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LIFE BIOBEST

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

D5.3: Proposal for quality standards for bio-waste entering biological recycling facilities

WP5: Policy and regulatory recommendations for bio-waste

T.5.4: Proposal for EU standards for bio-waste entering recycling processes for high-quality compost and digestate.

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LIFE BIOBEST

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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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Lead Authors:	Steffen Walk
Other Authors Involved:	Stefanie Siebert (ECN), Gemma Nohales (ENT), Alberto Confalonieri (CIC), Melanie Brait (KBVÖ)
Peer Reviewers:	CIC - Alberto Confalonieri ZWE - Enzo Favoino Members of ECN Task Group

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1.2 Document Revision History

Table 2. Document Revision History

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0.1	15/06/23	1st Draft	Draft outline	ECN – Steffen Walk
0.2	16/08/23	2nd Draft	1st report content draft	ECN – Steffen Walk
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0.5	27/09/24	4th Draft	Discussion with Advisory Board and ECN task group	Advisory Board, Task Group Sep-Col
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1.0	28/11/24	Definitive/ Approved	Final comments incorporated	ECN – Steffen Walk
1.1	29/11/24	Submitted	Submitted to Participant Portal in PDF	ENT - Gemma Nohales

1.3 Acronyms

Table 3. Table of Acronyms

Acronym	Term
% w/w	Weight based percentage (Weight per weight)
AI	Artificial Intelligence
BP	Best Practice
CAPEX	Capital Expenditures
EU MS	European Union Member States
Ho.Re.Ca	Hotel, Restaurants, Canteens
Inhab.	inhabitants
KPI	Key Performance Indicator
mm	Millimetre
n	Number
OPEX	Operational Expenditures
t	tonnes
WFD	Waste Framework Directive

1.4 LIFE BIOBEST Project Summary

EU obligations on the selective 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 closing effectively 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 (BP) 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.

2 Focus of the document

The quality of bio-waste impacts the production of compost and digestate. Quality can act as both a driver and, if requirements are overly stringent, a barrier, significantly affecting the wider market. This document aims to establish unified quality standards for bio-waste entering the recycling process in the European Union Member States (EU MS), aligning with § 22, point 3 of the Waste Framework Directive (WFD, European Commission, 2018), which states:

> *"By 31 December 2018, the Commission shall request the European standardisation organisations to develop European standards for bio-waste entering organic recycling processes, for compost and for digestate, based on best available practices."*

To date (2024), no such standard has been developed, which highlights the importance of this proposal.

LIFE BIOBEST D5.3: Proposal for quality standards for bio-waste entering biological recycling facilities considers the various approaches currently adopted by EU countries, beginning with a description of existing quality standards and defining controls or limits for impurities in bio-waste (Chapter 4). The establishment of a unified quality standard, however, necessitates a harmonised methodology for the physical analysis of bio-waste, specifically regarding the proportion of impurities. This crucial element, leading to recommendations for such a methodology, forms the core of this document. It includes a review of national and regional methodologies for bio-waste compositional analysis (Chapter 5). A concise literature review connects input material to product quality (Chapter 6). Chapter 7, aligned with Work Package 2 of the LIFE BIOBEST project, outlines Key Performance Indicators (KPIs) relevant to input quality and their impact on processing. Additionally, the proposal summarises bio-waste quality insights from the best practice cases described in **LIFE BIOBEST D3.1 Guideline on separate collection** as well as in **LIFE BIOBEST D3.3 Guideline to promote quality compost and digestate**.

A key step in developing a unified standard was a stakeholder consultation survey which gathered opinions and information on existing national and EU regulations for bio-waste quality standards, including targets for maximum impurities (Chapter 8). This was supported by two workshops with the project's Advisory Board and ECN's task group on separate collection. The consultation led to recommendations for a unified bio-waste quality assessment methodology (Chapter 9). In addition, the document gives an orientation value for a maximum share of impurities in bio-waste (Chapter 10) based on expert views. The document concludes with final considerations for the implementation of a standard comprising a methodology as well as a target control value (Chapter 11).

This document is aimed at authorities and organisations with the capacity to implement regulations at local, regional, national and EU level. However, particularly Chapter 9, concerning the practical application of the assessment methodology for input controls, addresses local entities in responsibility for their practical implementation.

Bio-waste quality is directly linked to the set-up and the efficiency of the collection system but as well to local circumstances. This topic is addressed in LIFE BIOBEST D3.1 **Guideline on separate collection**. Local policies and economic instruments serve as both a catalyst for improving bio-waste quality and a mechanism for financing measures, such as waste compositional analyses, to ensure compliance with established quality standards. These are discussed in LIFE BIOBEST D3.2 **Guideline on governance and economic incentives**. For product quality requirements, LIFE BIOBEST D3.3 **Guideline on quality compost and digestate** gives information on existing standards (e.g., ECN-QAS) as well as legal quality obligations within the EU. Lastly, effective communication programmes and activities approaching citizens' (bio-)waste sorting behaviour can be a driver for high-quality feedstock sent for biological treatment. This topic is discussed in LIFE BIOBEST D3.4 **Factsheets on the analysis of best practices in communication and engagement from various countries**.

3 Definitions

Commingled bio-waste

Refers to collection systems focussing on the mixed collection of food waste and garden waste. In contrast, other systems may focus on food waste or garden waste only.

Control value and Limit value

In this report, a control value specifies a target for the maximum allowable impurities in bio-waste. It can serve as an orientational benchmark based on practical experience, aimed at achieving high-quality products with minimal technical intervention. As well, it can be linked to a bonus-malus financial system for the waste producer or collector. It leaves the option for plant operators to make individual agreements with the waste producer or collector which can include potential consequences when exceeding the control value.

A limit value, on the other hand, implies legal consequences, if exceeded. An exceedance of the limit value certainly transfers responsibility to the bio-waste producer or collector. Consequences are financial burdens and the rejection of the delivered batch. They also exclude the option of pre-treatment to remove impurities for the plant operator or to make an individual agreement with the waste producer or collector.

Dragging factor

This term is used to describe the relationship between the physical impurities present in bio-waste and the overall material rejected. It is therefore a measure of the losses of material for compost or digestate production.

Input Quality and impurities

In terms of bio-waste, "input quality" refers to the physical quality of the assessed separately collected material and is commonly expressed as the share of impurities present in a sample. "Input" refers to the place of assessment during collection or the reception of the biological recycling facility. Common methodologies used for its assessment are described in this report. Materials considered as impurity are a potential threat to the process as well as the final product quality. The definition of materials considered as impurity differ slightly among EU MS. The ones commonly defined as an impurity are conventional soft and hard conventional plastics, coated (glossy) paper, metals, glass and textiles.

Pre-treatment

This step of the processing of bio-waste is required for the adjustment of particle size (shredding), removal of impurities (optional) and mixing. This is commonly done with techno-mechanical solutions. For further information, e.g., on specific technologies, see LIFE BIOBEST D3.3 **Guideline to promote quality compost and digestate**.

Product

In biological treatment, "product" mainly refers to compost and digestate. Other materials leaving the treatment facility, such as rejects, are not considered a product. Mass losses from input material to final fertiliser—such as evaporation, carbon dioxide from biodegradation, leachate, and biogas—are considered "inherent losses" (i.e., natural organic matter degradation) and may be included in recycling rate calculations. This inclusion is contingent on the biological treatment process being directed towards producing compost and digestate with benefits for soil and agriculture (European Commission, 2023).

Quality standard

A quality standard defines procedures and benchmarks for feedstock, process and product characteristics, such as the ECN Quality Assurance Scheme. In this report, quality standard refers to procedures for assessing bio-waste composition and quality prior to entering a biological recycling facility. It also refers to minimum standards of bio-waste quality, specifically a target on maximum allowable impurity level in bio-waste delivered by a municipality to a bio-waste recycling facility. This standard can have potential legal consequences if exceeded. Overall, such standards set the basis for the suitability of feedstock for processing, principles for producing high-quality compost and digestate, and must ensure that product quality criteria can be met with minimal technical equipment for impurity removal.

Refining

This step of the processing of bio-waste is required for the (physical) quality adjustment of the final product. It can also be referred to as post-treatment. It commonly includes screening, wind sifting and/or magnetic separation. Screening can be performed the same way as during pre-treatment, but usually with smaller mesh sizes of the sieve in order to remove coarse particles (impurities and undecomposed wooden materials) from the final product. For further information, e.g., on specific technologies, see **LIFE BIOBEST D3.3 Guideline to promote quality compost and digestate**.

Reject

A reject is defined as a material that is removed either prior to (pre-treatment) or subsequent to (refining) the actual biological treatment. The material is then subjected to further external treatment, such as landfilling, thermal processing or the recovery of additional materials, and it is not retained within the final product generated during biological treatment. This predominantly mechanically removed material is commonly characterised by a high concentration of impurities, including plastics and glass. However, it also includes organic and biodegradable materials, such as bulky bio-waste which gets discarded by the drum screens, bio-waste or compost that sticks to impurities to be rejected, and/or final compost that fails to meet the required quality standards. All these discarded materials are excluded from the recycling rate.

Waste category

Refers to a specific type of waste according to an official definition. This includes, for example, food waste, garden waste sorting aids or impurities.

Waste composition

This term includes all materials or fractions found in the specific waste to be analysed according to the specific waste sorting protocol. Therefore, waste composition refers to all acceptable bio-waste as well as impurities.

Waste compositional analyses can also include a differentiation of bio-waste materials into different fractions of acceptable material, to better understand the sorting habits and performance of the waste producer. This includes, for example, a distinction of food waste and garden waste.

Waste fraction

Refers to a sub-category of waste. For example, a fraction of impurities can be plastics, metals and glass.

Wet weight

This term is commonly used in relation to waste composition analyses. It is commonly also referred to as fresh matter or fresh weight. It defines that the basis of the results of a waste composition analysis is its initial mass, including moisture content. In this document, it is referred to this mass when discussing methodologies of bio-waste composition analysis Other reference points include a distribution of waste fractions by volume or by dry mass. Distribution as a share is mostly weight-based and therefore indicated as weight per weight and abbreviated as (%) w/w.

4 Bio-waste quality standards in place in EU MS

4.1 Reasons for the need for a target for maximum impurities in bio-waste

The following reasons are examples for the need of a target/control value of impurities in the feedstock material, at least as an orientational value.

1. The quality of bio-waste sets the basis for the quality to be expected for the products to enter the market.
2. The high costs associated with pre-treatment and refining (both OPEX as well as CAPEX) → These costs should be partly borne by the polluter, in accordance with the quality delivered. This could provide an incentive for the polluter to implement measures for improvement.
3. The limitations of mechanical pre-treatment and refining processes.
    - substantial losses of biodegradable material and therefore of final product to the reject fraction due to the "dragging factor" → This has a direct impact on the recycling rates
    - not all impurities can be technically removed and have to be reduced at the input
4. The fragmentation of materials poses a significant challenge, as small particles are likely to persist in the final product. These may either originate from the bio-waste itself or result from mechanical treatment processes. Of particular concern are plastic particles, which can degrade into microplastics, and glass particles. Minimising the presence of materials prone to fragmentation in the feedstock is essential to reducing the risk of their accumulation in the final product.

4.2 Examples of input quality standards and recommendations

Exemplary countries and regions with quality standards and recommendations in place are listed in Table 4. It shows information on their status, the point of assessment and assessment method. The latter is described in more detail in Chapter 5.

To date, in the EU only Germany, Austria, and, at regional level, Catalonia (Spain) have developed and implemented mandatory national/regional input quality standards and mechanisms for their compliance. The assessment methods are described in independent technical documents developed by composting organisations (e.g., BGK in Germany, CIC in Italy). Except for Germany, these methodologies do not hold binding legal status but have instead developed into widely accepted common practice.

Table 4. Existing input quality standards and recommendations in EU MS

Country	Statute	Legal status	Point of assessment	Assessment method	Method
AT	Kompost-verordnung, 2008	Mandatory, in revision (2024)	Set-up of compost pile	Visual inspection + Compositional analysis	Beigl et al., 2020
DE	Bioabfall-verordnung, 2022	Mandatory	Treatment input	Visual inspection (Compositional analysis is specific cases)	BGK, 2022b & BGK, 2021
IT	4° Compendio Tecnico CIC, 2012	Voluntary	Entrance of treatment facility	Compositional analysis	UNI, 2021
ES, Catalonia	Catalan Law 8/2008, (2008)	Mandatory	Entrance of treatment facility	Compositional analysis	ARC, 2022

4.2.1 Austria

The Austrian Compost Ordinance (Kompostverordnung 2008, amendment in 2024 and probably in place in 2025) regulates the production, marketing and use of compost made from bio-waste. The amendment to the ordinance includes requirements for the quality of material sent for biological treatment and introduces a three-tier classification for impurity levels in the bio-waste intended as input material for composting (anaerobic digestion is still excluded).

1. Control value: A maximum of 2% w/w impurities is required at the point the material is prepared for composting without further pre-treatment.
2. Intermediate range: Material with impurities > 2% w/w and < 5% w/w must undergo pre-treated to reduce impurities below 2% w/w.
3. Limit value: Material exceeding 5% w/w impurities must be rejected by the plant operator, as this constitutes a legally binding limit. However, such material may still be processed by a third party to reduce impurities.

The definition of impurities generally excludes bio-waste collection bags made of paper (incl. coating) and biodegradable plastics certified by EN 13432 as well as natural stones.

The ordinance does not specify a mandatory methodology for the assessment of impurities in bio-waste. However, it is clarified that a documentation by photo may be sufficient to verify the degree of impurities. A commonly used methodology for the bio-waste compositional analysis in Austria was developed by Beigl et al. (2020).

