Bin2Bean

# D6.1 – Charging Systems for Bio-Waste Collection and Valorisation

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**BIN2BEAN project**

## D6.1 Charging Systems for Bio-Waste Collection and Valorisation

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# Index

**BIN2BEAN project** ..... 3
Executive Summary ..... 8
1. Introduction ..... 10
2. Preparatory work ..... 11
3. Costs and revenues – step by step ..... 14
3.1 Existing waste management system: Costs and revenues ..... 15
3.2 Collection of bio-waste and related activities ..... 17
3.3 Processing of bio-waste and production of soil improvers ..... 19
3.4 Potential subsidies ..... 21
3.4.1 Horizon Europe ..... 21
3.4.2 Interreg ..... 22
3.4.3 LIFE ..... 22
3.4.4 Other programmes ..... 22
3.5 Financial contribution from the waste producers ..... 23
4. Taxes, fees, charges, pay-as-you-throw ..... 26
4.1 Charging systems ..... 26
4.1.1 Definitions ..... 26
4.1.2 Examples from European municipalities ..... 27
4.2 Identification of waste producers ..... 28
4.3 Impacts of financial incentives ..... 30
4.4 Basic fees ..... 34
5. Experiences from the Living Labs ..... 36
5.1 Hamburg ..... 36
5.1.1Business model for compost and biogas production ..... 37
5.1.2 Optimizing the collection of bio-waste ..... 39

5.1.3 Potential improvements of the regulatory frame ..... 44
5.2 Amsterdam ..... 45
5.2.1 Approaches for the valorisation of bio-waste ..... 46
5.2.2 New approaches – which ones are promising? ..... 49
5.2.3 Comparison of the different systems: Convenience, ecology, economy ..... 50
5.2.4 The regulatory frame – overcoming legal restrictions ..... 52
5.2.5 Consequences for Amsterdam's waste management fees ..... 52
5.2.6 Summary of political implications ..... 52
5.3 Egaleo ..... 53
5.3.1 Analysis of the current situation and experiences gained so far ..... 54
5.3.2 Taking the value chain into account ..... 56
5.3.3 Egaleo's strategy for bio-waste valorisation ..... 56
5.3.4 Collection of bio-waste from different waste producers ..... 57
5.3.5 Awareness raising ..... 58
About Bin2Bean ..... 59
References ..... 61
Annex I: Introduction of the „brown bin": Costs, revenues, charges ..... 63
Annex II: Costs of separate collection and supporting activities ..... 64
Annex III: Costs of processing of bio-waste ..... 65
Annex IV: Valorisation of organic waste: Balance of costs and revenues ..... 66
Annex V: Calculation of charges and charging policy ..... 67
Annex VI: Management of quality problems at different intervention points ..... 68

## List of figures

Figure 1 Balancing revenues and costs for the valorisation of bio-waste (own source) ..... 11
Figure 2 Value chain for bio-waste to soil improvers (own source) ..... 15
Figure 3 Balancing costs and revenues for the whole waste management system (detail from Annex I) ..... 16
Figure 4 Plan-do-check-act cycle (source: ASQ) ..... 17
Figure 5 Necessary financial contribution to the waste service after taking into account all costs and other income ..... 24
Figure 6 Identification of users – clipping from Annex I ..... 28

Figure 7 Specific amount of residual waste and bio-waste in European cities (source: Friege& Hentschel [2026]) ..... 31
Figure 8 Specific amount of separately collected bio-waste vs. population density (source: Maike Hentschel, Master Thesis) ..... 32
Figure 9 Level of impurities in bio-waste in relation to the local fee system and enforcement measures (own source) ..... 34
Figure 10 Recycling yard accepting green waste among about twenty waste fractions (source: SRH) ..... 37
Figure 11 Installation of the 1000th underground container in Hamburg (source: SRH) ..... 40
Figure 12 Dispenser for water-proof bags attached at the bio-waste container ..... 41
Figure 13 Work on the expansion of the Bützberg facility (source: SRH) ..... 43
Figure 14 City of Egaleo: Bio waste bin at the kerbside ..... 55

## List of tables

Table 1 List of socioeconomic parameters for the calculation of costs and revenues of bio-waste management ..... 18
Table 2 Charging systems and bio-waste collection in European municipalities (data from [Friege & Hentschel 2026]) ..... 27
Table 3 Amsterdam waste statistics, all figures in kg per inhabitant ..... 46
Table 4 Preliminary ranking of mulitple indicators per valorization strategy ..... 51

## List of acronyms

| | |
|---|---|
| **CAPEX** | Capital expenditures |
| **DIY** | Do it yourself |
| **DtD** | Door-to-door |
| **d.w.** | dry weight |
| **EC** | European Commission |
| **ECN** | European Compost Network |
| **EP** | European Parliament |
| **EU** | European Union |
| **FSTP** | Financial support for third parties |
| **GDPR** | General Data Protection Regulation |
| **GHG** | Greenhouse gas emissions |
| **LAP** | Landelijke afvalbeheerplan (Netherlands) |
| **LL** | Living Lab |
| **MRV** | Monitoring, reporting and verification |

| | |
|---|---|
| **OPEX** | Operational expenditures |
| **PAYT** | Pay as you throw |
| **PF** | Policy forum |
| **PPP** | Polluter pays principle |
| **SMEs** | Small and medium enterprises |
| **SRH** | Stadtreinigung Hamburg |
| **WFD** | Waste Framework Directive |

# Executive Summary

This report focuses on the costs and revenues involved in collecting and processing bio-waste for use as soil improvers. It includes recommendations for municipalities looking to introduce or optimise bio-waste collection. The report concentrates on economic issues, particularly charging systems, thus complementing other Bin2Bean project publications, specifically the Bio-waste Collection and Processing Guidelines (D3.1) and Guidelines for Communication and Awareness Raising (SPG22). Changes to waste collection systems and decisions on waste management fees are important issues for local councils. This guide therefore highlights the key political decisions relating to the recycling of organic waste. Our aim is to ensure that these decisions are based on technically accurate information and the most reliable data possible. The results of the policy forums in the three living labs — Hamburg (Germany), Amsterdam (the Netherlands) and Egaleo (Greece) — were evaluated alongside many other experiences, and both were integrated into the guideline.

Due to the low revenues for soil improvers and reasonable costs for collection and processing in most EU Member States, the valorisation of bio-waste from private households and commerce in Europe is not possible without additional financing. Optimal bio-waste management can decrease overall waste management costs and yield further social benefits in the form of healthier soils and active citizen participation in waste sorting.

The economic perspective on bio-waste recycling should be considered alongside technical considerations and carefully prepared for the necessary decisions in administration and politics. A thorough analysis and preliminary calculation along the value chain or individual stages in the chain help to avoid unpleasant surprises due to excessive costs.

It is advisable to closely monitor costs in pilot areas in order to draw conclusions for the steady expansion of the collection area. In the event of optimisation, data collected over many years will be available.

Before introducing weight- or volume-based fees, a series of management games, trials and intensive discussions with citizens should be conducted to test reactions and implementation. There are numerous possibilities for the structure of such a system, which must be examined in relation to housing structures, population density and measures to enforce waste sorting at source. Financial incentives for waste sorting can considerably reduce the amount of residual waste. However, quality issues can arise in bio-waste as an unintended consequence. Solutions must fit the municipality in question.

While examples from other cities are useful, they should never be introduced without testing. For the identification of single households even in multi-family houses additional technical systems are necessary. After the introduction of advanced fee systems monitoring of the quality of bio bins should be enhanced to detect potential misuse.

