFE BIOBEST D3.2 Guideline on governance and economic incentives**.

3.3 The quantity factor

The type of scheme applied to separately collect kitchen waste from households will significantly affect the quantity collected per inhabitant. This determines a potential as well for reducing the amounts of residual waste collected and decrease the quota of organics inside the residual waste.

According to **LIFE BIOBEST D2.2 Statistical analysis identifying best practices, successful and less successful cases**, door-to-door schemes for "kitchen waste only" determine significant larger quantities collected per inhabitants compared to bring schemes. In case of schemes collecting bio-waste (i.e. a mixture of kitchen and garden waste) the amounts per inhabitant may be larger than schemes for kitchen waste only. This result derives from the collection of large amounts of garden waste; the latter choice affects the scheme negatively in terms of a strong seasonal variation of the amount collected. Examples can be seen in Table 9, which also includes a qualitative indication about the range of expected quality values of the collected kitchen waste, according for the types of collection schemes.

Table 9. Amounts of kitchen waste collected at households for different collection schemes

D-t-D scheme (KW)	Bring scheme (KW)	D-t-D scheme (KW and GW)
		
Amounts collected: **90-114 kg/inhab./yr**	Amounts collected: **39-79 kg/inhab./yr**	Amounts collected: **67-83 kg/inhab./yr** (Bio-waste, of which KW is often around 40-50%)
Influence by seasonality: **low**	Influence by seasonality: **medium**	Influence by seasonality: **high**
Quality: **good** Typical range of contaminants: **1 - 5% f.m.:**	Quality: **acceptable to critical** Typical range of contaminants: **5 - 12% f.m.**	Quality: **good** Typical range of contaminants: **0.5- 5% f.m.**
Source of quantitative data: **LIFE BIOBEST D2.2 Statistical analysis identifying best practices, successful and less successful cases** from Denmark, Catalonia and Italy	Source of quantitative data: **LIFE BIOBEST D2.2 Statistical analysis identifying best practices, successful and less successful cases** from Denmark, Catalonia and Italy	Source of quantitative data: NABU, German Bio-waste collection in Germany 2023

Source: Pictures by © Marco Ricci

3.4 The quality factor

Separate collection of bio-waste faces the issue of physical contamination by non-compostable materials such as plastics, metal and glass. This affects both the efficiency of the recycling process and the quality of end products such as compost and digestate.

Visual examples of different batches of bio-waste received by the recycling facilities are shown in Table 10 indicating the rate of contamination. Contaminants are usually quoted as percentage of non-compostable materials related to the total amount of bio-waste, i.e. expressed as fresh matter (f.m.).

Table 10. Examples of physical contamination of separate collected bio-waste

Market waste with 1.5% contaminants

KW with <0.5% contaminants
 
KW with 1.5% contaminants
 

KW with 5% contaminants

KW with 10% contaminants

KW with 15% contaminants

GW with 1.3% contaminants

GW with 5% contaminants

Source: Pictures by © Waste Agency of Catalonia and by © CIC Consorzio Italiano Compostatori

As discussed in **LIFE BIOBEST D5.3 Proposition of quality standards**, since physical contaminants hinder the recycling process and reduce the effectiveness and efficiency of composting or anaerobic digestion plants, associations supporting bio-waste recycling such as ECN (European Compost Network) and EBA (European Biogas Association) recommend preventing contamination of sorted bio-waste, starting from a specific commitment by producers in sorting their recyclable waste correctly. Recommendations on this topic are also available in **LIFE BIOBEST D5.2 Policy brief**, **LIFE BIOBEST D3.3 Guideline on quality compost and digestate**, and **LIFE BIOBEST D5.4 EU Comprehensive guidance**.

3.4.1 Quality check and controls during collection

In door-to-door schemes, public authorities can mandate the waste collection operator to visually inspect the content of the bins and refuse to collect bio-waste that, at a glance, presents high amounts of contaminants (such as glass, metal and plastics) inside. In this case, the collector should leave an explanation for the waste producer about why the bin was not collected, together with advice on how to improve future separation.

An alternative is to fine the non-compliant household, e.g. the collection of the contaminated bio-waste as residual waste including a much higher fee.