4.2.2 Germany

The German Biowaste Ordinance (Bioabfallverordnung 2012, as amended in 2022, will come into force in May 2025) regulates the use of bio-waste on soils. It includes requirements for the quality of input material to be sent for biological treatment, for the treatment process itself and for quality standards for compost and digestate as well as rules and limitations of their application.

In terms of input quality criteria, the new ordinance includes the right to reject batches of separately collected municipal solid bio-waste from households and similar delivered to a recycling facility with total impurities > 3% w/w. The right to reject depends on the legal agreement between the municipality or collector and the treatment facility operator. However, it must be ensured that the control value is complied with. While the inspection shall be taken at the reception, the boundary at which the share of impurities of 3% w/w shall not be exceeded is the entrance of the biological treatment, taking into account the possibility of pre-treatment processes and to pass on the responsibility to the polluter.

In addition, a control value of 1% w/w for total plastic particles with a size > 20 mm was included. Therefore, the amendment introduced the obligation to assess the specific plastic content of each batch delivered to a treatment facility at least by visual inspection. This method is the primary tool that the facility owner must apply to justify the rejection of a batch of bio-waste to the bio-waste supplier if the level of plastic impurities exceeds 1% w/w. The Federal Compost Quality Association (*Bundesgütegemeinschaft Kompost*, BGK) created an assessment methodology, which is described in section 5.2.2.

The definition of impurities generally excludes bio-waste collection bags made of paper (incl. coating) and biodegradable plastics certified by EN 13432. However, plant operators may decide whether they see these items as an impurity.

4.2.3 Italy

The Italian Compost and Biogas Consortium (*Consorzio Italiano Compostatori*, CIC) gives recommendations for an input quality assessment since 2012, further developing methods and evaluation criteria year after year (Centemero et al., 2024). Different quality classes depending on impurities content (w/w) are laid down, each one associated to comments and possible feedback actions, ranging from excellence (impurities content below 2.5%) down to such a poor quality (impurities exceeding 15%) that represent a threat to the recycling process and to the quality of compost. In this case, urgent and extreme actions are necessary, including the possible rejection of the bio-waste by plant operators. CIC has also established a calculation method for the determination of a higher treatment fee proportionate to the higher amount of impurities in the bio-waste fraction (CIC, 2012).

In 2021 UNI, the Italian Standardisation Body, published a methodology for waste composition analysis developed by CIC (UNI, 2021). It is not a legal requirement in Italy, but it is applied by CIC to perform approx. 1,400 analysis per annum (see Chapter 5.2.4).

National guidelines for applying minimum environmental criteria in Green Public Procurement for urban hygiene services require that companies responsible for municipal waste collection commit to improving waste stream quality, including bio-waste, aiming for a maximum impurity content of 5%. The definition of impurities generally excludes items compliant with EN 13432. ARERA, the Italian Regulatory Authority for Energy, Networks and Environment is currently preparing quality standards for the recycling of bio-waste, that will affect the gate fees at compost and/or biogas facilities. The assessment of municipal waste quality will become mandatory.

4.2.4 Catalonia, Spain

The Catalan Law 9/2008, of 10th July (2008), amending Law 6/93, establishes the separate collection of municipal waste in all municipalities of Catalonia. This is a substantial advancement from the previous Law 6/93, which included the same initial obligation but only for municipalities with more than 5,000 inhabitants. The current waste management programme PRECAT20 (ARC, 2012) includes the objective to reduce the average share of impurities in bio-waste below 10% by 2020.

With regard to the quality of input material, the Catalan landfill and incineration tax and tax refund system constitutes a major factor in the reduction of impurities in bio-waste. The Catalan Law 8/2008, of 10th July (2008), replacing Law 16/2003, addresses the financing of waste management infrastructures and final waste disposal taxes. The legislation establishes a refund system that supports municipalities with separate bio-waste collection in place and efforts to reduce impurities. Two distinct mandatory refund concepts are applied for bio-waste, one for collection and another for treatment. The concept for the collection includes a control value of impurities in separately collected bio-waste of 11.5% for 2024, which is subject to an annual decrease. In case this value is exceeded, the municipality will not receive this particular tax refund. Impurities are measured for each collection route of each municipality with a defined methodology as described in section 5.2.5. The definition of impurities generally excludes items compliant with EN 13432.

The refund calculations for collection and treatment concepts encompass a range of drivers designed to promote the reduction of impurities. These calculations are updated and published annually by the Catalan Waste Agency (ARC, 2024). They are based on a set of parameters, which are described in **Annex 2** – Summary of the Catalan tax refund system. ARC staff closely monitors waste characterisation results, promptly contacting local authorities in cases of significant variations, increased levels of specific impurities, or when the impurity control value for the tax refund is exceeded. At the conclusion of each characterisation period (each quarter year), detailed trend analyses are conducted using a set of KPIs and dashboards.

Additionally, most treatment facility operators establish agreements with municipalities that include variable gate fees based on the impurity content of each delivered batch.

4.3 Summary of input quality standards

Table 5 provides a summary of the existing quality standards in the EU for bio-waste entering biological treatment. It also includes information on the current status (2024) and the reference points for the control or limit values.

Table 5. Summary of existing quality standards for bio-waste

Country	Control value	Additional control	Information on status
Austria	5%	2%	Expected implementation: 2025. Limit value for rejecting delivery; additional control value for initiating compost pile.
Germany	3%	1%	Implementation: May 2025. Control value for optional delivery rejection; additional control for plastics requiring pre-treatment.
Italy	None	None	Quality assessment introduction initiated by the Italian public authority. Current target value of 5% in Green Public Procurement regulation.
Catalonia, Spain	11.5%	3%	In place. Annually decreasing control value for receiving the collection tax refund; additional control value for extra bonus. No legal right to reject delivery. Regional programme PRECAT20 set a 10% target until 2020; follow-up programme likely to reduce this to 5%.

5 Methodologies for the analysis of bio-waste quality

Methodologies described in this chapter can be generally distinguished into waste compositional analyses on a mass basis as well as visual inspection. As described in section 4.2, the described methodologies are only partially included in a statutory regulation. However, they may be found in independent technical documents which have become common practice.

5.1 Reasons for the need for a unified methodology

For introducing an EU-unified target for maximum impurities in bio-waste, a unified methodology for the waste composition analysis is a crucial first step. As described subsequently, current methodologies vary in terms of scope, sample size and preparation as well as fractions to be sorted. To name a few, the following aspects are reasons to develop a homogenised characterisation methodology:

1. Comparability of data: A harmonised approach ensures that data from different countries can be directly compared, supporting EU-wide assessments, benchmarking, and policy-making.
2. Standardisation of best practices: A unified methodology ensures that all EU MS follow best practices in waste characterisation, improving the accuracy and reliability of results. This fosters better decision-making at both national and EU levels regarding bio-waste management strategies.
3. Coherence of regulations: A common methodology ensures that compliance with regulations such as recycling targets or target values for impurities is assessed and enforced in a standardised manner throughout the EU.
4. Streamline bio-waste valorisation: Harmonised characterisation methodologies help streamline bio-waste valorisation processes, resulting in a more cost-efficient processing. This enhances the quality of compost and digestate.

5.2 Examples of applied methodologies for compositional analysis

Methodologies described in this chapter are frequently applied on a regional/national level or at least in studies with a regional/national scope. An exemplary detailed description of a practical methodology for the sampling, preparation and analysis developed by the Catalan Waste Agency can be found in **Annex 1** – Characterisation protocol for bio-waste in Catalonia - Methodology.

5.2.1 Austria

Although mentioned in the recently amended Kompostverordnung (2008), there is no documented method for a waste compositional analysis. A draft note suggests quality control can be verified through photo documentation of delivered batches. The methodology commonly applied for compositional analyses in Austria is outlined by Beigl et al. (2020). It includes a detailed description of fractions for characterisation (**Annex 3** – Waste fractions of the Austrian sorting protocol). It also outlines a method for determining the correct sample size based on the analysis target and primary fraction, distinguishing it as the only known methodology in the EU without a fixed sample size recommendation, instead providing a minimum sample size.

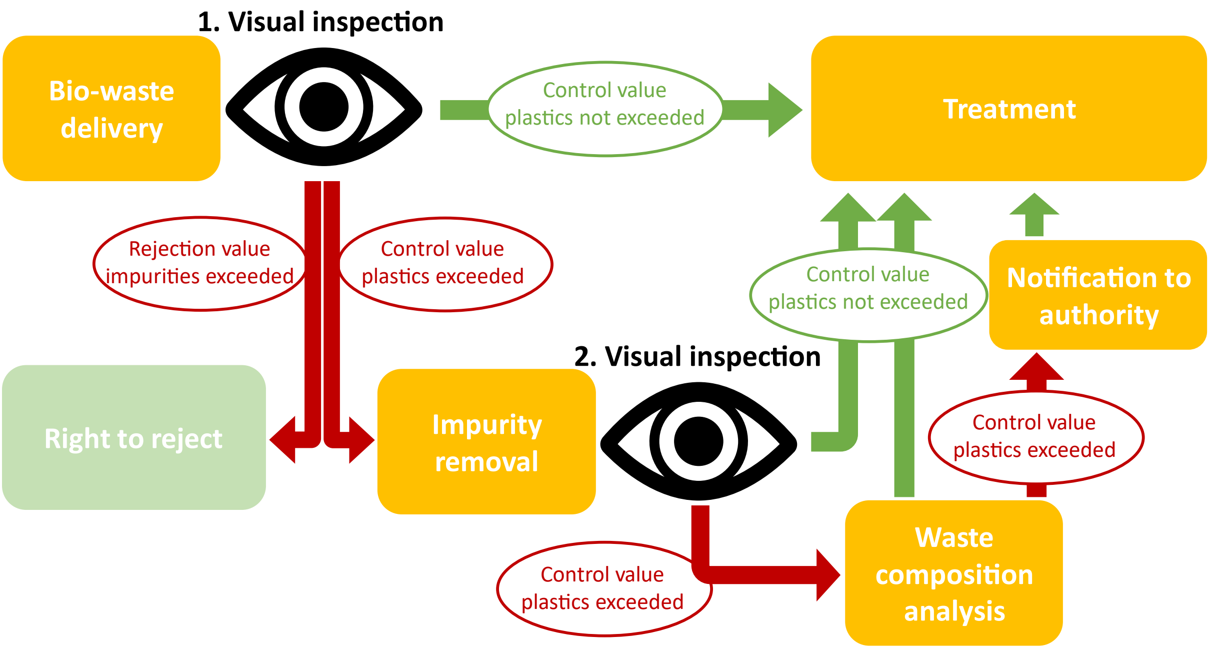
5.2.2 Flanders, Belgium

The methodology for assessing bio-waste quality in Flanders, Belgium, was introduced by Vlaco (2023) for an EU-funded project and is not yet a standardised method. It is based on compositional analysis. The description of fractions for the characterisation is shown in **Annex 4** – Waste fractions of the Flemish sorting protocol.

5.2.3 Germany

The methodology for the assessment of bio-waste quality in Germany was introduced by BGK. It is a three-step procedure which is shown in Figure 1. This procedure is mandatory for each batch delivered to a treatment facility.

Figure 1. Assessment methodology of input bio-waste quality in Germany



Source: Adapted from BGK (2022b)

The first step is a visual inspection of the delivered bio-waste. The details of this methodology are described in section 5.3.1. It results in three options: i) control value of 3% w/w and control value plastics of 1% w/w not exceeded → treatment; control value of 3% w/w exceeded → iia) Application of the right of rejection, if contract allows → iib) removal of impurities.

The second visual inspection has two options: i) control value for plastics of 1% w/w not exceeded → treatment, ii) control value for plastics of 1% w/w still exceeded after impurity removal → Batch waste compositional analysis. Again, there are two options for the procedure after the compositional analysis: i) control value for plastics of 1% w/w not exceeded → treatment, ii) control value for plastics of 1% w/w exceeded → reporting to treatment responsible authority and rejection or sending to treatment. The treatment responsible authority may specify additional measures to remedy deficiencies.

A waste composition analysis can be conducted if the visual inspection before and after pre-treatment of bio-waste sees total impurities and plastic impurities above 1% w/w. It can also be conducted by the waste collector after the first visual inspection. The methodology is described in BGK (2021). This methodology is based on Intecus GmbH (2014), who developed a uniform waste composition analysis method for residual waste and was therefore adapted to bio-waste. The methodology includes the sampling of two samples, each totalling 1 m^3 and/or 250 kg, of the batch of bio-waste to be characterised. The basic protocol includes the sorting of the fractions highlighted in **Annex 5** – Waste fractions of the German sorting protocol. The sorting protocol excludes particles with an edge length < 20 mm. Paper, except the coated one, is accepted as bio-waste while for biodegradable and compostable bags the decision lies with the local authority. The results shall be indicated as weight-based percentage of the total sample weight.