The experiences gathered in the living labs not only highlight the vastly different starting conditions but also allow for conclusions regarding meaningful regulatory changes and simplifications at the European and national levels.

# 1. Introduction

This report focuses on the costs and revenues involved in collecting and processing bio-waste for use as a soil improver. It provides recommendations for municipalities looking to introduce or optimise bio-waste collection systems. Therefore, the focus is on bio-waste from private sources. If the city is responsible for collecting bio-waste from small enterprises, particularly restaurants and hotels, this can be incorporated into collection planning and fee calculations. Fees for municipal services are an important policy issue, particularly in the event of price increases. Therefore, we advise policy-makers and administrators on how to make necessary decisions regarding cost accounting and financial contributions to be paid by waste producers. The guideline focuses particularly on charging systems that encourage people to sort waste more effectively at source. The necessity of political decisions, e.g. by the city council, is marked in red letters.

For more information on technical issues, e.g. the collection and processing of bio-waste and communication with citizens, please refer to the following Bin2Bean project publications: Bio-waste Collection and Processing Guidelines[1] and the Guidelines for Communication and Awareness Raising. The approach towards introduction or optimisation of the valorisation of bio-waste is supported by process schemes, which focus on relevant parts of the calculations and decision points. The idea behind is visualized in Figure 1.

[1] This delivery has not yet been approved by the project officer and may be amended after the end of the project.

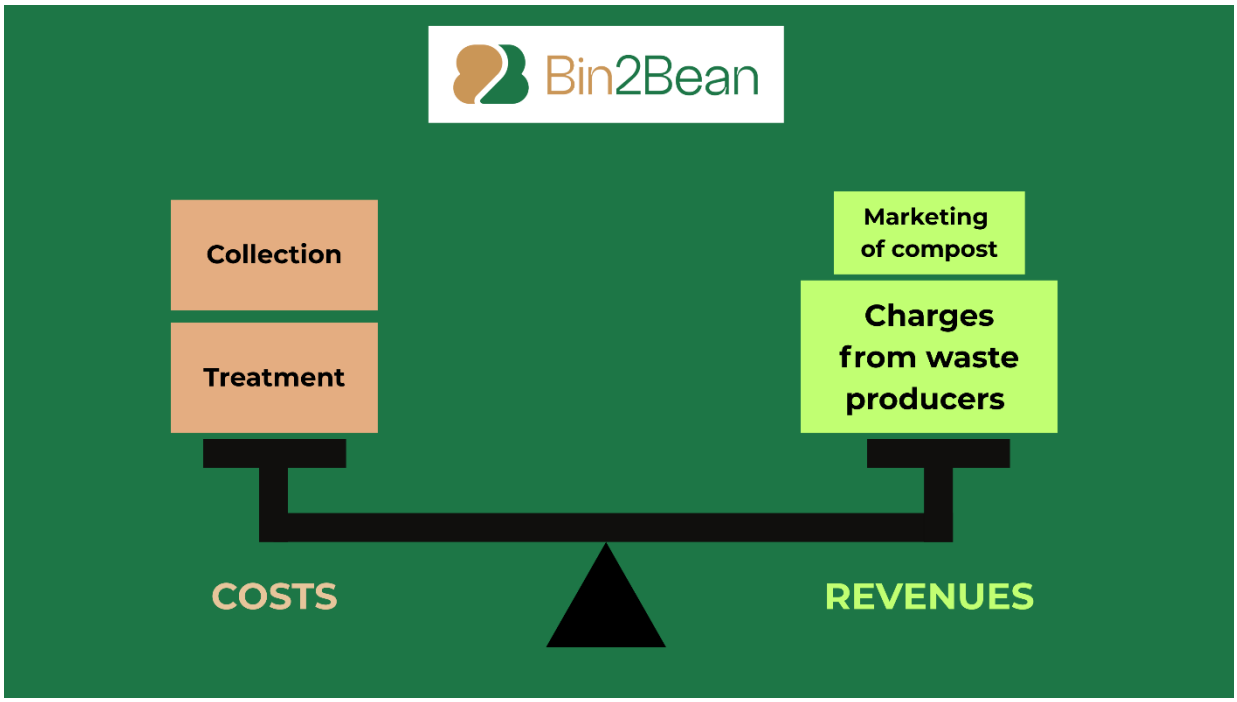



*Figure 1 Balancing revenues and costs for the valorisation of bio-waste (own source)*

The report is based on numerous discussions with the Living Labs (Hamburg, Egaleo, Amsterdam) in bilateral meetings, policy forums (at least one per each LL) and a cross-fertilization workshop. Detailed information of cost structures from SRH are gratefully acknowledged. Moreover, the impact of different charging systems on the quantity and quality of bio-waste was evaluated with a detailed survey covering more than twenty European cities; some of these cities are members of Bin2Bean's stakeholder forum.

## 2. Preparatory work

Bio-waste, i.e. food waste, kitchen waste, and green waste from gardens and parks, accounts for 34% of all municipal waste, corresponding to approximately 86 million tons [EEA 2020]. For this reason, recycling of bio-waste is of outstanding importance to meet the EU recycling targets, i.e. 65% for municipal waste by 2035. According to the EU Waste Framework Directive, the separate collection of bio-waste has been mandatory since 2024. According to the EU Landfill Directive, the amount of municipal waste sent to landfill must be reduced to 10% or less of the total amount of municipal waste generated by 2035. Detailed regulations have been implemented by the Member States to reach these targets, partially including economic instruments like landfill taxes. Consequently, European cities are introducing or enhancing the collection of bio-waste and its valorisation - i.e. the production of compost, fertilising agents, and biogas, depending on the chosen process.

Transforming bio-waste into compost and other products is an effective way to protect the environment.

- It avoids methane emissions caused by the uncontrolled degradation of landfilled organic waste.
- It helps to keep non-fossil carbon in a natural cycle through the production and application of soil improvers.
- By this transformation, soil improvers combat the loss of humus in many European regions.

As the proportion of municipal waste that was composted and/or digested increased from 11% in 2004 merely to 17% in 2018 [EEA 2020], there is an enormous need to introduce bio-waste collection in European cities. According to municipalities such as Hamburg, which began collecting bio-waste separately decades ago, continuous optimisation is necessary, particularly in densely populated areas.

The introduction of the separate collection and processing of bio-waste should decrease the overall costs for waste management, because of

- Avoided costs for landfilling (often plus landfill tax) or incineration
- Sale of compost and digestate
- Added value from the sale of products made from them

However, there are additional costs for the collection system, which can only be partially offset by reduced residual or mixed waste costs. Clearly, high specific costs for the disposal of mixed waste encourage the valorisation of bio-waste. The market price of compost, digestate and derived products depends on nutrient content, the prices of competing soil improvers or fertilisers, and regional soil quality needs.

Before starting the calculation of the whole process, it is necessary to define targets and priorities: What matters for the city? Besides the separate collection of bio-waste, the reduction of the amount and costs for residual waste, contributions to the local plan for the reduction of GHG emissions, improvement of regional agriculture, biogas as part of local power production can be secondary targets, which are important for choosing a certain process and definitely also for the economic outcome. The legal frame, particularly national regulations for waste management, soil protection, use of fertilisers etc. and the ability of the city to decide on taxes and charges must be clear. In the following box, examples from the LL's with regard to the respective national legislation are presented. In all three cases, the national regulation has financial consequences for the design of the process. This underpins the need to check the framework thoroughly before designing the valorisation of bio-waste.