Inspections and enforcement of controls are easy to be conducted at single-unit houses or single commercial producers, where they can reduce impurities[2] from 3% to about 1% as in the case of **Münster (DE)** mentioned in **Annex 1**. In large buildings comprising multiple apartments, individual controls are more difficult to implement and the inspection is usually applied to collective bins so a collective feedback is provided to group of users of the concerned bin (see the case of **Milan (IT)** in **Annex 1**). For more information, see **LIFE BIOBEST D3.3 Guideline on quality compost and digestate.**

In that case of **Münster (DE)**, a common inspection and sensitization approach was used, but recently, some interesting case studies using a different approach were tried, like "social norm" nudging techniques and positive reinforcement (e.g. a green sticker saying "well done", or a red one delivering a message like "your neighbours are doing better than you"). This is the case of the municipality of Latina[3] in Italy, which experimented a decrease in the number of bins rejected because of impurities during a trial period carried out in 2023.

At bring schemes, quality controls are possible, but with little chance of tracing contamination to single waste producers. On this issue, an interesting pioneering trial was performed in 2022 in the scope of the EU funded project LIFE RethinkWaste in Sant Just Desvern (ES) by sending WhatsApp messages to citizens who delivered kitchen waste in

[2] According to Schulenborg K. from EGW-DE , presentation at the BIOBEST workshop on 2024-03-13 in Lyon.

[3] "Un sorriso per l'ambiente", campaign performed in 2023. https://www.ireneivoi.it/migliorare-la-raccolta-differenziata-con-stelle-e-smile/

access controlled road-containers, comprising a picture of the content with the following quote: "the quality of the kitchen waste in the container you typically use is critical, please try to do better".

To prevent contaminated bio-waste from entering recycling facilities, economic penalties (e.g., through variable gate fees) should be defined in contracts with local authorities/municipalities and waste collection services; hence batches of bio-waste that do not meet acceptable quality standards and exceed the established threshold values for physical contaminants should not be accepted by recycling plants. Further details about these instruments can be found in **LIFE BIOBEST D3.2 Guideline on governance and economic incentives**.

Here, a specific governance role from public authorities is requested. If gate fees are simply left to market dynamics, quality may not be ensured as in some cases the priority for recycling plant operators is to maximise bio-waste quantity, neglecting its quality. Examples of this approach can be found in the best practice cases of the regions of **Catalonia (ES)** and **Sardinia (IT)**.

3.5 The home composting factor

For urban areas preference should be always given to municipal collection schemes for bio-waste, especially to assure a continuous service and diversion of kitchen waste from disposal towards recycling. Home composting may play a role in managing part of the garden waste arising from households in urban areas with an own garden.

To follow this approach, it is important that the set-up of the specific collection schemes or services for kitchen waste and for garden waste are not dis-incentivising the participation of households in home composting.

Convenient municipal services for collection of garden waste with door-to-door or bring-schemes will not drive household to commit to home composting, vanishing the intention of local authorities to prevent/reduce the amounts of garden waste to be collected. Instead, collection centres for garden waste represent a balanced approach between the needs for a collection service and the possibilities for households to recycle this bio-waste fraction at home (in their gardens). In the case that home composting and collection centres do not reap the intended outcomes, there must be flexibility to devise an alternative solution to collect garden waste. Home composting, as discussed in **LIFE BIOBEST D3.2 Guideline on governance and economic incentives**, can be supported by economic incentives in the charges.

The role of home composting becomes more significant in detached and rural areas where the logistics for collecting kitchen waste frequently becomes economically challenging. With a proper training and supported by local experts (so called "master composter"), this system can contribute to reduce the amounts of bio-waste collected inside the residual waste.

Table 11. Home composting approaches depending on the type of area

	Rural areas	Urban areas
Bio-waste streams addressed	GW and KW	Mainly GW
Role	Substitution of collection service in isolated areas	Alternative to collection service of GW and (partially) KW as a complementary model to collection
Potential	High for GW and KW	High for GW, low for KW
Percentage of households that can be involved	Medium to High	Low

In terms of effectiveness, a specific monitoring protocol should be implemented by local authorities to ensure that the home composting scheme is used effectively over time by households. In most rural areas where kitchen waste collection is not available and home composting is the only option, there is the risk that many households will not participate, leaving high amounts of kitchen waste inside the residual waste. Hence if it is economically viable a minimum collection service for kitchen waste should be established, even with low frequencies and optimized routes; in addition, periodical waste composition analyses on residual waste should be performed in order to assess the effectiveness of reducing kitchen waste in it through home composting.