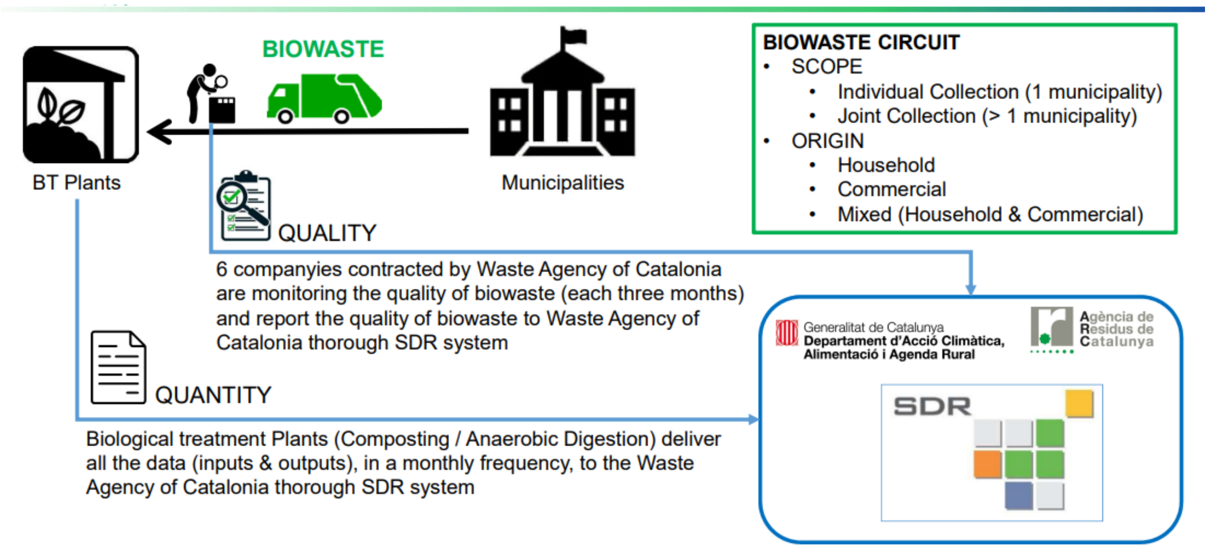
5.2.4 Italy

The methodology for waste composition analysis was introduced by the Italian Compost and Biogas Consortium, that together with the Italian National Standard Body, elaborated a reference practice UNI/PdR 123:2021 (UNI, 2021) which is not mandatory by law but is now entering the conversion process into a national standard. The document clarifies the procedure for the preparation of a bio-waste sample, the number and type of fractions to be sorted, their classification with respect to the acceptability by a recycling facility, a suggestion for the minimum number of characterisations to be carried out every year to assess the average quality of waste treated by the recycling facility, as well as the minimum number of characterisations to be carried out to assess the quality of bio-waste produced by a municipality or collected by an operator of separate collection service. Moreover, the methodology defines the criteria for the determination of the number and types of bags utilized by citizens for the collection of bio-waste. It is applicable for wastes with European Waste Catalogue codes 200108 (food waste), 200201 (garden waste) and 200302 (Market wastes). The waste fractions to be sorted can be found in **Annex 6** – Waste fractions of the Italian sorting protocol.

5.2.5 Catalonia, Spain

The methodology for the assessment of the quality of bio-waste in Catalonia was introduced by the Catalan Waste Agency when the tax refund system was implemented. The last update and publication of the protocol was in 2022 (ARC, 2022). The quality monitoring includes one waste composition analysis per collection circuit per quarter of the year (corresponding to a municipality or a few grouped municipalities when bio-waste is collected in a joint collection route). Therefore, the 600 collection circuits in Catalonia result in more than 2,000 waste composition analyses per year including public municipal bio-waste collection routes and private company routes (the number and type of circuits are continuously updated according to the real operation modifications). This intensive monitoring is funded by the landfill and incineration tax fund since it is linked to the calculation of the tax refund for the bio-waste collection and treatment concepts (see section 4.2.4). All results are published in the Waste Data System (ARC, 2023, Sistema de Dades de Residus, SDR). The general procedure is shown in Figure 2.

Figure 2. Catalan bio-waste input quality monitoring scheme



Source: Francesc Giró presentation for BIOBEST WP5.1 Stakeholders interviews (May 2023)

For traceability of the bio-waste collected by private operators, the ARC has a specific register for private commercial circuits in which the producers, tonnes and composition studies are also reported and monitored.

The templates used during the characterisations as well as pictures of proof are shown in Figure 3. The bio-waste is separated into the fractions shown in **Annex 7** – Waste fractions of the Catalan sorting protocol.

Figure 3. Characterisation result forms and pictures taken during the procedure

Source: Francesc Giró presentation at BIOBEST Capacity Building Event Barcelona (October 2023)

5.3 Examples of other approaches for quality analysis

5.3.1 Germany: Visual inspection and rating system

As stated in section 5.2.3 the common methodology for a simple evaluation of the delivered batches of bio-waste at the gate of the biological treatment in Germany is the visual inspection methodology. It is the first stage in a multi-step approach to assure that bio-waste meets the quality criteria before entering biological treatment (Figure 1).

The methodology for visual inspection is explained by BGK (2022). It must be noted that visual inspections are no quantitative assessment but only qualitative, basically distinguishing between control values being complied with or exceeded. The visual inspection must be done for the entire batch delivered. In case of exceeding the control value, a picture of the delivered batch shall be taken as proof. The second visual inspection, after pre-treatment to remove impurities, can also be done while the material moves on a conveyor belt. Visual inspection has its limitations especially in case the batch contains impurities close to the control value. In those cases, a waste composition analysis may be a useful tool to verify whether the control value is complied with or exceeded.

Special case of biodegradable and compostable plastic: bags made of these materials are included or excluded as an impurity, depending on their allowance in the area by the local authority. All other items made from these materials must be considered an impurity.

BGK offers training for visual inspections. This training combines visual inspection with waste composition analysis to check visual judgement against actual composition.

In addition to visual inspections, BGK (2022a) describes a five-stage rating scheme ('Bonitur') according to which the quality of each delivered batch of bio-waste delivered can be recorded (Figure 4).

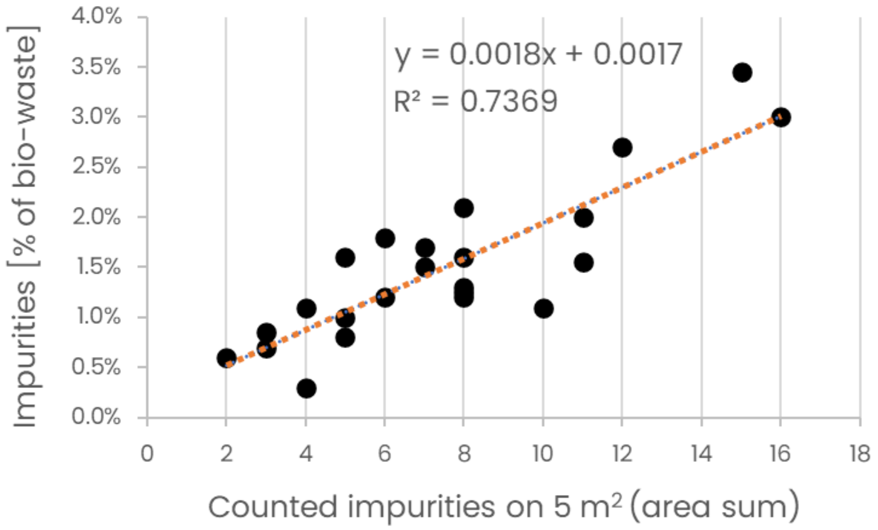
Figure 4. Visual rating scheme of bio-waste by BGK (Germany)

Rating	**Visual impression**	**Number of larger pieces of impurity (Pieces > 100 mm)**
1	Very good. No impurities recognisable.	0
2	Good. Individual/few impurities recognisable	1 - 4
3	Mediocre. Significant foreign matter content recognisable. Bio-waste still visually dominated by 'good fraction'.	5 - 10
4	Poor. High impurity content. Bio-waste not yet visually dominated by impurities.	11 - 15
5	Very poor. Very high impurity content. Biowaste visually dominated by impurities.	> 15

The procedure of the rating scheme is as follows: a sample of a batch of bio-waste is distributed to form at least a square of 15 m^2. In this square two smaller squares of 5 m^2 are evaluated. A frame can be used. The number of total "large" impurities is counted as well as the number of plastic impurities. Large impurities refer to those with a length of at least 100 mm. With the count of impurities in both squares, an average is calculated which forms the final grade. The grading system can be found in BGK (2022a).

It was found that the scheme based on the counting of the number of impurities found in a sample correlates well with the actual share of impurities as is shown in Figure 5. However, the authors argue that the correlation must be found for each local circumstance, comparing the number of impurities and the actual share of impurities in a waste composition analysis (BGK, 2022a).

Figure 5. Correlation between the number and weight of impurities in bio-waste



Source: adapted from ***Idelmann (2023)***

The figure including the linear trend shows that 7-8 counted impurities per 5 m^2 represent a share of impurities by weight of around 1.5%.

5.3.2 Visual inspection of bins or bags – Manual assessment

An alternative to visual inspections at the gate of a recycling facility is the inspection of the content of bio-waste bins or collection bags prior to collection.

A methodology for the manual assessment of bin controls in Germany is described by BGK (2023). It typically involves a two-person team, either additional staff or the collection crew. The bins are opened, and the top layer of the waste is inspected with tools available for examining deeper layers, if needed. The method also allows a rating scheme similar to the one shown in Figure 4. This method tackles impurities at the source, shifting responsibility for proper sorting to individuals rather than the recycling facility operator. In cases of poor sorting, bins may be left uncollected until corrected or collected with residual waste for an additional high fee. However, this approach faces challenges in multi-family buildings, where waste is collected communally from many households.

Besides Germany, a visual inspection methodology for the manual assessment of light plastics is applied in the United Kingdom (EPA, 2023).

5.3.3 Visual inspection of bins or bags – AI supported

An AI-supported visual inspection, conducted before or during collection, offers an alternative to manual checks for assessing the physical quality of bio-waste at source.

As briefly outlined in the LIFE BIOBEST D3.3 **Guideline on quality compost and digestate**, the application of AI technology is gaining increasing attention in (bio-)waste management. Several companies have introduced this technology to the market, enabling real-time bio-waste quality assessment during collection, either through top-view bin inspection or during the emptying process. A German study (INFA, 2023) confirmed the feasibility of this approach, with bio-waste composition analysis validating a positive correlation between detected impurities and actual waste composition. Typically, evaluations classify waste quality as "good," "average," or "poor," with systems offering adjustable sensitivity levels.

5.4 Summary of compositional analysis methodologies

The evaluation of methodologies for the compositional analysis resulted in the identification of four fundamental aspects to be considered for their development or implementation. These are the sample origin, the sample size, the sample preparation and the number of waste categories and fractions to be assessed. In addition, the type of bio-waste is worth considering as a critical aspect in the sorting methodology. A summary is shown in Table 6. Visual inspection methodologies are further referred to in Chapter 9.

Bio-waste type

Collection systems of municipal waste streams can generally be categorised as targeting food waste, garden waste, or a mix of both. Due to the bulkiness and heterogeneity of garden waste, larger samples may be required for accurate analysis compared to those dominated by food waste. Similarly, food waste collected in bags can lead to uneven and heterogenous distribution as well.

Sample size

Samples can be taken either from an entire truck delivery or directly from their origin (e.g., household bio-waste bins, restaurants). Both sampling methodologies fulfil different purposes. However, the most common methodology is the sampling from an entire batch of delivery. A distinction can be made between the initial batch mass and the final sample mass, which is the remaining mass to be analysed for its composition, resulting from the procedure of sample preparation. According to Table 6, the initial mass is a minimum of 1,000 kg or a truck load. The final mass after sample preparation ranges between 125 and 500 kg.

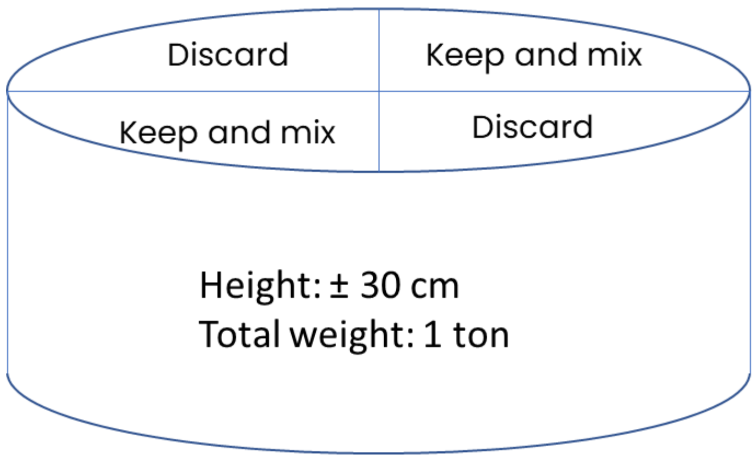
For the determination of the appropriate final sample size, it is important to consider the expected heterogeneity of the bio-waste composition, especially in countries with commingled collection, as well as the expected impurity content. The overview shows that the mass of the final sample is higher in countries with a commingled bio-waste collection system (Flanders, Germany) compared to those focussing on food waste (Italy, Catalonia).

For most cases described in this report, the current final sample size was derived from experiences. For example, CIC in Italy and ARC in Catalonia perform around 1,500 and 2,000 compositional analyses per year. This resulted in a high precision for the adjustment of the method including the minimum required mass.

Sample preparation

There is a main difference in the evaluated methodologies in terms of sample preparation: random sub-sampling versus elaborated coning and quartering (Figure 6). All methodologies require the homogenisation of the batch to be analysed. This is of particular importance for bio-waste with bulky (e.g., garden waste) or heterogenous (e.g., a variety of different fractions of impurities) materials. Especially in the case of bulky garden waste, some methodologies require its removal as an initial step and separate assessment. Furthermore, all methodologies require a reduction of the sample towards a minimum mass required for sorting.

Figure 6. Exemplary scheme of the quartering methodology



Waste categories and fractions

The number of categories and fractions to be assessed in a bio-waste sample varies broadly among the different methodologies. Most of them have a minimum list of fractions that can be extended by sub-fractioning. This allows either a simple or detailed analysis of bio-waste composition. As an example, the protocol of Germany requires a minimum level of differentiation into four fractions while it can be extended to 13 fractions. The full list of waste fractions for the bio-waste composition analysis methodologies can be found in **Annex 2 – 6**. Some fractions, especially impurities (plastics, glass, metals, etc.), are of major importance in all methodologies, since their separate assessment during bio-waste characterisation is the basis to apply targeted measures at the bio-waste producer level.