Furthermore, the European frame is under continuous amendment with consequences for the bio-waste business:

- The WFD was amended in 2025; the Member States are obliged to implement the new directive in their national regulations.
- The Soil Monitoring Directive passed the EU Council and will probably adopted by the EP. Member states will have three years after entry into force to transpose the new rules into national law.
- Some aspects, which are under political discussion (see D6.2): simplification of the EC mark for soil improvers, new threshold values for compost, coherent emission threshold values for aerobic and anaerobic processes in Europe.

**How national regulation goes beyond the European frame: Examples from the LL's**

LL Hamburg (Germany): Since May, 2025, a 3% limit is valid for impurities (1% for plastics) in bio-waste. Treatment facilities can refuse the bio-waste at the gate and should inform the authorities in case of continuous contamination. The application of compost, digestate etc. on soil is limited to 20 Mg d.w. / ha for 3 years, with some exceptions.

LL Amsterdam (The Netherlands): All organic waste processing from bio-waste of more than one household is a commercial activity and therefore requires a permit under the Environmental law decision, e.g. also small-scale processing by neighbourhoods or communities. Special quality requirements apply to compost that is marketed in the Netherlands: No biodegradable parts with a diameter greater than 50 mm and no more than 0.5 % of non-biodegradable parts foreign to the soil, at least 10% organic matter by weight of the dry matter.

LL Egaleo (Greece): The reduction of further landfilling is enforced by a landfill tax, which was introduced in 2014. In the beginning, the amount of the tax was 35 €/t and raised by 5€/t annually until 60 €/t. The tax can be decreased when municipalities introduce the collection of bio-waste. There is no additional guideline for the application of compost.

Before introducing bio bins, municipalities should review their experience with other separately collected waste fractions.

- Which communication measures were successful?
- How are quantity and quality influenced by the type of collection (e.g. door-to-door vs. containers in the street)?
- What has been the development of costs and revenues from the time of introduction until now?
- What impact did financial incentives have?

Although collecting bio-waste of suitable quality presents a particular challenge, evaluating experiences from other waste fractions can provide some initial insights into the risks and opportunities involved.

The composition of residual waste should be evaluated for further planning purposes. If it is not possible to analyse the amount of bio-waste and green waste in residual waste, data from national or regional studies or cities with similar socio-economic structures should be used instead. The amount of green waste from public parks is known. If hedge cuttings and clippings from private gardens are also to be collected, their volume can be estimated based on the surface area.

If the municipality is responsible for processing bio-waste and selling the resulting products, information on soil quality and fertilisation requirements in the region is needed. It is recommended that potential agricultural partners are contacted. Furthermore, it would be beneficial to discuss the city's intentions with private companies in the region that are involved in the organic waste business, e.g. waste collectors, plant operators and producers of fertilisers and soil improvers. For details, the reader is referred to D3.1 and the literature cited there.

In some countries, regional authorities are responsible for processing. Intensive coordination between cities and regions is necessary. How much bio-waste will be collected separately? What quality is required? How can regional authorities support municipalities? In these cases, the cities must cover the costs of collection, whereas the region is allocated the costs of processing and the revenues from the sale of products. These issues must be considered for data collection in section 3.

Last not least, European and nations programmes should be checked for potential subsidies. Details are provided in section 3.4.

**Key messages:**

- Before detailed planning of bio-waste valorisation, check the national regulatory frame and the market for soil improvers.
- Ask other municipalities for their experience with the collection and processing of bio-waste and remember the experience gained from separate collection of other waste fractions..
- Prioritize the targets of the city before going into details – policy decision necessary!

# 3. Costs and revenues – step by step

The costs and revenues for the valorisation of bio-waste must be balanced as shown symbolically in Figure 1. It includes all steps of the value chain as depicted in Figure 2. The calculation is an iterative process, which is going on parallel to the planning of

logistics, processing, and communication. To facilitate this work, some process schemes were developed (Annex I – V). Annex I covers the complete process of decision-making, which combines economic considerations and feedback from certain steps during the introduction of the bio bin. The Bin2Bean scoring system (to be published) can be used to collect financial data based on individual collection and processing concepts, enabling a complete system assessment. This is the basis for the parameters mentioned in sections 3.2 and 3.3. The 'Full Cost Accounting Tool for Waste Management in Municipalities' [BMU/GIZ, 2020], which considers all potential factors, can then be used to make detailed calculations of (bio-)waste costs and revenues once a decision has been made on a certain system.

## 3.1 Existing waste management system: Costs and revenues

The calculation for the valorisation of bio-waste must be structured in a way that is consistent with the existing basis for calculating the costs of the waste management system, i.e. collection, waste processing, disposal and communication costs. Ideally, the calculation for the entire system and for each step in the value chain should resemble a business plan and include all relevant cost categories, such as operational costs (e.g. salaries, fuel, repairs) and capital costs (e.g. depreciation of waste bins and collection trucks). These cost categories should be available for all the aforementioned cost centres.

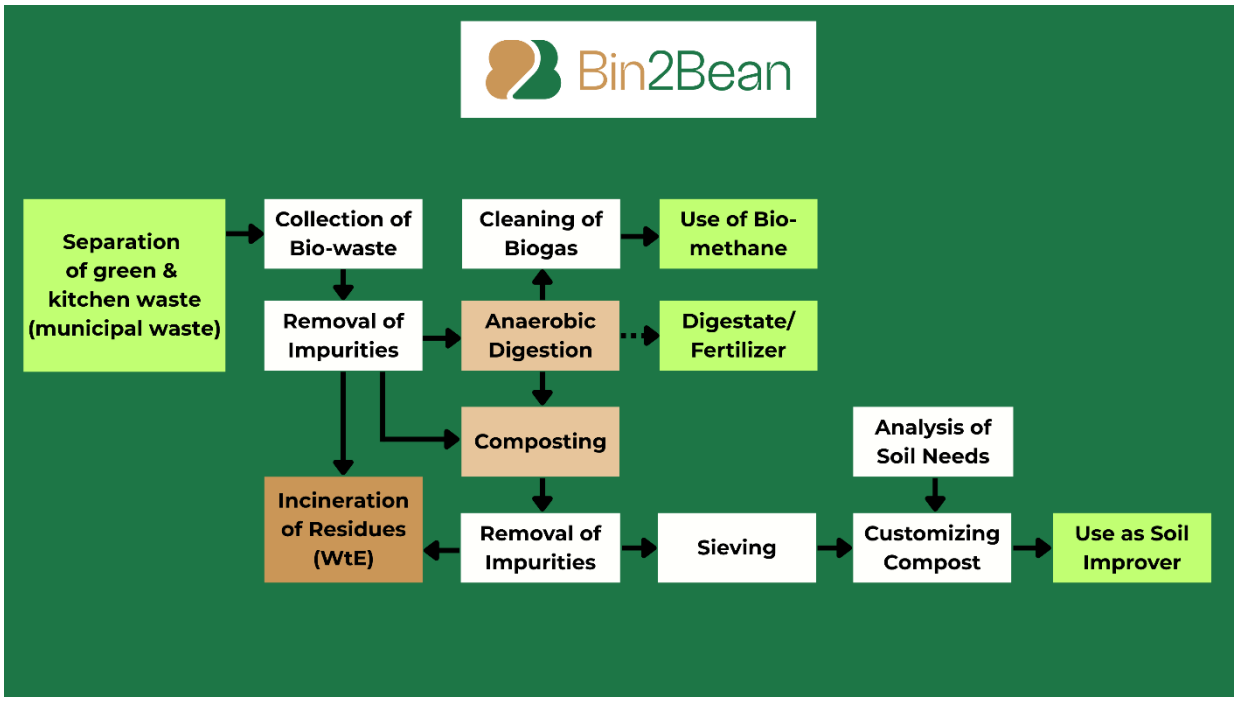



*Figure 2 Value chain for bio-waste to soil improvers (own source)*

This data is required in order to assess the financial impact of the valorisation of bio-waste on the waste management system.