A number of the best practice cases mentioned in this guideline (see **Annex 1**) include also home and community composting as part of the local approach to collect and treat bio-waste separately, for example the cases of **Berguedà (ES)** or in the district of **St. Pölten (AT)**. Some experiences rely also on home/community composting for recycling kitchen waste at a number of households located in urban areas, as in the case of the city of **Hernani (ES)**.

4 Tools for separate collection

4.1 Tools for kitchen waste collection

There are many possible collection tools that local authorities or waste collection companies should provide to households and commercial producers to enhance their participation in sorting kitchen waste, considering its fermentable nature, its high moisture content and tendency for odour and leachate release during inappropriate in-house storage.

Single use bags become a necessity when households are requested to collect most of the kitchen waste produced including cooked food leftovers, liquid food residues, etc. Conventional plastic bags must be avoided to prevent plastic fragments to end-up in the recycled final products (i.e. compost or digestate).

Biodegradable and compostable paper or plastic bags are a proven and a valid alternative largely used since decades. However, this includes the restriction that only items certified according to the EU harmonised standard[4] EN-13432 comply with the standard process of industrial composting facilities. The choice of the type and material of bags should be made upon the type of recycling facilities (i.e., composting, anaerobic digestion or combined anaerobic digestion and composting plants).

Table 12 lists a selection of collection bins, buckets of single use bags and other tools for households involved in separate collection schemes for kitchen waste. The set of best practice cases summarised in **Annex 1** visualize how and in which contexts this range of waste-receptacles is applied to different collection schemes and situations.

In some contexts, the collection services include also large, non-domestic producers. Kitchen waste collection at commercial producers (i.e. coffee-shops, restaurants and canteens and others) can be organised with the same type of wheeled bins listed in the tables for households.

As a general rule, bring schemes with bins or containers located permanently on the road should avoid oversizing the volumes installed to prevent the commingled collection of bio-waste with other non-compostable waste streams (such as plastics, glass, etc.) that are generated in municipalities and that negatively affect the recycling process of bio-waste.

[4] EN-13432 "Requirements for packaging recoverable through composting and biodegradation - Test scheme and evaluation criteria for the final acceptance of packaging".

Table 12. Tools for kitchen waste collection at households and commercial producers

Tool for households	Picture	Comment
Kitchen-caddy (6-12 L)		For each household
Bags and liners (made of paper or compostable plastics)	 	Usually between 50- 100 per household per yr
Caddies for collection (20-30 L)		For schemes collecting KW only from households in detached and low-rise buildings
Wheeled bins (80-240 L)		For households in high-rise buildings (KW only schemes) and for CP For households with gardens (commingled bio-waste collection schemes) For KW collected with bring-schemes
Containers (400-3,200 L)	 	For households in high-rise buildings (KW only schemes) and highly densely populated areas (bring-schemes)

4.2 Tools for garden waste collection

The possible collection tools that local authorities or waste companies should provide to households for the collection of garden waste are listed in Table 13.

Reusable tools such as bins or thick conventional plastics bags are the main alternatives for garden waste door-to-door schemes. Roadside bring schemes are implemented with standard volume road containers. Single use conventional plastic bags must be avoided to prevent plastic fragments to end-up in the recycled final products (i.e. compost or digestate). Single use biodegradable and compostable paper bags certified according to the EU harmonised standard EN-13432 can be used.

Table 13. Tools for garden waste collection at households

Tool for households	Picture	Comment
Single use Paper bags Reusable Plastic bags (100-150 L)		For D-t-D schemes collection
Wheeled bins (120-240 L)		For D-t-D schemes collection
Containers (400-3,200 L)		For bring schemes collection
Containers (>10,000 L)		For collection at municipal centres or other drop-off points

5 Frequencies of collection

5.1 Frequencies of collection for kitchen waste schemes

Collection frequencies for household kitchen waste need to consider the climatic conditions, the density of population and the average production of bio-waste from specific waste producers. The collection frequency often varies even between single cities or different municipalities belonging to the same Member State.

As a general rule, for schemes tackling kitchen waste, it is preferable to have a higher collection frequency compared to residual waste and in warmer climatic conditions frequencies need to be increased in summer months to avoid possible odours. In addition, seasonal variations can occur also in regions with commingled bio-waste collection, including a reduced frequency during low vegetation season.

Where kitchen waste is collected more frequently than residual waste, acceptance of the system and participation of households are usually high, since odours are avoided. Typical frequencies applied in a range of different situations are shown in Table 14 below (see **Annex 1** for a more detailed description of each best practice case). As it can be seen in the Annex, a ratio of at least 2 to 1 between the collection of kitchen waste and the one of residual waste is often applied.