Table 6. Summary table of bio-waste characterisation methodologies

Country	Bio-waste type	Sample preparation	Initial sample mass (kg)	Final sample mass (kg)	(Minimum) No. of waste categories	Source
Austria	Food waste	Random sub-sampling	-	125	5	Beigl et al., 2020
Flanders (Belgium)	Commingled bio-waste	Random sub-sampling	1,000	300	11	Vlaco, 2023
Germany	Commingled bio-waste	Coning & Quartering division into two heaps, One half coned repeatedly, other half discarded, Repetition until minimum final sample mass reached, Second sample unit taken from the second heap with same procedure Sampling alternative: from trench slots	Load of delivery	2 x 250 kg (or 2 x 1 m^3)	4	BGK, 2021
Italy	Food waste, Garden waste Market waste	Mixing (2 or 6 turns or entire load), Coning & Quartering, Repeated diagonal sampling, Sampling of 300-400 kg, Final sampling of minimum mass	3 options: a) < 1,000 b) 1,000 – 10,000, c) > 10,000	130 ± 10%	3 / 19	UNI, 2021
Catalonia (Spain)	Food waste	Coning & Quartering Two opposite subsamples selected, others discarded. Repetition until minimum final sample mass reached	Load of delivery	250 ± 10%	15	ARC, 2022

6 Studies on the interdependency of feedstock-product qualities

A few studies exist, in which it was possible to find a correlation between the quality of feedstock material and product. Those studies aimed at finding solutions for improving the quality of bio-waste resulting in an increase of the recycling rate.

Rodrigues et al. (2020) found a positive correlation between the share of impurities (plastics, metals, etc.) in the bio-waste and the quality of the compost, including the share of impurities and some heavy metals. Heavy metals concentration is in positive correlation with the share of impurity materials in the feedstock. Furthermore, impurities in bio-waste have a negative impact on the electrical conductivity and the maximum temperature of the self-heating test. Compost quality is also influenced by treatment technology, such as the mesh size of the pre-treatment drum screens and the existence of an anaerobic digestion step in a combined system with subsequent composting. The latter especially increased the concentration of heavy metals due to the additional degradation of organic matter to biogas compared to composting only. The study concludes that the effects of the bio-waste quality on the product quality can be reduced by improved sorting at source and by the pre-treatment. As elaborated in previous chapters, the advantage on increasing the final product quality through pre-treatment and refining comes at the potential cost of losses of biodegradable/putrescible material to the reject fraction ("dragging factor").

A study performed within the German ProBio project (ProBio, 2024) in the Composting Plant "Wernfeld" in Northern Bavaria looked into a way to increase the amount of organic certified high-quality compost by reducing rejects during the processing by means of different approaches. Besides the product, the plant generates different fractions of intermediate products and rejects (e.g., sieved materials). In a first attempt, a mass balance of all flows showed a high potential to recover biodegradable materials, which was proven by compositional analyses of all intermediate fractions. It was also found that a higher share of impurities in the feedstock led to higher losses in product quantity and a decrease of its quality. Subsequently, a second sieving step for different reject fractions (12-30 mm and 30-200 mm fractions) to separate impurities from biodegradable materials was implemented. Results showed that this post-treatment led to an increase of the mass of final compost (0-12 mm fraction) by 5%, while decreasing the overall quantity of reject fractions by up to 15%.

7 Best practices in bio-waste treatment

This chapter highlights aspects of the LIFE BIOBEST WP2 and WP3 including the identification of best practices, which were published in the Annex of the LIFE BIOBEST D3.1 **Guideline on separate collection** as well as in the LIFE BIOBEST D3.3 **Guideline to promote quality compost and digestate**. The best practice cases were identified based on KPI presented in the LIFE BIOBEST D2.1 **Improved and homogenized datasets**. The KPIs relevant for this document are summarised in Table 7.

Table 7. Key performance indicators for biological treatment

Type of data	KPI (Collection/Treatment)	Function & Description
Quantitative KPI05	Impurities inside bio-waste/food-waste collected (% of total bio-waste)	Quality of bio-waste as the degree of purity. Shows recycling potential at a treatment facility
Quantitative KPI12	Ratio between rejects/total inputs (% of total bio-waste input)	Describes recycling efficiency of a bio-waste management system including collection (quality of feedstock) and treatment (quantity of rejects)
Quantitative KPI13	Dragging factor at recycling facility: Ratio between total rejects and impurities in input bio-waste (% of impurities in input bio-waste)	Assesses the material recovery performance of different treatment facilities accepting same or similar types of bio-waste

These KPIs specifically describe the quality of material entering biological recycling as well as the impact of impurities on the share of organic material actually recycled into compost or digestate. For some of the best practice cases, all of these indicators were evaluated.

The share of impurities (KPI05) ranged from less than 1% to 8.5%. Where data was available, KPI12 ranged between 3% and 40%. Due to few data available in this case, there can be no clear statement about potential correlations. However, it appears logic that KPI12 is influenced by both, the quality of bio-waste as well as the pre-treatment and refining technology applied (see LIFE BIOBEST D3.3 **Guideline to promote quality compost and digestate**). The cases presented in the aforementioned report highlight that even minor proportions of impurities can result in a considerable "dragging factor", whereby biodegradable material is removed during the process and therefore unavailable for its conversion into compost and digestate. The impact can be reduced by optimisation of the treatment technology, however, at the potential cost of additional investment as was shown exemplarily in the study of ProBio (2024).

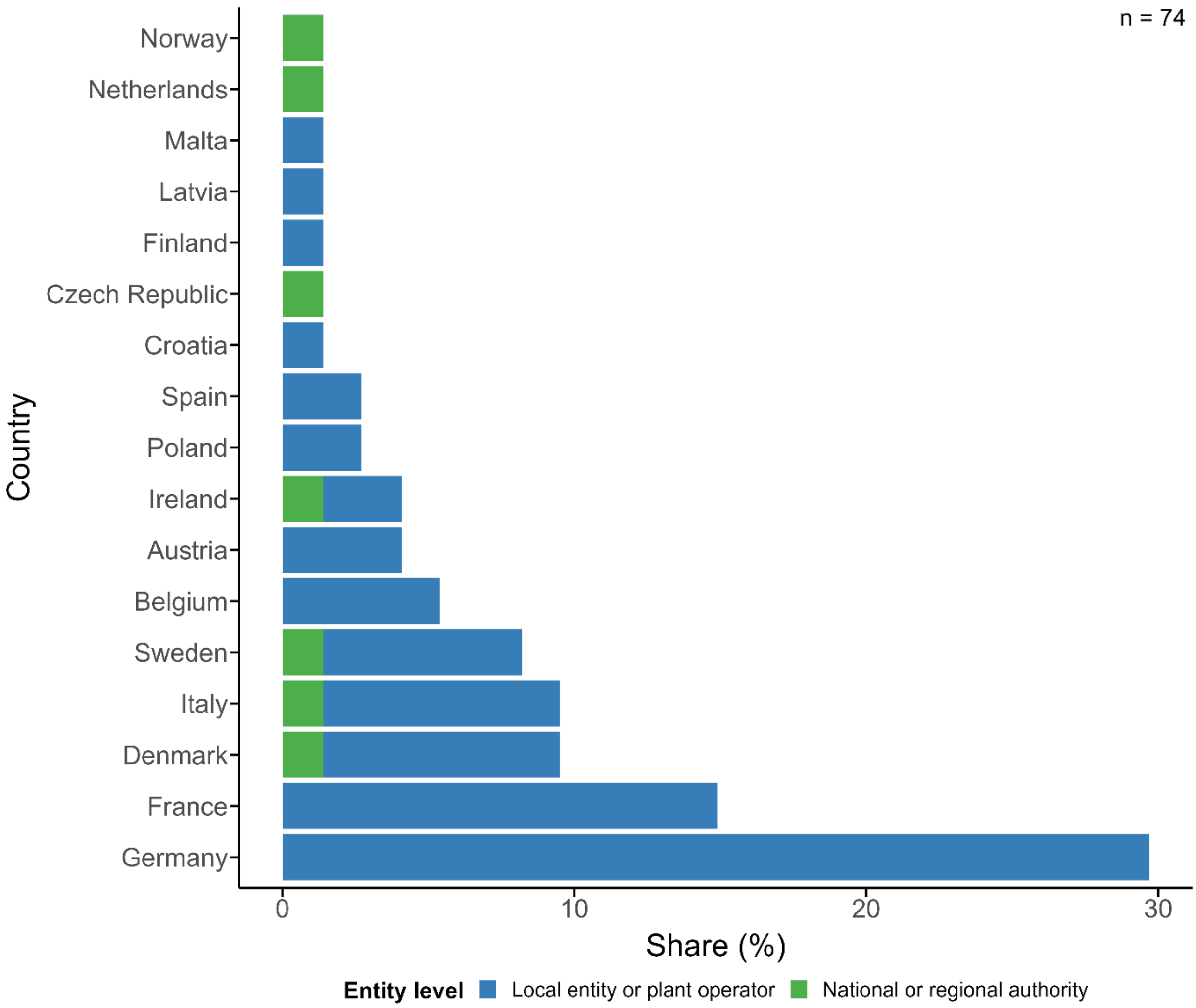
8 Insights from bio-waste management experts

A survey was performed with the goal of gaining plant operators' insights on treatment performances, existing input quality regulations as well as their perspectives on requirements for the quality of material entering their biological process.

General information

Overall, 74 respondents from 16 EU countries (+ Norway) answered (Figure 7) the survey. For some countries, institutions with a national perspective answered the survey as indicated in green (e.g., CIC for Italy).

Figure 7. Respondents of the input quality survey

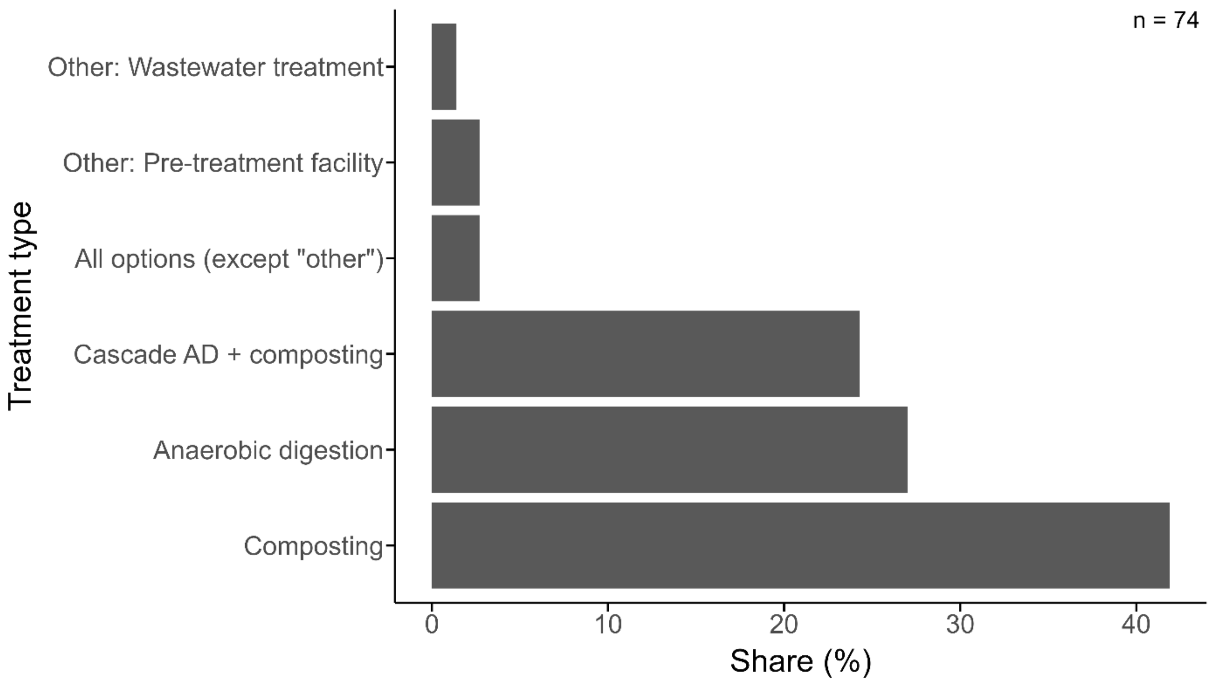


Most responses were provided by German plant operators. However, the overall responses offer a comprehensive overview of the situation in the European Union.

Given that Germany will have one of the most rigorous regulations on input quality among all EU MS, the responses may reflect the precise wording of the regulation rather than the experience or opinion of the plant operator. To ensure the integrity of the data, some of the questions were compared including and excluding the German answers.

The respondents' representation of treatment technology was asked as well (Figure 8).