- The introduction of the bio bin will lead to expenditure on a new logistics system. On the other hand, in the long run, less residual waste will be produced and fewer collection trucks will be necessary.
- The costs of processing bio-waste must be compared to the savings made on landfilling or incineration. National taxes for landfilling of waste (see [EEA 2023]) raise the costs for residual waste, which increases the pressure on sorting bio-waste at source
- Revenues from selling soil improvers decrease the overall costs and potentially the charges to be paid by the citizens.

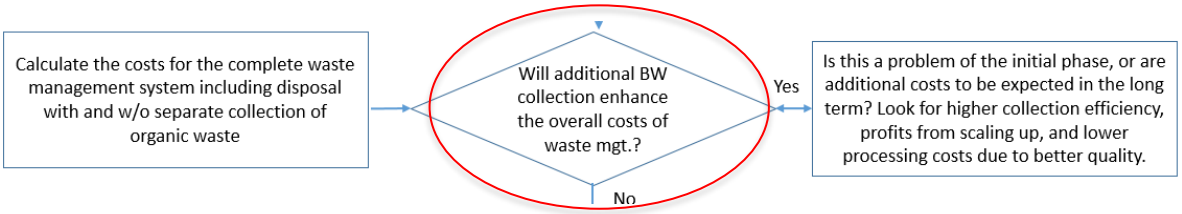



*Figure 3 Balancing costs and revenues for the whole waste management system (detail from Annex I)*

Section 3.2 and 3.3 discuss the details of calculating costs and revenues for the valorisation of bio-waste. Sections 3.4 and 4.2 explain the calculation of fees to be paid by citizens and the special aspects of charging policy, respectively.

Additional costs are unavoidable in the initial phase of bio-waste collection. The present system and the expected changes to the future system after the initial phase should balance out more or less. If not, it is recommended that all costs and revenues are checked again, and that ways of managing bio-waste valorisation more efficiently are sought. This review should also cover the residual waste management system. For example: Although the total volume of residual waste is decreasing, lower logistics costs can only be achieved if the number of bins and/or the number of collections is considerably reduced. Other optimisation steps may include improving the quality of bio waste, which would lead to higher revenues from products. Another step would be to achieve economies of scale for the processing plant by cooperating with other municipalities. This iterative process may take several years. When introducing the bio bin to a city, it is highly recommended that not only technical improvements but also changes to the charging system are tested in pilot areas according to the PDCA principle (Figure 4).

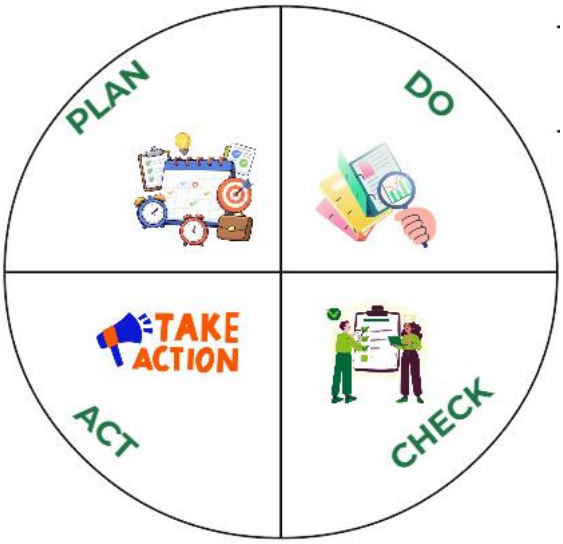



*Figure 4 Plan-do-check-act cycle from the BIN2BEAN approach*

The promotion of small-scale composting in private or community gardens can be considered as an additional tool of municipal waste management policy, particularly as an element of awareness raising in schools and public parks. (For the technical frame, see D3.1, section 5.7) In case of home-composting, the city saves on collection and the associated costs, households save on charges for the bio-waste bin or are compensated by lower fees for the residual waste. Potential compensation mechanisms are discussed in section 5.

## 3.2 Collection of bio-waste and related activities

All relevant cost and revenue positions are described in a process sheet (Annex II), which is structured in the form of a traditional profit and loss statement. Experience from other waste fractions can be used to roughly assess the costs of collecting bio-waste, e.g. the number of bins, collection trucks, maintenance and repairs. Unlike residual waste, information and intensive communication with citizens is necessary (for details, see Bin2Bean Guidelines for Communication and Awareness Raising). Therefore, 'waste advisors', i.e. staff who have received appropriate training for contact with waste producers, and the corresponding expenditure on information, must be taken into account. In Southern Europe in particular, special lids for bio bins may be useful for aerating the bin and avoiding unpleasant odours (see Bin2Bean D3.1 Bio-waste Collection and Processing Guidelines, section 4 for details). In order to make the costs comparable the same assumptions should be made for the depreciation period of trucks and other investment goods as for other waste fractions. Whether interest on investments has to be taken into account depends on national regulations and / or the city's budget policy. In Table 1, socioeconomic parameters are listed, which should be considered in the calculation. More details for these parameters (BIN2BEAN scoring system) will be published on the Bin2Bean website.

It is useful to share the results of the cost calculations with other cities for the purpose of comparing accounting structures and specific costs. To get an initial idea of the costs of waste services in European cities, it is recommended to take a look at the results of a LIFE-funded survey [Mc Quibban, 2023].
Regional cooperation can be a key for more efficient and cheaper collection service, particularly for municipalities with less than 50,000 inhabitants and/or low population density: Management on a regional scale could save money on the budget due to shared maintenance and repair equipment for garbage trucks, optimised collection routes, and the construction of waste transfer stations in cases where the processing plant is far away.

*Table 1 List of socioeconomic parameters for the calculation of costs and revenues of bio-waste management*

| **Category** | **Parameter** | **Description** | **Unit** |
|---|---|---|---|
| \ | Population served | Nr. of inhabitants that benefit of the service/ (proposed) solution | People |
| Bio-waste management system | Qref | Amount of bio-waste produced in the bio-waste management system. | Tonnes wet weight |
| Separation | CAPEX (€/total) | Investment for separation infrastructure | € |
| Separation | Lifetime - collection | The expected useful operational duration of the equipment before it requires full replacement | Nr of years |
| Separation | OPEX (€/year) | Yearly operational costs for the separation solution | €/year |
| Separation | Type of separation | Specify the type of source separation at the household (or restaurant) level | Text |
| Collection | CAPEX (€/total) | Initial investment for biowaste collection infrastructure | € |
| Collection | Lifetime - collection | The expected useful operational duration of the equipment | Year |
| Collection | OPEX (€/year) | Yearly operational costs for the collection solution | €/year |
| Collection | Type of collection | Specify if door-to-door, underground bins, roll containers, etc. | Text |
| Collection | Bio-waste collected amount | Amount of bio-waste expected to be collected through the (proposed) solution | t/year |
| Collection | Avoided collection costs for residual waste (€/year) | Savings from avoiding collection of non-sorted waste | €/ton |
| Processing | CAPEX (€/total) | Initial investment for processing infrastructure (e.g. composting, AD) | € |

| | | | |
|---|---|---|---|
| Processing | Lifetime - processing | The expected useful operational duration of the facility | year |
| Processing | OPEX (€/year) | Yearly operational costs (utilities, maintenance, staff) | €/year |
| Processing | Type of processing | Specify if composting, anaerobic digestion, incineration, etc. | Text |
| Processing | Rejection rate | Share of separated bio-waste that is rejected for quality issues | % |
| Processing | Revenues from energy | Market revenues from selling electricity/biogas/heat | €/year |
| Processing | Avoided disposal costs - processing (€/ton) | Savings from avoiding landfill or incineration | €/ton |
| Processing | Service fee | Process tariff if BW treatment is outsourced via fixed fee/tonne | €/ton |
| Marketing | CAPEX | Investment for marketing infrastructure | € |
| Marketing | Lifetime-marketing investments | The expected useful operational duration of the equipment | years |
| Marketing | OPEX | Yearly operational costs for marketing | €/year |
| Marketing | Revenues from compost | Average market price for compost or other soil improvers per year | €/ton |
| Marketing | Soil improver amount | Amount of soil improver sold | ton/year |
| BMS | Waste management tax | Average waste management tax (or fee) per capita in the city | €/capita |
| City-region | Waste management tax | Average waste management tax (or fee) per capita in the region or country | €/capita |