Table 14. Frequencies of collection for kitchen waste in door-to-door schemes

Case	District Dabagoiena (ES)	City of Parma (IT)	Island of Krk (HR)	District St. Pölten (AT)	City of Münster (DE)
Type of KW collection	KW only	KW only	KW only	KW only	KW & GW
Frequency of collection at households (times per wk)	3	2 - 3	2 - 3	0.5 - 0.75	1
Ratio KW vs residual collection freq.	3/1	3/1	2/1	2/1	2/1

For touristic areas, the increase of collection frequencies for kitchen waste in the high-touristic season becomes even more important, considering the increase of population; examples of touristic areas with collection schemes for kitchen waste at households are mentioned in **Annex 1** (in particular **Sardinia (IT)** and **Krk (HR)**).

Collection frequencies at commercial producer should be at least the same applied to households; where there is a sufficient number of those "large producers" of kitchen waste, a dedicated collection service, with higher frequencies of collection is advisable, and frequencies can be up to daily in hot, typically mediterranean areas.

5.2 Frequencies of collection for garden waste schemes

Collection frequency needs to consider the seasonal arisings due to climatic conditions and the number of households with gardens in specific areas.

As a general rule, the collection for garden waste only schemes should be seasonal, with frequency to increase from late spring to autumn; thus the service of collection can be reduced or suspended in winter period. Schemes collecting garden waste commingled with kitchen waste can increase the frequencies of collection during periods of larger production of garden waste; this avoids excess volumes per household during the rest of the year.

For households in rural areas, it is recommended to not propose a collection service for garden waste, thus promoting the participation of households in home composting and the delivery by them directly to municipal collection centres.

Table 15. Frequencies of collection for garden waste schemes for households

Case	D-t-D scheme	D-t-D scheme with PAYT[5]	Bring scheme - road containers	Bring scheme - containers	Collection centres
Frequency of collection (times/wk)	Up to 1	Up to 1	Up to 2	1/month	-
Detail	Seasonal service	Seasonal service	Annual service with changing frequencies	Temporary available	Emptied when full

[5] Pay-As-You-Throw is a scheme in which waste fees paid by users are modulated according to the amount of mixed waste delivered to the waste management system.

6 Integrating collection schemes with different types of bio-waste recycling plants

Bio-waste recycling can be divided into two main biological processes: composting and anaerobic digestion. These processes may be applied also combined (first the anaerobic digestion of the bio-waste followed by the composting of the resulting digestate). Composting plants can be locally available in a wide range of scale or capacity ranging from micro scale (individual, home and community composting initiatives) up to large-scale industrial plants treating tens of thousands of tonnes per year. How to manage the recycling of bio-waste at industrial facilities is described in **LIFE BIOBEST D3.3 Guideline on quality compost and digestate**.

Table 16. Types of biological treatment for recycling bio-waste

Type of biological treatment[6]	Composting	Anaerobic digestion	Combined anaerobic digestion & composting
Process description	Aerobic biodegradation and stabilisation of bio-waste	Anaerobic biodegradation and stabilisation of bio-waste	Anaerobic biodegradation of bio-waste followed by composting of the digestate
Number of facilities available in Europe[7]	3100	1600	
Output products	Compost	Digestate Biogas	Compost Biogas
Scaling and size of facilities	Can be scaled from small, to medium and large capacity	Needs minimum capacity to sustain investment costs	

Hence, the selected type of collection scheme planned to be realised has to consider the constraints of the recycling facilities that are already locally available or that are in the planning phase. The main aspects to evaluate when integrating collection schemes with different types of bio-waste recycling plants are schematised in Table 17 and consider:

- Three main types of biological treatments (composting only, anaerobic digestion only and combined facilities).

[6] In this document we do not describe the difference between digestate and compost from an agronomic point of view.

[7] Number of facilities in Europe in 2022 treating separately collected biowaste. Source: ECN, Data report 2022.

- Three types of collection schemes (for kitchen waste only, for garden waste only and collecting kitchen waste jointly with garden waste).
- The effect on the gate fee and the possibility to vary the cost according to the type and the quality (in terms of physical contamination) of bio-waste delivered at the plant.
- The type of bags acceptable for each type of biological treatment, considering biodegradable and compostable paper or plastic liners; in all cases these single use items need to be certified according to EN-13432 standard.