Figure 8. Type of treatment represented by the survey respondents

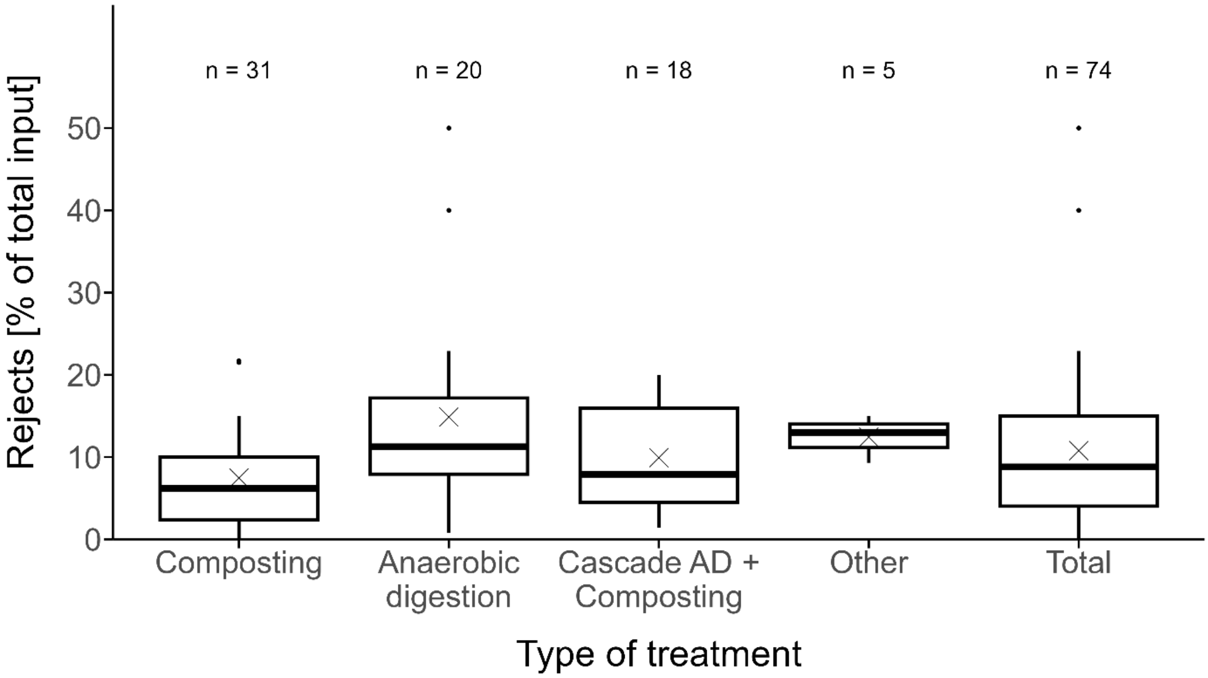


The figure indicates that more than 90% of the treatment refers to composting, anaerobic digestion or a combination. "All options" was answered by institutions with a national perspective.

Rejects

As it was defined in Chapter 3, a reject is material removed prior to or after the actual biological treatment. Survey participants were asked for the average input and reject quantities of the plant or region they represent. Figure 9 shows the share of rejects based on the total input of the respective treatment. Overall, rejects ranged from 0.1% up to 50%. The average share of rejects was around 10%, with lower values for composting and combined AD and composting systems.

Figure 9. Share of overall rejects per treatment type

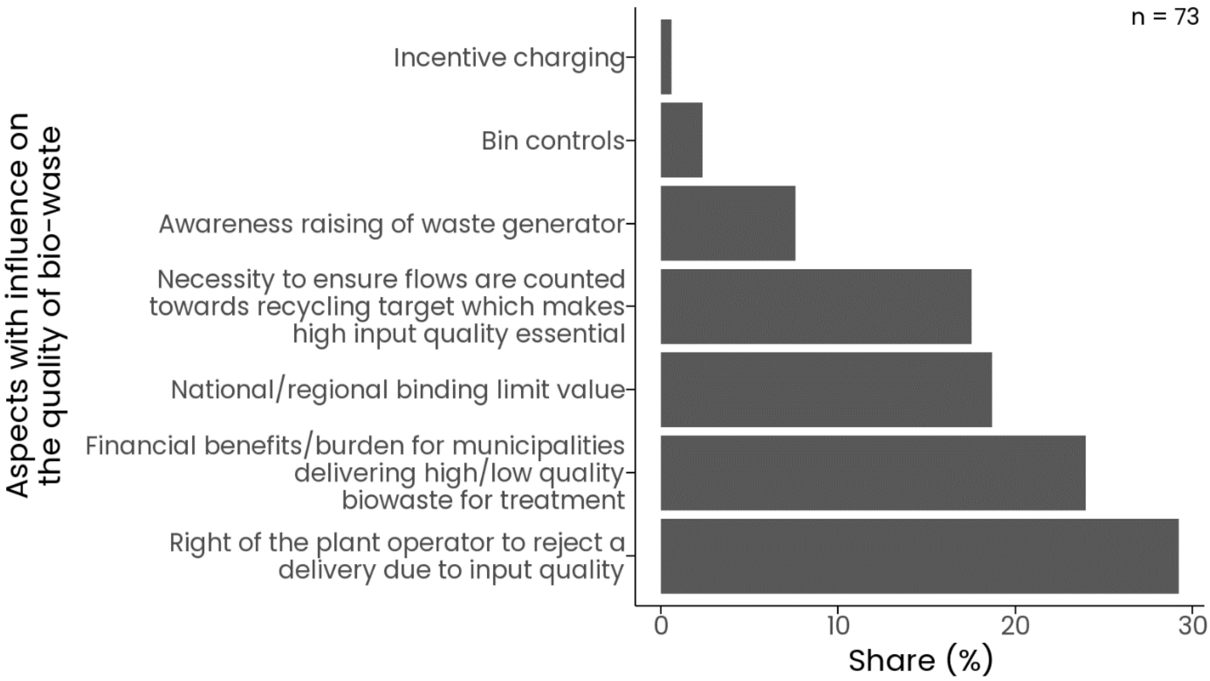


An expert of bio-waste management from the Netherlands made an important observation. It was calculated that, on average, three times as much biodegradable material is commonly lost as reject fraction, relative to the percentage of impurities present in the delivered bio-waste. To illustrate, the removal of a 3 - 4% impurity in source-separated bio-waste may result in the loss of an additional 9 - 12% of good material based on total feedstock material (total loss of 12 - 16%). This relates to the concept of "dragging factor", hence the importance of minimising impurities, for the total amount of rejects gets magnified during the process.

Influencing aspects to achieve high quality input

Asked for their opinion on the potentially most successful incentive to achieve high quality feedstock material, respondents mostly named the right of the plan operator to reject a delivery due to low quality as well as financial incentives for municipalities depending on the quality of feedstock, they deliver to the treatment facility (Figure 10). Also, more than 40% requested a national or regional target for a control value for input material. Asked if such regulation exists already in their country or region, 55% answered with "yes". Of these, 30% were answers from Germany, which currently has the strictest regulation (the Bio-waste Ordinance) on input quality assessment in the EU. Other answers included rather local regulations specified in contracts between plant operators and municipalities.

Figure 10. Influencing aspects to achieve high quality input



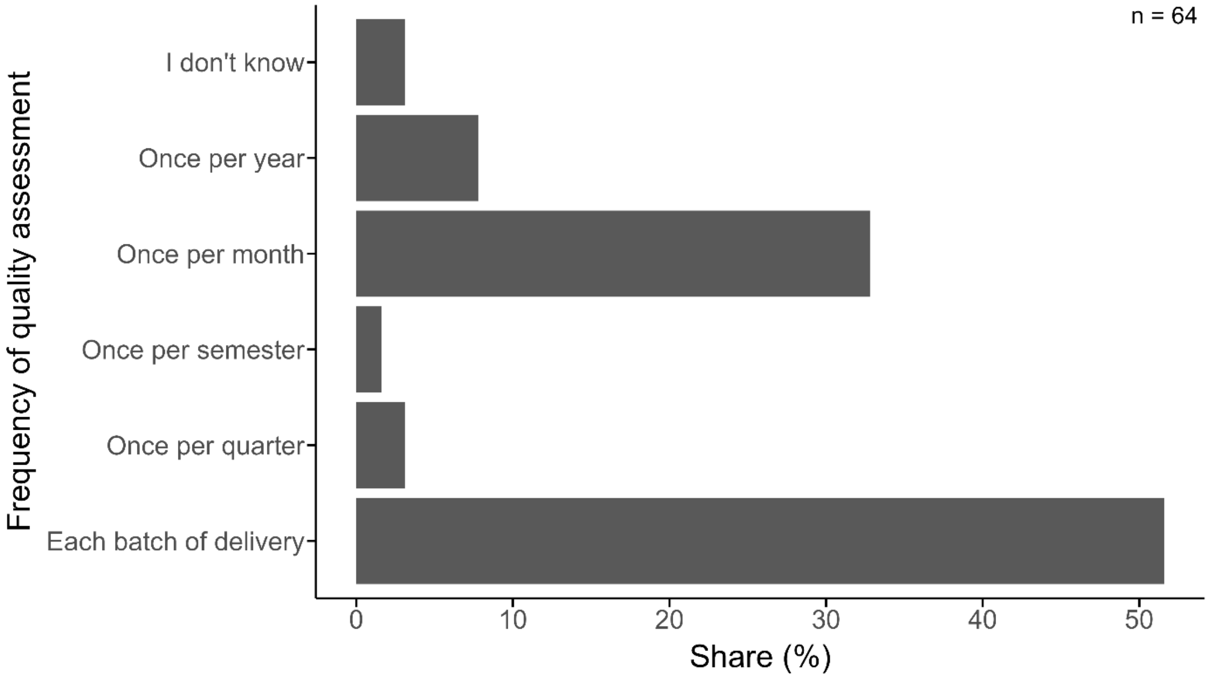
Feedstock quality assessment

More than 90% of respondents would welcome a regulation on frequent quality assessment of input material. The share even slightly increases when excluding answers from Germany.

Some respondents made additional comments, such as that the analysis "has to be performed by the plant operator", that "only visual inspections are feasible on a frequent basis" and that the "waste producer has to carry the expenses".

Asked for the required frequency, most answered that every batch of delivery should be analysed (Figure 11), followed by "once per month". Only around 15% did not answer or stated they do not know which frequency would be appropriate. The distribution remains similar when excluding answers from Germany.

Figure 11. Frequency of input quality assessment



Furthermore, around 68% of respondents agreed that the evaluated feedstock quality should be communicated to a regional or national authority in a compulsory manner.

When asked whether a visual inspection is a sufficient method for determining the quality of the feedstock in comparison to a waste sorting analysis, respondents expressed uncertainty. While approximately 50% of respondents indicated agreement, the remaining 50% either disagreed or were undecided. This distribution remained very similar when excluding the answers from Germany.

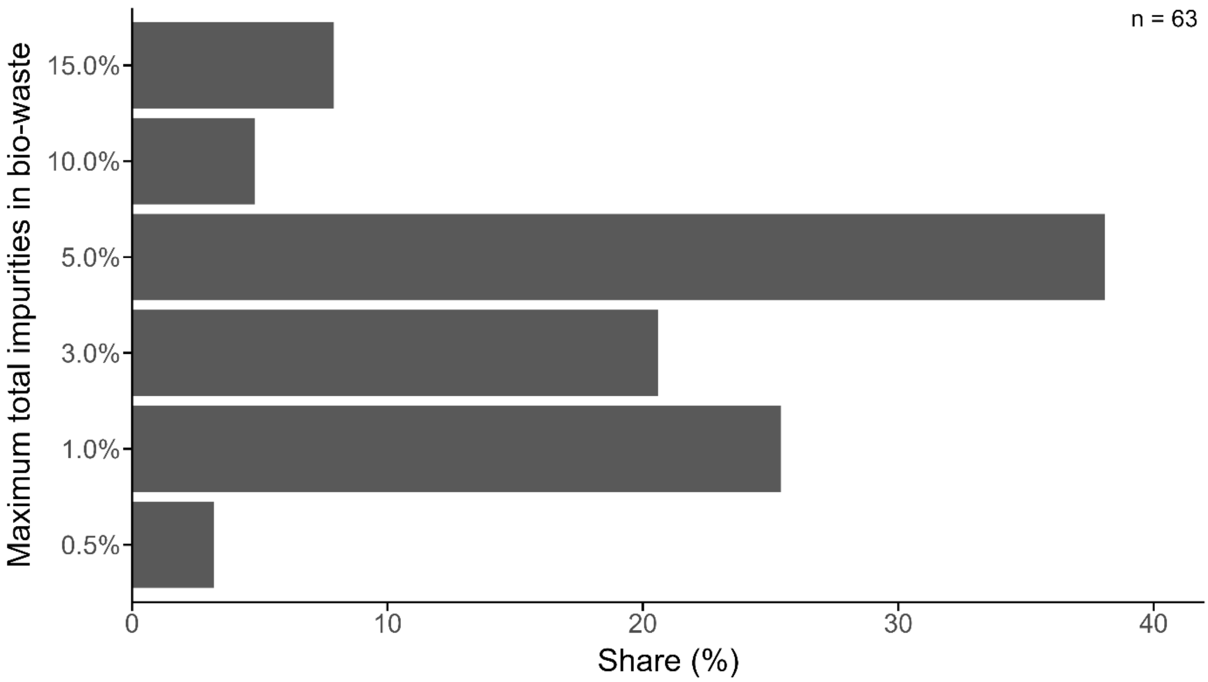
Some respondents suggested that the use of AI, e.g., visual screening systems on collection trucks, could facilitate future visual inspections, while others emphasised the importance of experienced personnel for its accurate performance. In addition, some stated that both visual inspections and waste compositional analysis are essential for a comprehensive assessment of feedstock quality.

Maximum impurities in bio-waste

A substantial majority of respondents (90%) indicated their support for a target on maximum impurities in the bio-waste, which remains the same when excluding the answers from Germany.

Subsequently, survey participants were requested to specify the maximum share of impurities in the feedstock that they consider necessary to produce high-quality compost or digestate. Figure 12 illustrates the distribution of responses among those who answered the question.