## 3.3 Processing of bio-waste and production of soil improvers

A similar scheme must be used for the calculation of processing and marketing of the products (Annex III). Also here, socioeconomic parameters, which can be used for the scoring system, should be used to facilitate the approach for the calculation. Please refer to Table 1.

As there are different types of aerobic and anaerobic treatment processes as well as an enormous variety of potential machinery and combinations thereof (see Bin2Bean D3.1 Bio-waste Collection and Processing Guidelines, section 5 for details). It is not feasible to simply copy and paste the costs from existing facilities. As outlined in the guideline cited above, the process must be adapted to the regional mixture of bio-waste (kitchen waste, green waste, industrial residues…) and on the products, which depend on the regional markets. Furthermore, the input streams vary with

the seasons. The cost of pre-sorting, i.e. the removal of impurities, depends on the quality of the bio-waste. Therefore, successfully controlling the bio bins before and during collection reduces the facility's costs. Revenues from compost and digestate depend on the regional market. According to the ECN's 2022 market overview [ECN 2022], the price of compost in the EU typically ranges from € 0 to € 20 per tonne, depending on regional demand and intended use (e.g. in agriculture or on golf courses). Waste managers often cover the costs of transporting and spreading organic fertilisers. On the other hand, the average total value of compost used as a soil improver is assessed about 37 - 39 € per tonne [ECN 2026].
Revenues can be increased by using special input materials that provide a higher percentage of nutrients after composting, as well as by mixing with other compounds to produce items such as potting soil or soil improvers for special crops. High prices can be achieved for compost sold in bags to private consumers (see sections 3.5 and 5.1); however, this requires the appropriate machinery and marketing partners, such as DIY stores and garden centres.

Subsidies for using biomethane to produce electricity (and heat), or to substitute natural gas, differ between Member States and must be carefully considered during the planning process. Unlike the production of electricity from wind turbines and photovoltaic cells, biomethane can be stored and used for power production according to a timetable for the operation of the grid or to meet actual demand from the grid. Therefore, the combination of anaerobic digestion and composting (see e.g. experience from the Bützberg plant (SRH) section 5.1 and D3.1, section 5.6) can yield higher revenues compared to mere composting.

According to the economies of scale, larger facilities may have economic advantages, particularly with respect to biogas purification, storage and use. Conversely, centralised plants require greater logistical effort.

If the municipality is unable to plan its own composting or fermentation plant, the administration should ask other cities about their experience with regard to the costs of processing bio-waste and potential revenues, in order to establish a solid foundation for its tendering process.

**Key messages:**

- The valorisation of bio-waste pays only in the long run. Higher costs at the beginning should be decreased by higher efficiency, considerable reduction of residual waste, and improvement of quality in plan-do-check-act cycles.
- The environmental value of compost is not reflected in market prices. Higher revenues could be generated by production of biomethane in combined aerobic / anaerobic facilities.
- Tests in pilot areas are not only a source of information, but also useful for the communications with the citizens – support by local policy will be helpful.

- The calculation should be based on standard commercial principles. A simple income and expenditure statement is not sufficient. The accounting structure for bio-waste should be the same as for residual waste.
- Balancing costs and revenues for the whole waste management system and a suitable budget for the valorisation are of utmost importance – policy decision year by year is recommended.

## 3.4 Potential subsidies

Due to the necessary expansion of bio-waste collection and processing in many European countries, funding programmes, particularly at national and regional levels, may be available for projects involving the use of bio-waste for soil improvement [EEA 2022]. This applies in particular to innovative technological and economic approaches, as well as corresponding pilot measures and soil resilience. Such potential programmes should be examined carefully during the preparation or optimisation phase.

While there are no funding programmes specifically for topics related to the collection and application of bio-waste at the European level, a wide variety of funding programmes with more general objectives are available for projects in this area, provided the project meets the respective programmes' general conditions or can be adapted to them. These programmes promote research, development and innovation, for example, or aim to improve the regional economy and infrastructure. Other programmes target specific groups, e.g. start-ups, SMEs and researchers, as well as local authorities such as municipalities. Many programmes also require cooperation, e.g. between research and practice, municipalities and industry, or between several municipalities. In some cases, cooperation even extends across state borders, which is standard for EU programmes. Clearly, these programmes do not support long-term subsidies, but rather intend to fund innovative approaches that could be extremely valuable in developing new products, enhancing the efficiency of collection and processing, or improving communication methods with citizens.

The following section presents some important funding mechanisms.

### *3.4.1 Horizon Europe*

Cluster 6 of the current EU research framework program, which runs until 2027, is dedicated to promoting innovative measures in the areas of food, bioeconomy, natural resources, agriculture, and the environment. Relevant areas of intervention include biodiversity and natural resources, agriculture, forestry and rural areas, food systems, bio-based innovation systems in the EU's bioeconomy, and circular systems. Of particular interest to the bio-waste issue is the EU's soil mission (“A Soil Deal for Europe”). The final two-year phase of the Horizon Europe program is

currently (early 2026) getting underway. Funding with respect to soils can be found on a special Horizon Europe website.
The 2026/2027 work program for the EU missions is available in draft form and can be downloaded from the Commission's comitology register after approval. There is no specific topic addressing bio-waste for soil improvement. However, the work programme foresees calls for proposals within the framework of the Soil Mission for the establishment of some further Living Labs, but with clearly defined specifications regarding the geographical setting (e.g., rural areas, Alps, and coasts) and topics. For more information on HORIZON a specific portal is available.

### *3.4.2 Interreg*

Interreg forms part of the EU's structural and investment policy, representing European Territorial Cooperation. Through Interreg, the EU supports cross-border infrastructure, job market integration and cultural exchange (known as Interreg A). Interreg also covers transnational cooperation in larger regions, such as the Baltic Sea Region and the Alpine Space. The aim is to promote the territorial integration of these regions (Interreg B). The current programme runs from 2021 to 2027. Each EU member state implements Interreg differently, according to its specific needs and priorities. One example of an Interreg project relating to soil is the German-Dutch project SHAPE - Soil Health Check and Practices. The consortium of nine SMEs from Germany and the Netherlands along with the Rhine-Waal University of Applied Sciences is developing innovative measurement and analysis systems for this purpose, which will be integrated into a new type of monitoring system that enables farmers to assess the current health status of their land at any time. For Southern Europe, Interreg Euro-MED might be of particular interest, which bundles funding for countries in the Mediterranean. The mission objectives include “Carbon Neutral and Circular Blue Economy”, which provide a link to the valorisation of bio-waste.