Composting appears to be the most flexible approach in terms of sizing the capacity of plants according to the amount of bio-waste produced locally. An initial step of anaerobic digestion before the composting process tends to reduce the dependency on structuring materials (garden waste) especially when treating large amounts of kitchen waste.

Table 17. Type of feedstock accepted according to the local recycling facility

Feedstock	Compost plant	Biogas plant	Combined biogas & compost plant
GW only	Accepted	Limit acceptance (avoid wooden GW)	Accepted (as structuring material)
KW only	Accepted (supplemented with structuring material)	Accepted	Accepted
Bio-waste	Accepted	Accepted	Accepted
Bags and liners (types)	Made of biodegradable and compostable paper or plastic	Made of biodegradable and compostable paper only	Made of biodegradable and compostable paper or plastic
Combined KW and GW collection scheme	Same gate-fee applied for all feedstock provided Facility capacity affected by seasonal fluctuation		
Separate schemes for KW and GW collection	Different gate-fee applied for KW and for GW Facility can buffer GW during peak-season		

The acceptance of specific types of single-use bags or liners, made of biodegradable and compostable paper or plastic, should be verified in advance with the local facility.

7 Communication and involvement

Communication needs to be considered as an integral part of the tools applied in modern MSW management to reach the recycling target established by the WFD. It plays a strategic role in involving households and commercial producers in sorting their waste regularly, paying attention to the quality of the feedstock that will be delivered to composting and anaerobic digestion plants for recycling.

How communication campaigns have been rolled out in specific cases and context is shown in **LIFE BIOBEST D3.4 Factsheets on the analysis of best practices in communication and engagement from various countries**. For the context of this guideline, it is worth highlighting the following main aspects:

- When local authorities aim to start collection schemes for bio-waste, communication needs to be planned from the beginning, as part of the new scheme.
- Communication initiatives need to address waste producers (i.e. households) by both motivating a change of habits and by giving practical instructions on how to sort bio-waste correctly.
- Communication should be continuous, being able to inform waste producers about the results achieved in bio-waste recycling and the fate of the recycled product (for example, which is the use of the compost produced from the recycling of bio-waste).
- If individual monitoring is in place (e.g. when kitchen waste buckets and bins are equipped with a UHF-RFID[8] tag, a microchip able to support the traceability and the identification of waste) these "big data" generated should be used for specifically targeted sensitization campaigns, for instance to assess who is not participating enough to kitchen waste collection and why.
- Making recycling products available to waste producers is an excellent closed loop approach; this can be achieved for example by making the compost - obtained from bio-waste recycling – available to local households or by advertising the use of biomethane – produced from the anaerobic digestion plants – in local public transports.
- Communication initiatives can involve local "resources" such as non-governmental organisations and non-profit organisations engaged in social or environmental issues.

[8] UHF-RFID = Ultra High Frequency-Radio Frequency Identification

Finally, communication initiatives need to be correctly budgeted to be developed in a timeframe aligned with the start-up of new collection services for kitchen waste recycling.

Figure 2 provides a list of accepted and unaccepted waste types in kitchen waste in various languages to cover the population of a large metropolitan area. Figure 3 shows an example of communication focusing on reducing contaminants (plastics) in the bio-waste bin.

Figure 2. Examples of information in Italian about kitchen waste collection in the City of Milan (IT) in various languages

Source: www.amsa.it, accessed in March-2023

Figure 3. Examples of information in German about kitchen waste collection avoiding plastic waste in the district of Borken (DE)

Source: https://www.wirfuerbio.de/egw/, accessed in March 2023

8 Best Practice cases

This guideline includes a set of best practice cases from different EU Member States and for a range of urban or rural areas (see **Annex 1**); the survey is intended as a useful reference and example to the concepts and approaches mentioned in the guidelines prepared within the LIFE BIOBEST project.

Focusing on kitchen waste collection, each best practice case applies mainly door-to-door schemes, while some bring schemes (road containers or wheeled bins) are applied to part of the population (such as in rural areas) or as a general choice. A few rural districts rely also on home composting for part of the households that are not linked to a collection scheme for kitchen waste.