Figure 12. Maximum share of impurities demanded by survey respondents

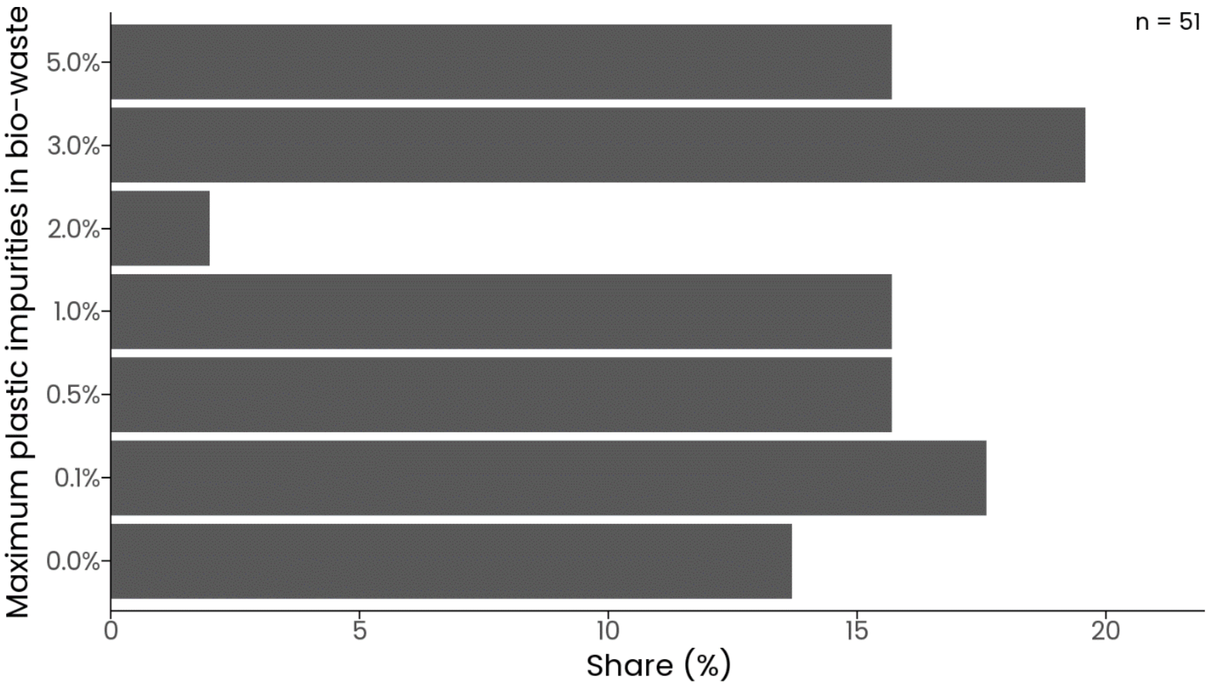


The majority (87% of respondents) indicated a maximum share of impurities below 5% in order to be able to produce high-quality products. This figure shows only a slight decrease when the answers from Germany are excluded (84% of respondents). However, there was a shift in the responses towards a higher value. When German responses were included, the average value was 4.5% (± 3.8%), while when they were excluded, the average was 5.0% (± 3.9%).

Those who did not answer with a specific control value did, however, offer reasons for their decision. Most of these respondents argued that a generalisation would be challenging and that the minimum feedstock quality should be evaluated based on the treatment technology. However, they concurred that impurities should be as low as possible in any case. One argument against a potential legally binding limit value (without tolerance) for impurities was that the alternative to biological treatment implied by the rejection due to the exceedance of such can only be thermal treatment, which would result in the complete exclusion of material recycling.

Overall, there was a general conclusion that the issue of plastics should be given a special attention in the development of a unified methodology for the assessment of bio-waste quality. 74% of the respondents agreed on the need for a specific target of plastics in bio-waste. 8% did not agree while the remaining 18% did not know. The survey also asked for a maximum percentage of plastic impurities in the feedstock (Figure 13).

Figure 13. Maximum share of plastic impurities demanded by survey respondents



The respondents demonstrated a greater degree of indecision in comparison to the specified target for total impurities. However, a majority of 63% indicated a target for plastics in bio-waste below 1%, while 100% of the respondents indicated a target below 5% (Figure 13). Excluding German answers reduces the share of answers demanding a target value below 1% to 59%.

Those who did not provide a definitive response offered explanations for their stance. One of these explanations pertained to the matter of plastic weight, whereby a low percentage by weight could be indicative of a high proportion when observed visually. Another argument put forth was the necessity for differentiating between bags and other plastic items, given that the former may be easily removed during the pre-treatment or refining processes.

9 Recommendations for a standard methodology to assess bio-waste quality

The following recommendations are specifically intended to guide the future development of an EU-harmonised standard methodology for the quality assessment of bio-waste as feedstock material for biological treatment to produce compost and digestate. Typical equipment required for waste compositional analyses can be found in **Annex 8** – Typical equipment required for sorting analyses.

9.1 General recommendation for methodology

As a conclusion from the review of methodologies as well as the expert consultation, both, **visual inspection and waste compositional analysis,** should be considered viable approaches for the quality assessment of bio-waste. Consequently, a methodology that allows for the combination of both approaches should be developed. This should be carried out with due consideration of the distinct advantages and disadvantages of the respective approaches, as illustrated in Table 8.

Table 8. Comparison of visual inspection and waste sorting methodologies

Visual inspection	Waste composition analysis
Efficient in time and resources	Demanding in time and resources (human, equipment, space limitation), hence more expensive
Enables automation	Does not allow automation
Allows the analysis of multiple batches per day	Allows the analysis of only a few batches per day
Can be performed directly during delivery	Requires some preparation and potential delay after delivery until performed
Not very detailed (e.g., distinguishing type and share of impurities)	High degree of detail, i.e. for the total share of impurities and each of its fractions
Prone to errors (requires intense training)	Less prone to errors (requires less training)

Visual inspection can be performed frequently, while waste composition analysis, being more time-intensive and costly, should be used selectively to validate visual assessments and measure the actual quality of bio-waste by mass percentage (w/w). Using the rating system described in Figure 4, the accuracy of visual inspections can be calibrated through periodic waste composition analyses (see Figure 5). Each biological treatment facility may need specific calibrations until a solid approximation is reached.

Although these recommendations focus on assessing quality at the facility gate, methods to evaluate quality directly at the source (e.g., households) are also relevant, as described in section 5.3.

9.2 Waste categories and fractions

Coverage of materials and origin

The materials included refer to municipal bio-waste, either kitchen waste from households or the Ho.Re.Ca sector, garden waste or a mixture of the aforementioned.

When conducting a bio-waste composition analysis or visual inspection, it is important to consider the type of bio-waste. Materials like bulky garden waste or food waste in knotted bags can create a heterogeneous sample, which increases the likelihood of significant deviations from the actual average composition if sampling is not done carefully. For such mixed samples, either a larger sample size or thorough pre-sampling homogenisation may be necessary to ensure accurate representation.

The fractions into which the final sample has to be sorted should adhere to a classification system based on a positive, negative, and conditional material list. These terms are explained in the following:

Positive material list

The positive list covers the actual bio-waste, including kitchen/food and garden waste. These can be further specified in sub-categories to avoid confusion.

Conditional material list

This list is subject to local policies. It includes items that are not defined as bio-waste, but are in fact either tolerated or even promoted as materials to aid sorting at the source, mostly of kitchen waste. Materials include mainly those certified under EN 13432 or EN 14995 in the EU. Furthermore, this list may include newspaper or other tissue paper used in the kitchen. The local waste management authority has to decide whether to include these materials into their positive or negative material list. In each case, they should be considered separately to allow a separate assessment with the actual bio-waste and a unified comparability among EU MS.[1]

Negative material list

The negative list includes all materials and items that are explicitly excluded from disposal in the bio-waste stream. There is a consensus among experts regarding this list, which

[1] Note: The materials on this list are subject to ongoing debate for they are accepted and promoted somewhere, while they are not elsewhere. However, this issue is not discussed further in this document.

includes conventional or bio-based (non-biodegradable and non-compostable) plastics, glass, metals, and other materials that can or cannot be recycled in another waste stream.

Recommended sorting protocol

It is recommended to sort a minimum of 7 different fractions as indicated in the left column of Table 9. Furthermore, one may include additional fractions in order to allow a more detailed insight and comparison, especially of those fractions that are not fully accepted in bio-waste across different EU MS. A detailed analysis of the actual bio-waste provides an insight into the recyclability of the materials in the biological processes, either anaerobic digestion, composting or both. This may add up to a total of 20 fractions to be sorted. Table 9 shows the list of the recommended fractions.

Table 9. Recommended fractions to be sorted in the bio-waste composition analysis

Main sorting categories	Additional fractions
Positive material list	
Food waste	Compostable
	Non-compostable (bones, shells)
Packaged food waste	
Garden waste	Herbaceous material and leaves
	Woody/lignocellulosic material
	Peat and other growing media
Conditional material list*	
Sorting aids (certified under EN 13432)	Paper bags
	Compostable plastic bags
Other compostable materials (certified under EN 13432 or EN 14995)	Packaging
Paper & Cardboard (uncoated)	Kitchen paper
	Newspaper and tissue
Stones	
Negative material list	
Impurities	Soft plastics (Plastic bags, foils)
	Hard plastics (bottles)
	Coated (glossy) paper
	Metals
	Glass
	Textiles
	Sanitary items
	Others

*To be decided nationally, whether to be accepted (positive list) or forbidden (negative list) with the option of local adjustment. See explanation above.

Materials that cannot be identified shall be sorted into an additional “non identified” fraction. This might include a sub-fraction with bags not identifiable whether they were certified according to EN 13432 (or EN 14995 for non-packaging items) or not.

Packaged food waste requires a specific sorting procedure depending on the packaging's integrity. If the packaging is open and the food content can be easily separated, the materials should be sorted into their respective fractions (e.g., food into food waste, plastics into plastics). However, if the packaging is intact, it must be sorted into a distinct fraction labeled "packaged food waste." Under no circumstances should intact packaged food waste be grouped with unpackaged food waste.

9.3 Sample size

The required sample size depends on the scope of the compositional analysis. For analysing a single truck load (batch) from a specific collection route, a representative sample can be taken from that delivery. However, if the aim is to determine the average composition for an entire municipality, a different approach is needed, potentially involving samples from multiple bio-waste deliveries from various origins to ensure comprehensive representation.

It is recommended to **use the full batch of one delivery as initial mass or at least 1,000 kg.** If this mass is not achieved by one batch of delivery, it can be mixed with another, unless the target of the compositional analysis is the local identification of the bio-waste composition of a specific collection circuit.

Depending on the type of bio-waste, the final sample size has to be adopted. Therefore, the final sample size to be analysed for its composition is defined by the type of bio-waste targeted by the collection scheme, with regards to the percentage of food waste in it. The following quantities are recommended, based on the long experiences of the revised input quality measurement methodologies:

Food waste >70% (w/w) of batch: 130 kg (± 10%)
Food waste <70% (w/w) of batch: 250 kg (± 10%)

During the initial phase of an introduction of a frequently applied bio-waste composition analysis methodology in a country/region, the higher quantity should be chosen to verify the actual share of food waste, garden waste and other materials (see section 9.2 for waste categories and fractions). Following the verification, the mass to be analysed per batch can be adjusted. It is common that collection systems focussing on food waste achieve at least an average of 70% (w/w) of food waste, while systems collecting a mix of food waste and garden waste may collect a lower share of food waste. A system focussing on park and garden waste should only contain food waste in the form of fallen fruit which should be below 10% (w/w).

9.4 Sample preparation

The **repeated coning, quartering and sample reduction methodology** is the recommended methodology of the sample preparation. The number of repetitions has to be defined by the initial mass of a batch delivery and can be reduced with reduced masses.

The analysis must be conducted as soon as possible after the delivery of the batch with a maximum delay of 48 hours, during summertime 24 hours, to prevent degradation, particularly in food waste, which can hinder fraction differentiation and lead to liquid leakage from the batch to be analysed, increasing impurity levels in the sample. To standardise the approach, this time constraint should be observed, especially in regions where the collection frequency is rather low and some of the bio-waste may be already a few weeks old. Furthermore, the analysis should take place at daylight.

9.5 Interval of quality analyses

It is essential to implement a comprehensive monitoring scheme at each bio-waste recycling facility. **Visual inspection**, a straightforward and adaptable method, can be performed at the reception stage of the recycling facility with a high-frequency. Therefore, the methodology should be applied to gain knowledge **on each distinct collection route**, ideally on **each batch delivered** to the gate of the biological treatment. This provides an ongoing overview of waste quality from different origins.

An additional ranking system, counting the items of impurities on a specific surface can be used to calibrate the visual inspection methodology with actual impurities found in a waste composition analysis (see section 5.3.1). Nevertheless, the identification of a correlation must be conducted for each bio-waste recycling facility.

Compositional analysis campaigns should provide a broader scope than visual inspections and therefore statistically robust coverage of the collection area, ideally targeting each municipality or region with distinct collection schemes or organisational entities. This can be done by analysing individual collection routes and elaborated further by distinction of housing types (e.g., single-family vs. multi-family areas), or area types (e.g., rural vs. urban). In regions with commingled kitchen and garden waste collection, it is advisable to account for seasonal fluctuations in quantities and qualities. For kitchen waste, this may include lower generation during holiday seasons, especially in summer. For garden waste, this includes the growing (much vegetation) season and the dormant season (winter, little vegetation). For both waste types, a definition of the season including their start and end points should be made. Depending on the focussed fraction of the collection system, for each season a compositional analysis should be performed. This approach helps capture variations in waste composition and impurity levels.

If a bio-waste recycling facility is the reference point including its catchment area, factors such as the average tonnage of bio-waste it receives and the population it serves should be considered to determine the total number of batches to analyse. Results from these campaigns should be linked to the corresponding treatment facility for accurate quality assessment. A dedicated methodology to create a collection route inventory and a protocol to identify them while entering the recycling facility are needed to optimize the composition analysis campaigns.

Considering the aforementioned factors, performing **compositional analysis campaigns twice per year** can be a starting point**.** The widespread implementation of the monitoring programme including experiences gained by operators, may help fine-tune the frequency in the future.