### *3.4.3 LIFE*

The LIFE Program is the EU's funding instrument for the environment and climate action. Since 1992, the program has funded over 6000 projects with concrete and practical benefits at the local level. Information and advice for interested parties and applicants can be found on the LIFE website. As an example. the Bin2Bean project used numerous information from the LIFE BioBest project, which aimed to promote greater efficiency in bio-waste management by identifying and validating best practices, from production to treatment, and establishing a list of reference key performance indicators for the sector.

### *3.4.4 Other programmes*

There are also a number of interesting funding approaches at the EU level for smaller companies and other applicants such as start-ups with lower project costs and funding amounts compared tom the programmes presented above. One example

is Cascade Funding, also known as Financial Support for Third Parties (FSTP), which is a Commission mechanism for distributing public funding to assist beneficiaries, such as start-ups, scale-ups, SMEs, and/or mid-caps, in the uptake or development of innovation. It enables participation in ongoing EU-funded projects, usually with clearly defined practical contributions. Current calls for proposals of this type related to the topic of bio-waste include, for example:

- iCOSHELLs Open Call: New innovations and solutions to be tested by the Living Labs: Engages new stakeholders to test and validate innovative solutions for improving soil health in diverse European Living Labs.
- COPILOT Extra Call4Travel Vouchers - Open call 3 – BIOKET: The objective is to award 20 travel vouchers to bioeconomy innovators, enabling them to strengthen collaboration, broaden their international outlook, and support the scaling of bioeconomy initiatives across Europe.
- LILAS4SOILS - Open Call for MRV Providers: Facilitates the testing and validation of innovative Monitoring, Reporting, and Verification (MRV) technologies to enhance soil organic carbon assessment and simplify MRV processes.
- Path4Med Open Call: Offers financial support to local and regional authorities to deploy and scale solutions that cut fertilizer use and nutrient pollution across the Mediterranean.

Anyone interested in finding out about the current range of such cascade funding calls can do so via the EU Funding & Tenders Portal or via the 'New open call alert!' service provided by the company Sploro in Pamplona, Spain (https://sploro.eu/).

**Key messages:**

- Public subsidies are normally only granted in case of investments, not for the normal operation of the processing of bio-waste.
- In case of innovative approaches, it is recommended to check the European funding mechanisms aiming at financial support for projects.

## 3.5 Financial contribution from the waste producers

After calculating the costs of collection and processing, the potential gap between revenues and expenditure can be estimated, as shown in Annex IV. Figure 5 provides a clipping from this Annex, which shows all necessary factors. The financial contribution required from the (bio-)waste producers must cover the difference between revenues and costs, with the aim of achieving a balance between the upper and lower parts of the chart.

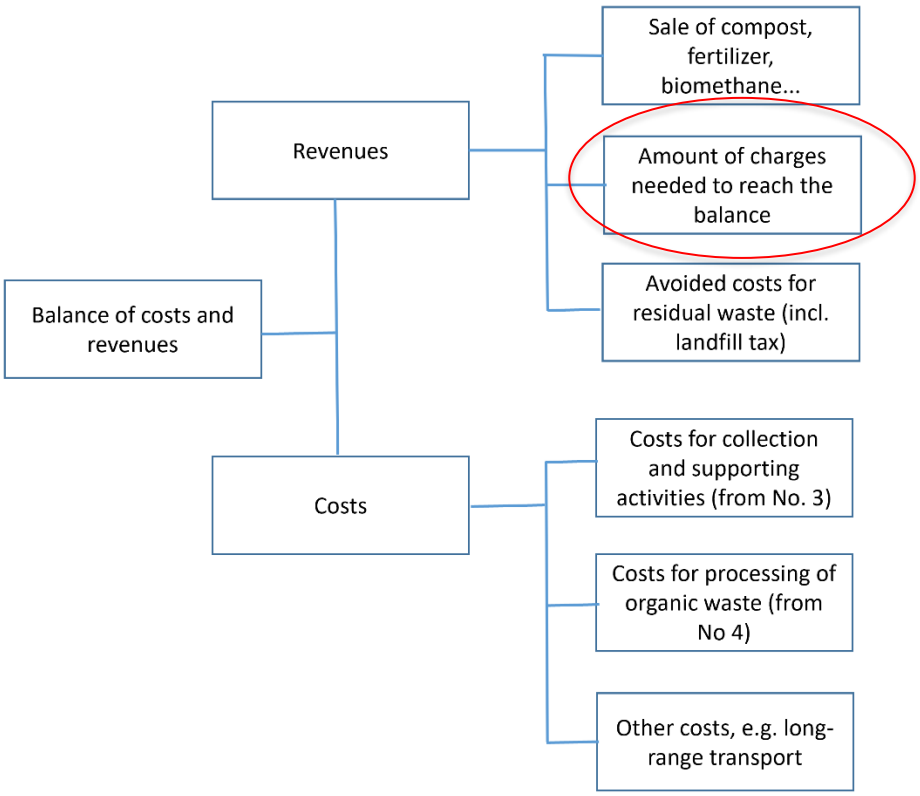



*Figure 5 Necessary financial contribution to the waste service after taking into account all costs and other income (detail from Annex IV)*

When the valorisation of bio-waste is introduced, different scenarios for collection systems, processing, and marketing of products should be considered aiming at a technically sound and viable solution to keep the financial burden for citizens as low as possible. Do not forget: Policy matters! In Annex V, some opportunities for improving the balance are indicated on the right side of the graphics:

- The value chain can be extended to include higher-value products, such as selling packaged compost to consumers or producing potting soil. However, a large amount of compost is needed to achieve competitive industrial scale and prices for these goods. This requires the centralised organisation of multiple facilities.
- As part of the organic carbon in soil, humus is not easily available to plants, leading to carbon sequestration. According to an assessment of ECN, 60–150 kg of $CO_2$ can be stored for more than eight years [ECN 2020]. Following the current value for $CO_2$ in the emission trading system (January 2026) leads to a price of about €5–12 per ton compost. Currently, however, this benefit for climate protection cannot be traded, unlike other carbon farming activities. But this may change. Further information can be found in D3.1, section 2.1.
- Costs can be reduced through optimising logistics. Specific collection costs (e.g. per tonne, per bin, per inhabitant) decrease with an increasing number of people served. If long-range transport from the city to a central facility is required, the construction of a waste transfer station should be considered to

reduce costs: A driver can transport around 30 t with a walking floor trailer, whereas a normal garbage truck carrying a driver and two refuse collectors can only load around 10 t. For example, the waste from Egaleo is sent to a transfer station in the city, which was constructed for the City of Athens. From there, large trucks transport the waste to the EDSNA facility which is about 30 km away. In Southern Europe, bio bins must be emptied several times per week due to high temperatures, which favour biochemical degradation and lead to unpleasant odours. This can be mitigated by special bins with passive aeration and lids filled with absorbent material (see D3.1, section 4.4) also aiming at a reduction of the logistical effort required.

- It was already mentioned above (section 3.3) that bio-waste of suitable quality lowers the efforts for sorting out impurities.

How can the financial gap be closed in practice? According to the 'polluter pays principle' (PPP), waste producers should pay an amount proportional to the quantity and quality of their waste. This presents not only a technical challenge, but also a political question. In many municipalities, fees or charges for collecting bio-waste are lower than for an equivalent amount of residual waste (for example in Hamburg, see section 5.1) to incentivise citizens to sort waste thus following the waste hierarchy. While this reduces the financial gap for bio-waste, it increases the gap for the complete waste service. This is discussed in detail in the next chapter.