Table 18. Best practice cases summary

BP case	Type of area	D-t-D scheme for KW	Bring scheme for KW	Home composting for KW
City of Maia (PT)	Urban	x		
City of Hernani (ES)	Urban	x		x
County of Berguedà (ES)	Rural	x		x
County of Debagoiena (ES)	Rural	x	x	
City of Mataró (ES)	Urban	x	x	
City of Milan (IT)	Urban	x		
City of Parma (IT)	Urban	x		
City of Bratislava (SK)	Urban	x		
Island of Krk (HR)	Touristic	x		
District St. Pölten (AT)	Rural	x		x
District of Straubing-Bogen (DE)	Rural	x		
City of Münster (DE)	Rural-Urban	x		
District of Kempen (BE)	Rural	x		

Each case summarises the relevant information to understand how bio-waste produced by households (and by other waste producers) is managed locally. The cases also include information about the management of garden waste and residual waste.

The regional cases of **Catalonia (ES)** and **Sardinia (IT)** are also included among the best practices (**Annex 1**) and they are described with larger detail on their legal and economic instruments, designed to promote the separate collection and recycling of MSW and studied in detail within **LIFE BIOBEST D3.2 Guideline on governance and economic incentives**.

Table 19. Regional best practice cases summary

BP case	Type of area	D-t-D scheme for KW	Bring scheme for KW	Home composting for KW
Region of Catalonia (ES)	All range	x	x	x
Region of Sardinia (IT)	All range	x		

9 Lessons learned

There are a number of elements that can be highlighted from the best practice cases investigated and the suggestions included in this document. Bio-waste is a mixture of variable amounts of kitchen and garden waste, whose quantities depend on how the scheme is set-up and what types of biodegradable waste is requested to be sorted, according to the instructions delivered by local authorities and the collection services to waste producers.

1. **Regarding kitchen waste collection:**

- Kitchen waste is a critical waste to sort at home, considering its high moisture and the tendence to degrade fast, especially if it contains meat or cooked residues. Hence, almost all success schemes make use of a set of tools to ease households in sorting their kitchen waste at home. These tools start from (vented) kitchen caddies including biodegradable and compostable paper or plastic liners.
- Kitchen waste collection at households works better where door-to-door schemes are in place, allowing the design of the service according to the production and the needs of single (or groups of) waste producers. In addition, door-to-door schemes allow to check the quality of the waste sorted at single households or buildings. Hence, compared to bring-schemes these approaches increase the amount collected and reduce the physical contaminants.
- Frequencies of separate collection play an important role when aiming to engage the participation of households and large producers. In this context, kitchen waste should be always collected more frequently than residual waste.
- Type and size of the bins for kitchen waste collection influence the possibility to allow garden waste to be delivered together with kitchen waste. Kitchen waste -only schemes are characterised by the production of smaller volumes per person compared to schemes collecting both garden waste and kitchen waste. The availability of large volume bins bear the risk to collect also non-recyclable or bulky MSW.

2. **Commingled versus separate kitchen waste and garden waste collection:**

- Bio-waste represents a commingled collection of both kitchen waste and garden waste generated in private gardens and/or vegetable gardens.
- Commingled collection is logistically simpler to perform compared to single-stream schemes. However, the joint delivery of both, garden waste and kitchen waste, at the same recycling plant and therefore with the same fees, may impact negatively the costs for recycling, considering that the cost for treating kitchen waste is generally higher than the one for garden waste.
- Separate collection of kitchen waste and garden waste as individual streams allows a better planning of both collection services, adapting the latter to the seasonal

arisings and limiting unrequired bin volume that could be filled with contaminants otherwise. It also allows local authorities to collect kitchen waste more frequently.

3. **Regarding garden waste collection:**

- Garden waste is collected less frequently than kitchen waste, reflecting the different characteristics of the two streams and the seasonality of garden waste compared to the generation of kitchen waste; supervised collection centres or door-to-door schemes perform better in preventing contamination during separate collection.
- Low-frequency collection schemes for garden waste also stimulate the participation of households in home composting initiatives, thus preventing large amounts of bio-waste to be managed by public services.

The best practice cases attached to this guideline clearly show how kitchen waste collection has been established by local authorities, by considering a broad picture of integrated MSW management. Thus, in most cases it includes a significant reduction in collection frequency for and amount of residual waste, following the reduction of the amounts of putrescible waste that is sorted with a dedicate collection scheme.

The cases investigated also prove that intensive sorting scheme for kitchen waste can be successfully applied in a wide range of houses, ranging from detached, to semi-urban and to metropolitan areas. In addition, the role and contribution of home composting is detailed in a number of rural, low-density areas.

The examples investigated cover also most climatic conditions that can be found in EU countries, ranging from West to East and from South to North.

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- Annex 1: Best Practice cases on bio-waste collection

References

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