9.6 Financing of bio-waste quality measurement

Financing of the monitoring programme of bio-waste quality assessment is crucial for its implementation. The costs should be borne by the waste producer or collector and not be placed on the recycling facility operator.

At the local level, regulations already exist regarding the frequency of compositional analyses for (bio-)waste, along with economic instruments for funding. For instance, in Catalonia, waste compositional analyses are funded through taxes on landfill and incineration, as briefly outlined in section 4.2.4 and detailed further in the **LIFE BIOBEST D3.2 Guideline on governance and economic incentives**.

9.7 Additional considerations

Combining a waste composition analysis for bio-waste with one for residual waste can also facilitate the reinforcement of separate collection and recycling targets. The analysis should be carried out within the same timeframe and at the same frequency in order to have the best possible conditions for comparison.

10 Recommendations for a control value for impurities in bio-waste

Introducing a quality standard may not only include the implementation of a methodology for the quality assessment but as well a target for maximum impurities in separately collected bio-waste. This may be introduced as a control value to improve the overall bio-waste management scheme including the product. Such control value should be defined as orientation/target and allow some flexibility. This includes the possibility for an agreement between the plant operator and the waste producer or collector. On the other hand, a limit value would have legal status. This certainly implies consequences for the producer or collector of waste without the option for additional agreements.

It is therefore important to put the point of assessment the latest at the entrance of the respective bio-waste recycling facility. However, the quality can be as well verified already at the point of collection as described in section 5.3.

As a result, there was no unified consensus during the expert consultation for introducing a specific and binding limit value. However, it was agreed on a target to be introduced as a **control value.** The target shall be the driver to define the actions to maintain or improve bio-waste quality. It shall be based on long experiences with waste compositional analysis and minimum requirements of bio-waste quality in reference to its implications on the efficiency of the biological treatment as well as the product.

Based on the aforementioned experiences, it is recommended to target a maximum of **3% impurities for systems focussing on commingled bio-waste (FW < 70% w/w)** and **5% impurities for systems focussing on food waste (FW > 70% w/w),** assessed at the gate of the recycling facility.[2] Impurities are defined as those described in the negative list in section 9.2, Table 9.

It should be aimed at gradually decreasing the target value. Especially in countries or regions at the beginning of bio-waste management, a dynamic system may be introduced with reducing target values over time, allowing each authority to adjust progressively towards high-quality bio-waste as input for biological treatment.

Concluding from the discussions, **specific attention must be given to plastics impurities** as they pose the most severe issues in treatment and final product quality.

[2] Different types of bio-waste must be considered for the target. Experiences showed that a share of impurities between 3 and 5% in a collection system focussing on food waste can be considered as good quality, while it cannot be considered as such for commingled bio-waste collection with a share of food waste below 70%, or collection of green waste only. Especially for systems focusing on green waste, the share of impurities should not exceed 1%.

Since a control value offers the option to agree on specific terms and conditions between the plant operator and the bio-waste producer or collector, it should aim to **relief the plant operator and give responsibility to the producer/collector of waste.**

Either by additional agreements on a control value or a legally binding limit value, consequences for exceeding the value can range from economic incentives to improve bio-waste quality until a rejection of delivered batches. Both circumstances should focus on a **bonus-malus (i.e. variable gate fees) or tax refund system related to the quality,** with a rejection as a last option. This part of a potential standard shall promote the improvement of bio-waste quality already at the place of its origin (e.g., households) and motivate the responsible authority to closely control the quality at the place of the bio-waste producers, e.g., by the implementation of additional controls prior to collection or by the implementation of a user identification system and to set-up a communication programme dedicated to improving the quality.[3]

[3] Note: The suggestions focus on material entering the recycling facility and not just entering the first biological treatment step in the facility, allowing for standardised input quality controls regardless of pre-treatment intensity. This approach is essential, as higher impurity levels in bio-waste increase the mass of discarded material, including both bio-waste during pre-treatment and compost during refining ("dragging factor"). Thus, any improvement in material quality through pre-treatment and refining invariably results in some bio-waste and compost loss.

11 Final considerations for the implementation of a standard

The following key aspects to introduce a quality standard for bio-waste on a regional or national level were identified:

1. The European Commission shall mandate an institution for standardisation with the development of a standard methodology as outlined in the WFD § 22, point 3, based on the recommendations in this report.
2. The introduction of a control value should be informed by a thorough examination of existing national and regional quality requirements and assessment procedures. The few national and regional frameworks currently in place adopt differing approaches to bio-waste quality assessment. Additionally, these frameworks vary in their definition of a target, either as a control value or a limit value, with impurity levels in source-separated bio-waste ranging from 1% to 11.5%
3. A crucial step in introducing regulations on quality standards for bio-waste as feedstock for biological treatment is the definition of the "quality" term in the bio-waste quality assessment methodology. This includes establishing positive and negative lists regarding the acceptance of materials and fractions as proposed in this report. Additionally, a conditional material list should be created, allowing materials to be classified as acceptable or unacceptable at the EU MS level. However, some flexibility should be given to biological recycling facility operators due to treatment technology and facility-specific practices. These materials mainly refer to those aiding separate collection (bags, wrapping material).
4. A control value shall consider the minimum technical equipment for pre-treatment and refining of a bio-waste recycling facility. There shall be the option to agree on a limit value between facility operator and waste producer or collector in individual contracts that go beyond the control value specified in a future EU-standard.
5. The development of a standard methodology and control value requires practical trials that account for regional variations, variations in collection systems (e.g., collection schemes and focus materials), and the technical characteristics of treatment facilities (including diverse pre-treatment and refining technologies).
6. Besides introducing minimum quality requirements, it is also important to implement options for an effective bonus-malus system (with higher gate fees for lower qualities) or a rewarding scheme with (landfill and incineration) tax rebates for higher quantities and qualities of separately collected bio-waste. The factor of quantities in the calculation should include only the net bio-waste excluding impurities.

7. The results of the quality analysis should be reported to the corresponding local authorities and all the instruments implemented should focus on the promotion of the improvement of bio-waste quality already at the place of its origin (e.g., households, commercial producers) as well as motivate the responsible authority to update the collection model with efficient systems that allows the control of the impurities at source (during the collection) along with setting-up a continuous communication programme address to producers and operator

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Annex

Annex 1 – Characterisation protocol for bio-waste in Catalonia - Methodology

The following procedure was described by the Catalan Waste Agency (ARC, 2022).

Homogenisation of the material

In order to guarantee a sampling as representative as possible, all the material requires effective homogenisation. If the homogenisation is carried out by shovel or tractor, it has to be avoided to pass over the material so that it may not suffer neither compacting nor the production and loss of leachate.

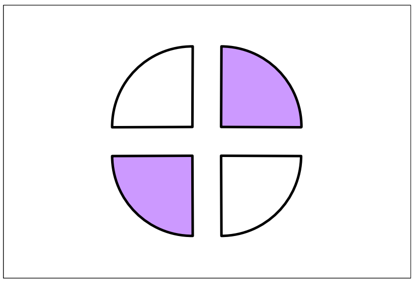
The quartering will involve the total quantity unloaded by one truck. If the FORM has been deposited on a tarpaulin, it has to be made sure that during homogenisation the tarpaulin is not damaged and the FORM mingled with the underlying soil. To that end a layer nearest to the ground shall remain unmixed.

Sampling and quartering

If after homogenisation and prior to characterisation more bulky wastes are detected (also bulky garden waste), those are manually removed and weighed individually. The weight is registered in the reporting sheets.

The sampling procedure and quartering system consists in making successive quarters of the lot until arriving at selecting a representative sample fraction of 250 kg approx. This is achieved in the following steps:

1. The entire lot is distributed volumetrically in an approximately circular form. The sample is divided in 4 homogeneous parts by means of a plastic tape (see photo).
2. For the quartering two diametrically opposed subsamples are selected and the rest is discarded.
3. The two selected subsamples are homogenised again to obtain a uniform sample and the quartering procedure is repeated as previously.



4. This procedure is repeated successively until obtaining a subsample of approximately 250 kg, which will be characterised subsequently.
5. The sample to be characterised will be reserved and deposited preferably on pavement, in order to guarantee its integrity. If no paved surface is available, the entire sample to be characterised is deposited on a tarpaulin covering the soil in order to avoid any kind of undesired influence.

In the event that the characterization company decides that it is not necessary to quarter the lot due to the low weight of this, it must be taken into account that there is always to characterize the whole lot, regardless of its final weight.

Initial weight of the sample and bag opening

The total weight of the material to be characterised is registered (approximately 250 kg). All considered waste fractions have to be referenced to this initial weight, including possible material losses during the characterisation. Taking into account the difficulty to adjust the weight of the material to be characterised to about 250 kg, it is considered to allow a tolerance of 10%. This means that in order to be considered valid by ARC, a characterisation has to be carried out on a sample quantity of minimum 225 kg, under normal circumstances.

There are only two exceptions admitted:

1. When the quantity of bio-waste collected in a particular circuit is less than 250 kg.
2. When a characterisation had to be interrupted due to circumstances presenting force majeure (accident at work, appearance of hazardous or specific healthcare waste, etc.)

In any of these two cases the quantity of bio-waste that will be assigned for the purposes of the calculations will be the one that has really been characterized until the moment when the characterisation had to be stopped.

Subsequently the material has to be deposited manually or with shovels into a tared bucket or bag and weighed. Immediately afterwards the material is placed on a working table with a clean surface. This surface should preferably be elevated in order to facilitate the work of the staff that has to carry out the characterisation.

Those bags that have not been split open during the homogenisation have to be opened manually making sure that the maximum of their content is emptied to the table. Non-compostable bags are deposited into a container reserved for "plastic bags", for later quantification.

Compostable bags will also have to be quantified separately in order to know the percentage they occupy with respect to the total of bags Later they will be classified as organic fraction.

After this procedure, the characterisation into fractions according to **Annex 7** – Waste fractions of the Catalan sorting protocol can be performed. The procedure looks as follows:

1. The selected and separated items and materials are deposited in well-labelled and previously tared containers (boxes, flexi baskets, etc.). Check frequently the tares of the containers.
2. Once finalised the separation, each fraction shall be weighed and documented photographically.
3. After weighing each of the fractions the obtained impurities shall be handed over to the collection and treatment system for residual waste established by the composting plant or corresponding installation, whereas the organic matter shall be reincorporated, provided this is possible, into the biological treatment system of the organic waste. Impurities and compostable fraction must not be mixed under any circumstances.
4. Finalised the characterisation procedure, the area of operation as well as the instruments and tools used have to be cleaned.
5. During characterisation digital photos are taken which afterwards will be uploaded to the application SDR (Sistema Documental de Residus) of the ARC, together with the results of the characterisations.

Figure 14. Example of the waste characterization form and photos from Catalonia

Agència de Residus de Catalunya | Generalitat de Catalunya | sistemas medioambientales

Butlletí de caracterització de la FORM. ANY 2024

Entitat Caracteritzadora	SM SISTEMAS MEDIOAMBIENTALES, SL				
Núm. Butlletí	27.000	**Lot**	Lot 1	**Caracterització**	4r Trimestre 2024

Dades Generals

Tipus Recollida: ☑ Individualitzada ☐ Conjunta

Tipus de FORM: ☑ Domèstica ☑ Comercial

Estat de butlletí: Acceptat

Circuit	CERVELLÓ
Descripció circuit	Recollida mitjançant contenidor en superfície, a tot el municipi. Contenidor amb sobretapa i model de recollida posterior.
Ens Local titular recollida	AJUNTAMENT DE CERVELLÓ
Municipis	CERVELLÓ

Recepció de la FORM

Dia i hora de la recepció	Dilluns, 25 de novembre de 2024 11:57
Matrícula vehicle	1276KRW
Quantitat	980 Kg
Instal·lació caracterització	PLANTA DE TRACTAMENT BIOLÒGIC DE TORRELLES DE LLOBREGAT

Caracterització de la FORM

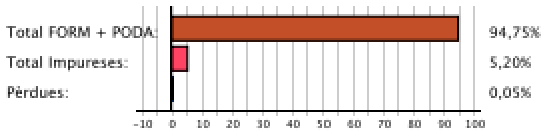
	inici	fi	durada
Presa de mostres de la FORM	26-11-2024 07:00	26-11-2024 07:08	00:08
Caracterització de la FORM	26-11-2024 07:42	26-11-2024 10:13	02:31

Número de treballadors: 2 — Pes FORM a caracteritzar (bàscula precissió): 249,31 Kg

Resultat de la caracterització

FORM a caracteritzar 249,31 Kg — Inclou part proporcional de PODA i Residus Voluminosos

Fraccions	Pes en Kg	% en pes
FORM	234,89 Kg	94,75%
Poda	0,00 Kg	NaN%
Total FORM + PODA	234,89 Kg	94,75%
Vidre	2,52 Kg	1,01%
Paper i Cartró*	1,99 Kg	0,53%
Plàstic, Mixtos i Film	2,97 Kg	1,19%
Bosses Plàstic*	1,40 Kg	0,30%
Metall Fèrric	0,67 Kg	0,27%
Metall no Fèrric	0,35 Kg	0,14%
Tèxtil	0,00 Kg	0,00%
Tèxtil-Sanitari	0,07 Kg	0,03%
Residus Especials	0,11 Kg	0,04%
Residus Voluminosos	0.00 Kg	0,00%
Altres Residus	4,21 Kg	1,69%
Total impropis	14,29 Kg	5,20%
TOTAL:	249,18 Kg	99,95%
Pèrdues:	0,13 Kg	0,05%



Observacions caracterització:
Medicaments, 1 xeringa amb la agulla tapada, piles. 0 bosses resta

Presència majoritària de bosses compostables per a la recollida selectiva de la FORM:
☐ Ús Majoritari ☐ Força ☐ Algunes ☑ Cap

Observacions residus voluminosos:

Observacions altres residus:
Cendra, burilles de tabac, elements multimaterial, porcellana. Producte alimentari envasat

TORRELLES DE LLOBREGAT, 26 de novembre de 2024

Butlletí de caracterització de la FORM. ANY 2024

Fotos


1. Lot


2. Identificació del Lot


3. Mostra


4.1 Malbaratament alimentari FORM


4.2 Fracció vegetal assimilable a FORM


4.3 FORM no inclosa als grups 4.1 i 4.2

5. Poda voluminosa (trobada al lot)

6. Poda voluminosa (trobada a la mostra)

7. Poda no voluminosa (trobada a la mostra)


8. Vidre


9. Paper i cartró


10. Plàstic, mixtos i film


11. Bosses de plàstic


12. Metall fèrric


13. Metall no fèrric

14. Tèxtil


15. Tèxtil-sanitari


16. Residus especials

17. Residus voluminosos (trobats al Lot)

18. Residus voluminosos (trobats a la mostra)


19.1 Malbaratament alimentari Altres


19.2 Altres no inclosos en grup 19.1


20. Altres aspectes

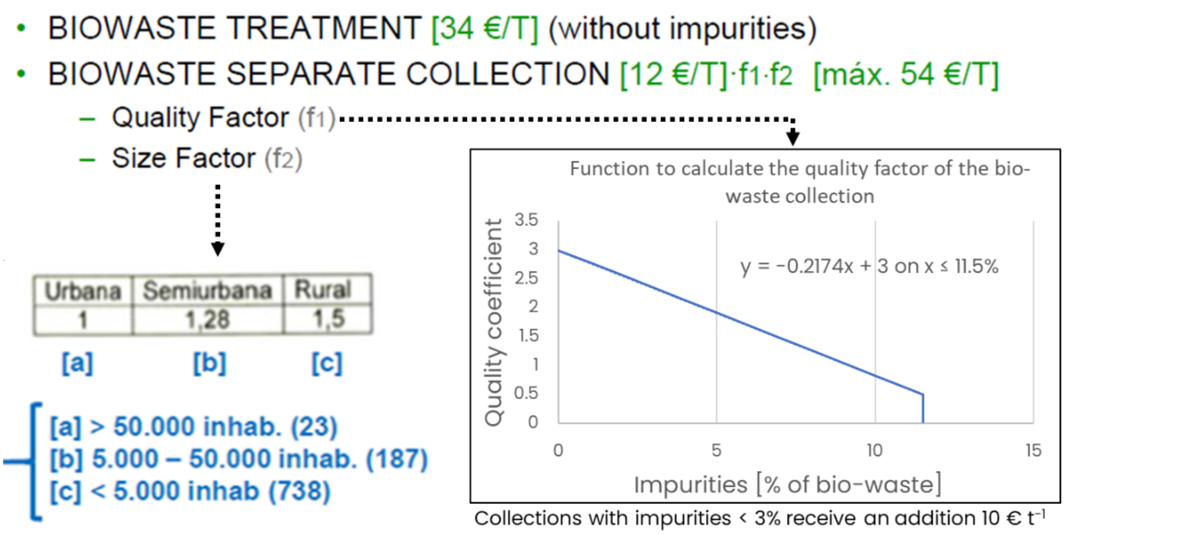
21. Altres aspectes

Annex 2 – Summary of the Catalan tax refund system

The following describes the procedure for the calculation of the landfill and incinerator tax refund system for separately collected bio-waste in Catalonia according to the results of quarterly bio-waste compositional analyses (see section 5.2.5), which is also summarised in Figure 15. The factors for the calculation are updated and published annually by the Catalan Waste Agency (ARC, 2024):

1. With regard to the treatment refund concept including an amount of 34€ per net tonne, the following factors are to be applied:
    a. The net tonnes of managed bio-waste (excluding the garden waste from pruning) are applied, with quantities of impurities discounted.
    b. A new maximum percentage of impurities of 20% is applied as a limit to receive the refund.
2. With regard to the collection refund concept including a starting point of 12€ per tonne (multiplied by two coefficients, municipality size and quality), the following factors are to be applied:
    a. The tonnes of selectively collected bio-waste are applied (excluding the garden waste from pruning) when entering composting and/or anaerobic digestion plants.
    b. The current control value for impurities in bio-waste is 11.5% w/w (2024). Municipalities whose impurities in bio-waste exceed this control value will not be eligible to receive a refund. As the waste characterisations are conducted on a quarterly basis, the penalty is applied to the amount corresponding to each quarter, based on the specific value of impurities analysed.
    c. A quality correction coefficient is applied according to the following equation (for 2024): $Y = -0.2174X + 3$ where $X \leq 11.5\%$ (see Figure 15), where Y is the quality correction coefficient factor and X is the share of impurities in %.
    d. For collections with less than 3% impurities, to the final amount, resulting from application of the unit amount and the different coefficients, an additional €10/t are added.

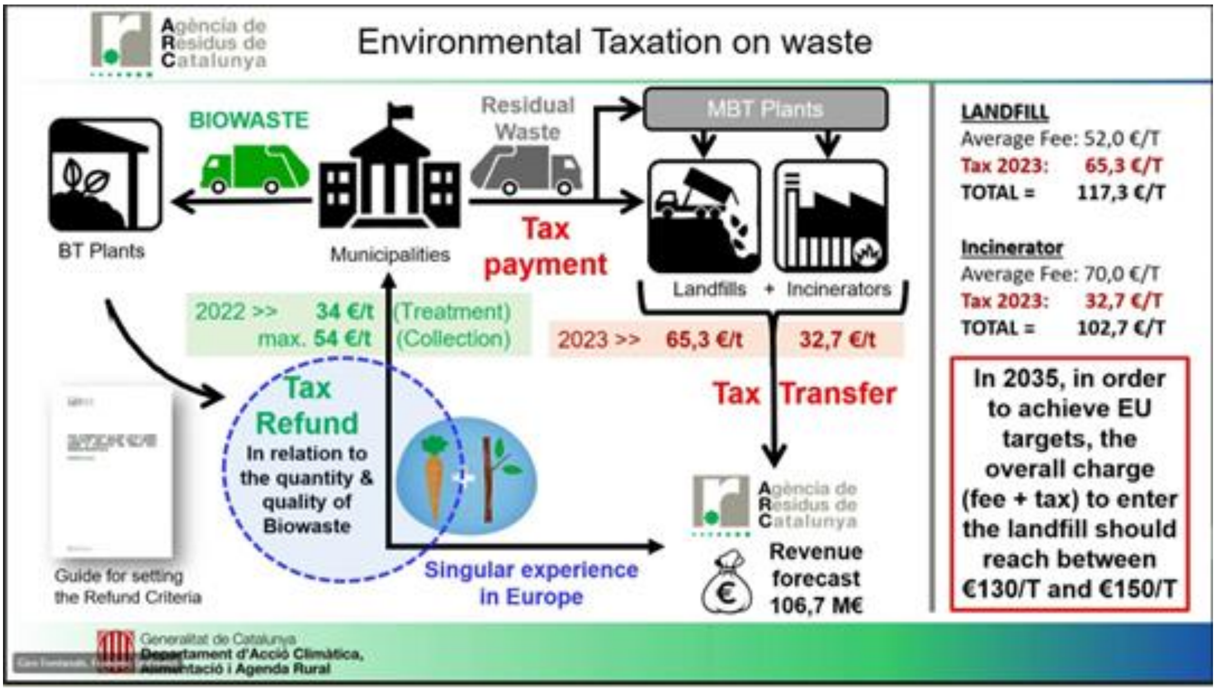
Figure 15. Procedure for the bio-waste collection and treatment tax return concepts



Source: Francesc Giró presentation at BIOBEST Capacity Building Event in Barcelona (October 2023)

The full complexity of the tax and tax refund system is shown in Figure 16. In addition, a tariff system is in place for bio-waste entering a treatment facility, whereby the waste is classified according to the share of impurities and the associated treatment costs are borne by the municipality and to be paid to the plant operator.

Figure 16. Catalan waste tax and tax refund scheme



Source: Francesc Giró presentation at BIOBEST Capacity Building Event Barcelona (October 2023)

Annex 3 – Waste fractions of the Austrian sorting protocol

Main group	Sub-group 1	Sub-group 2	Sub-group 3
Biogenic waste – Garden			
	Tree- and bush trimmings ('woody')		
	Leaves, grass cuttings, weeds ('soft')		
	Other garden wastes and similar		
Biogenic waste - Kitchen			
	Kitchen waste (non-avoidable, preparation remains)		
	Avoidable food waste		
		Dairy products	
		Meat/fish (cooked & raw)	
		Bread	
		Fruit & vegetables	
		Leftovers	
		Other food	
	Other organics (non-mineral, e.g., animal litter)		
Paper (incl. sanitary paper)			
Impurities			
	Plastics	Plastic bags	Biodegradable Non-biodegradable Not assignable
		Foils	
		Other plastics	
	Glass		
	Metal	Ferrous Non-ferrous	
	Hazardous substances		
	Waste of Electrical and Electronic Equipment		
	Other impurities		
Residuals (not assignable)			

Annex 4 – Waste fractions of the Flemish sorting protocol (Belgium)

Waste fraction	Materials
Kitchen waste (Vfg waste)	Kitchen waste
	Paper kitchen towel, cardboard, newspaper, paper filter
	Allowed compostable bags (used for separate collection)
Garden waste	Grass
	Light fraction garden waste (diameter < 5 cm): prunings, leaves, …
	Inorganic fraction (soil)
	Woody material (diameter > 5 cm)
Impurities	Bags with residual waste
	Stones and ceramics
	Plastic (empty or full)
	Glass (empty or full)
	Metals (empty or full)
	Wood (B-wood)
	Diapers and related materials
	Not-allowed compostable bags
	Other impurities (e.g. litter box, cadavers, manure, shells, bones, coffee pads and capsules, dust, package, textile, tea bags, cork, charcoal, …)

Annex 5 – Waste fractions of the German sorting protocol

Simplified list of materials

Waste fraction	Materials
Bio-waste	All materials considered as actual bio-waste
Biodegradable plastic bags	Bags made from biodegradable plastics
Other plastics	All other
Other impurities	All materials that are neither bio-waste nor plastics

Extended list of materials

Waste fraction	Materials
Impurities	Plastic bags (films)[1]
	Other plastics[2]
	Glass
	Metals
	Packaged food waste[3]
	Harmful substances (e.g., batteries, drugs)
	Composites
	Minerals
	Textiles
	Others
Bio-waste	Garden waste
	Kitchen waste → includes food waste, paper, collection bags[1]
	Other biodegradable materials

[1]Those made of biodegradable materials (certified according to DIN EN 13432) may be accounted as bio-waste depending on the local policy.
[2]Any item other than biodegradable plastic bags (point [1]) meant for collection must be included as impurity.
[3] Food waste that is unpacked during the sorting analysis can be categorised as bio-waste and its packaging as the respective material of impurity. For unopened food, the protocol specifies a factor for plastics, glass and metals, which was estimated empirically.

Annex 6 – Waste fractions of the Italian sorting protocol

Waste fraction	Materials
Compatible material (CM)	Food waste (raw and cooked)
	Paper or bioplastic collection bags - certified according to UNI EN 13432:2002
	Compostable plastic articles inside the collection bags - certified according to UNI EN 13432:2002 or UNI EN 14995:2007
	Paper-based catering articles, paper bags inside of collection bags - certified according to UNI EN 13432:2002 or UNI EN 14995:2007
	Other paper (tissue, napkins, household paper)
	Herbaceous garden waste
	Lignocellulosic garden waste
	Other food contact items - certified according to UNI EN 13432:2002 or UNI EN 14995:2007
Neutral material (NM)	Other untreated paper and cardboard
	Untreated wooden materials – pallets, crates, corks, coffee stirrers, etc.
	Other manufactured articles - non-food - certified according to UNI EN 13432:2002 or UNI EN 14995:2007
	Household ash from virgin wood (up to 5% wt:wt)
Non-compatible material	Plastic (collection) bags
	Plastic items other than those in CM and NM
	Glass
	Metals
	Inert materials
	Absorbent sanitary products
	Other

Annex 7 – Waste fractions of the Catalan sorting protocol (Spain)

Category	Materials
FORM (Organic fraction of municipal waste)	Food Waste
	Small non-woody plants
	Other material not included in above (Includes compostable/biodegradable materials: packaging, rigid materials other products such as plates, glasses and covers)
	Garden waste
Impurities	Glass
	Paper and Cardboard
	Mixed plastics and films
	Plastic bags
	Ferric metals
	Non-ferric metals
	Textile
	Sanitary textile
	Hazardous wastes
	Bulky wastes
	Others

Annex 8 – Typical equipment required for sorting analyses

For sorting

- Sorting Protocol (electronic or printed)
- List of fractions to be sorted
- Camera / Smartphone
- Reusable whiteboard and pen (for description of waste fraction on picture)
- Extension cable, distribution plug
- Tools: Small broom, large broom, shovel, garden fork, hand rake, folding rule, cable ties, (plastic) bags, scissors, knife, etc.
- Buckets / containers incl. labelling of fraction (number depending on the number of fractions to be sorted + some reserve)
- Sorting table
- Electronic scale (minimum limit of 150 kg)

Optional: Laptop

Personal safety equipment

- Dust mask, cut-resistant gloves, overall, safety goggles
- Safety shoes
- Safety vest
- First aid kit

Working space

- The material to be characterised shall be deposited preferably in a paved, clean and roofed area.
- The owners and/or operators of biological treatment plants must ensure that sufficient space is available for characterisation, which is well separated from other work processes and, if possible, well-lit and ventilated. The circulation of heavy machinery in the proximity of the reserved space shall be avoided during characterisations.

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