Any calculation for future activities is not more than a good assessment. As already mentioned, the efficiency of the collection and processing steps will increase over time. This influences the financial contribution, which must be paid by the waste producers. Based on the experience of the first year, the calculated contribution may prove to be too high or too low and will then need to be adjusted. Provided that the waste service represents a closed financial cycle, surpluses or underfunding can be balanced out over several years so that the charges (see section 4) do not have to be changed annually.

The specific model for allocating costs to households and commercial users is described in the next chapter.

**Key messages:**

- The amount of charges should fill the gap between costs and revenues because waste management is a service which should not be financed from tax money – policy decision necessary!

# 4. Taxes, fees, charges, pay-as-you-throw

As outlined in chapter 2, the valorisation of bio-waste from households is mostly not possible without public subsidies, i.e. partially financed by waste fees paid by private households and commercial waste producers. In this chapter, different types of waste charges and their influence on sorting behaviour, quantity and quality of bio-waste are presented. The calculation of charges for waste management service should follow the process, which is indicated in Annex VI:

- First of all, the expenditures for residual waste and other services (see Annex I) and the fees for bio-waste (Annex V, section 3.5), which are not covered by revenues, must be added. This sum must be contributed by the waste producers.
- This is followed by a policy decision, if a financial incentive for waste separation at source shall be introduced.
- If this is not the case, the taxes or charges can be calculated on a per person or a per household basis, maybe also related to the size of the property.
- If a financial incentive is intended, the city council must decide, which part of the fees must be paid for residual waste, for bio-waste and for other waste fractions or services.

## 4.1 Charging systems

### *4.1.1 Definitions*

An enormous variety of methods to finance municipal waste services can be found in Europe ranging from taxes based e.g. on the property size up to charges, which are calculated for the type and weight of waste produced (“pay-as-you-throw”). For sake of simplicity, a system published by Lüssenhoop et al. [2024] is used, which distinguishes between four categories:

“Flat”: A flat fee is based on the characteristics of a dwelling (e.g. per household, according to the number of residents, the property's size, or its value). All citizens pay the same relative amount of fees or taxes, regardless of the actual amount of waste generated.

“Flexible” (in the following “Flex”): Users have one choice regarding the waste charge they pay, usually by selecting a container size, which is charged at a different rate (larger containers cost more than smaller ones).

“Flexible +” (in the following “Flex+”): Users have more than one option for paying the waste charge, usually by selecting a container size and collection frequency.

"PAYT": Users are charged for each kilogram of waste collected, or for each waste bin collection. Collections are counted via sensors in the bins, or via stickers or bags, which households must purchase in advance.

### *4.1.2 Examples from European municipalities*

The charging systems of more than twenty European cities and counties are presented in Table 2 together with a short characterization of the collection system. Obviously, PAYT systems are usual in smaller cities or counties with limited population density, whereas large cities with high population density tend to Flex+, Flex or Flat fees. Most cities with Flat fees collect bio-waste either via containers and/or drop off points. The impact of the charging system and the collection methods on quantity and quality of separately collected bio-waste is discussed in section 4.3.

*Table 2 Charging systems and bio-waste collection in European municipalities (data from [Friege & Hentschel 2026])*

| Name | Charging system | Household bio-waste (Food and garden waste) | Green waste | Commercial bio-waste |
|---|---|---|---|---|
| | | DtD = Door to door collection | | |
| Turnhout, Belgium | PAYT | DtD via bin | Recycling centres | / |
| Liechtenstein | PAYT | DtD via bin | Drop-off points, Composting facilities | / |
| Albano Laziale, Italy | PAYT | DtD via bin | | DtD |
| Parma, Itlay | PAYT | DtD via bin | Street containers, recycling centres | DtD via bin |
| Argentona, Spain | PAYT | DtD via bin | Recycling hub | DtD |
| Zürich, Switzerland | PAYT | DtD via bin | Recycling centre | No commercial waste collection |
| Zagreb, Croatia | PAYT | DtD via bin, drop-off collection from underground containers; recycling yards | DtD, recycling yards | DtD |
| Berlin, Germany | Flex+ | DtD via bin | Recycling centres, optional seasonal bin for garden waste | No commercial waste collection |
| Helsinki, Finland | Flex+ | DtD via bin | Recycling centres | No commercial waste collection (except municipal service companies) |
| Hamburg, Germany | Flex+ | DtD via bin, underground containers | Recycling centres | No commercial waste collection |
| Tallinn. Estonia | Flex+ | DtD via bin | Drop-off points | DtD |
| Vienna, Austria | Flex+ | DtD via bin | Street containers, Recycling centres | DtD via bin for SMEs |

| | | | | |
|---|---|---|---|---|
| Krefeld, Germany | Flex+ | DtD via bin | Recycling yards, Mobile drop-off points twice per year | / |
| County Höxter, Germany | Flex | DtD via bin | DtD on request. Drop-off points | / |
| Riga, Latvia | Flex | DtD via bin | DtD | DtD |
| Amsterdam, The Netherlands | Flat | DtD via bin (in few districts), underground containers | Recycling centres, DtD on request | No commercial waste collection, smaller companies' waste is all mixed waste |
| Utrecht, The Netherlands | Flat | DtD via bin (not all districts), above-ground container (being developed) | Recycling hubs | DtD via bin (only if contracted) |
| Copenhagen, Denmark | Flat | DtD via bin (only food waste) | DtD fixed for single-family households, DtD on request for multi-family houses, Recycling station | |
| Lisbon, Portugal | Flat | DtD via bin, street containers, drop-off points | DtD (by request), street containers, drop-off points | DtD, Street containers, Drop-off points |
| Lyon, France | Flat | Drop-off points (kitchen waste) | / | / |
| Brno, Czech Republic | Flat | Drop-off points, DtD (one district) | Recycling centres, mobile containers | / |

## 4.2 Identification of waste producers

The identification of individual waste producers is a pre-supposition for charging the households or commercial sources following the PPP and / or to penalise misuse of the bins (for details, see section 4.4). According to Annex I, the municipality should check if all or many users of bio bins can be identified. Figure 6 provides a clipping of this part of the decision tree.

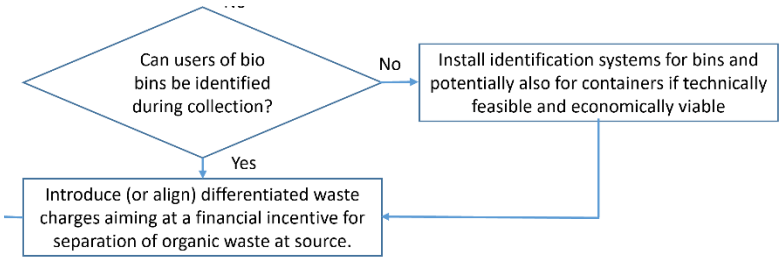



*Figure 6 Identification of users – clipping from Annex I*

Many cities already have identification systems in place. Bins can be fitted with an RFID tag that is read when the bin is emptied, providing the address of the property. For large containers, locks are available that can only be opened with a key card to identify the household (example: Gijón, Spain). Technical details can be found in D3.1, section 4.6. It is also possible to monitor the location of bio-waste containers using a camera or video system. While this does not measure the amount of waste produced

by individual households, it largely prevents the misuse of organic waste containers for disposing of residual or bulky waste or littering in general (see e.g. examples from Antwerp and Amsterdam [WINPOL 2020]). In small cities, collection can be organised using prepaid bags marked with the user's address (example: Argentona, Spain). Although the enforcement of the PPP is preferred, the technical efforts required for identification systems may be high. Therefore, the technical feasibility for the respective city and its economic viability should be checked in a pilot area. (See also section 5.1 for experience from Hamburg.) The LL Amsterdam reported concerns regarding data protection, with the result that identification of users was waived when using the access locks on the containers. These can be ruled out if the meaning of the GDPR is properly understood and the necessity of monitoring for environmental protection is taken seriously. This is discussed more in depth in the next box.

**Key messages:**

- According to the Polluter-Pays principle, flexible and differentiated fees, which are linked to the quantity and type of waste should replace flat fees and taxes for waste service as soon as possible – policy decision necessary!
- The identification of users of bins is key for charging systems. If this is not possible due to technical problems, lack of space, or too high costs, solutions should be found, that resembles Polluter-Pays charging systems as far as possible – policy decision necessary!
- The GDPR is not in contrary to the identification of waste producers who violate local statutes. National data protection laws should be checked for potential problems.

**Could data protection impede the identification of polluters?**

In some cities, the monitoring of waste disposal in containers has been called into question because it is considered an unauthorised invasion of privacy, and collecting such data is not permitted according to Europe's General Data Protection Regulation (GDPR). However, this argument misunderstands the idea behind the GDPR: The temporary storage of identification lock numbers and waste disposal times are only used for specified, legitimate purposes, i.e. to detect households that misuse the bio bin thus violating local statutes. There is no reason to refrain from this documentation if:

- The confidentiality of the data is ensured; i.e. only responsible persons from the city administration or the commissioned logistics company can read the file;
- Data usage is transparent, i.e. citizens have been informed prior to the installation of the lock;
- Data will be deleted after the container has been emptied in accordance with the principle of purpose limitation.

There is one more simple argument. In the case of bio bins used by a family in a detached house, any misuse can be detected when the lid is opened by the refuse collector. So why should identifying users in multi-family houses violate data protection principles? The protection of personal data is not intended to hide those who misuse (bio-)waste containers!

(I appreciate my colleague Thomas Schomerus (Leuphana University, Lüneburg) for his advice. HF)

## 4.3Impacts of financial incentives

There are numerous factors, which influence the sorting behaviour of waste producers, Therefore, information about the sorting principles, awareness raising for the ecological value of compost, and a convenient frame for sorting number among the instruments for the motivation of citizens (for details, see the Bin2Bean's guideline on communication). Financial incentives are an important part of the external motivation. Flat fees do not incentivise people for sorting, because the amount of waste disposed is not related to the fees. In the contrary, the charges are directly related to the type and amount of waste in case of PAYT systems. Experiences from numerous cities and scientific research proved that waste separation at source is incentivised by higher prices for residual waste compared to recyclable fractions. FLEX+ and PAYT systems are in line with the polluter-pays principle (PPP), which belongs to the main principles of environmental policy. Comparisons between municipalities with PAYT systems and those, which remained with non-incentivising systems show an increase in the rate of separately collected

recyclables [Starr et al. 2015], this also applies to bio-waste [Morlok et al. 2017, Walk 2025].

However, financial incentives can also have negative effects if waste producers save money by illegal behaviour. This is well-known from free-of-charge "yellow bins" intended for mixed packaging waste, which are often also filled with residual waste leading to far higher costs in the recycling facilities (see e.g. [Friege 2017]). As impurities like plastic bags, glass cullets, or residual waste are extremely difficult to separate from bio-waste the level of contamination is key for a successful composting or fermentation process yielding a product, which meets the quality targets for soil improvers or fertilizers (see D3.1). Therefore, it is necessary to balance financial incentives carefully and to avoid too large differences between the fees for residual waste and bio-waste. In case of changes of the charging systems, testing in pilot areas is recommended.

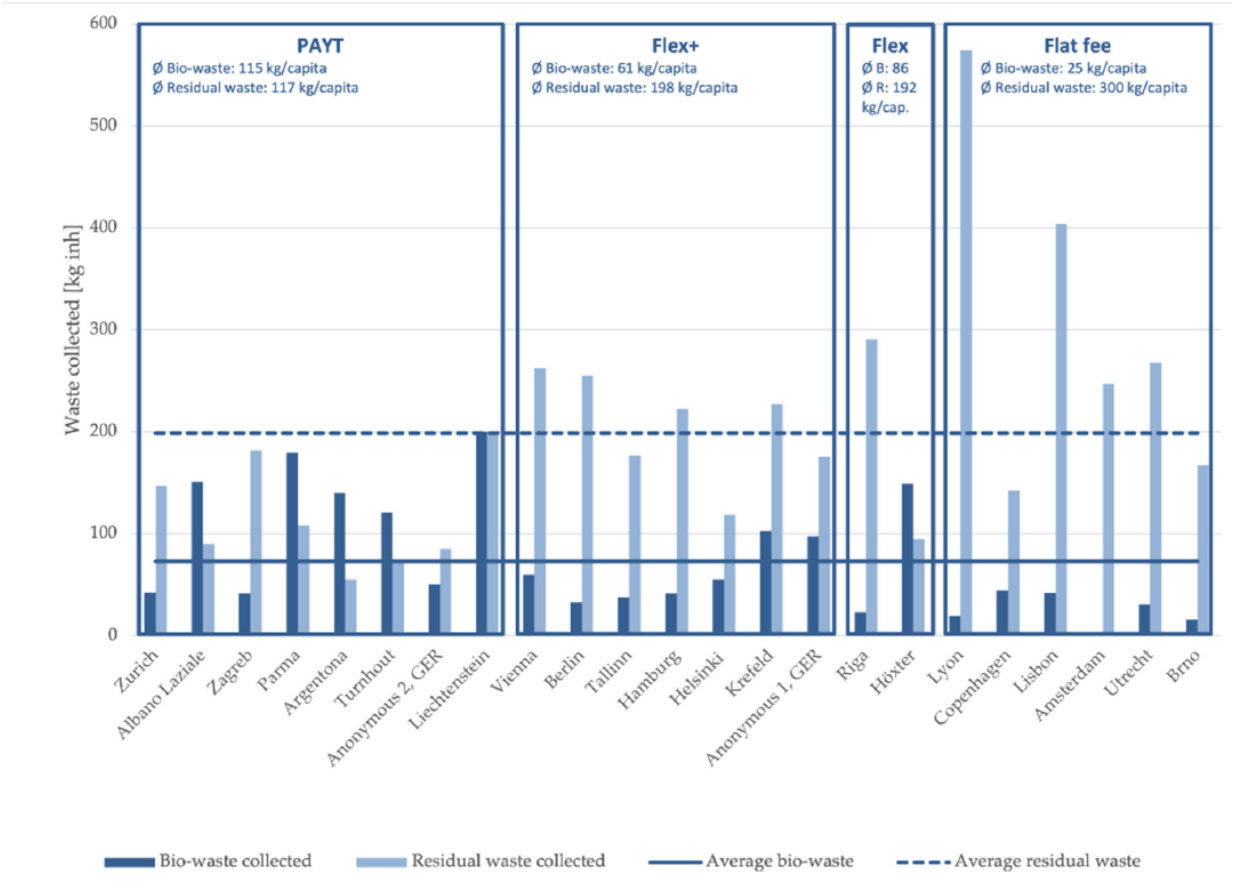



*Figure 7 Specific amount of residual waste and bio-waste in European cities (source: Friege& Hentschel [2026])*

A recently published evaluation [Friege & Hentschel 2026] of the experiences of more than twenty European cities confirmed that cities, which provide financial incentives for waste sorting, yield a higher quantity of separated bio-waste (see Figure 7).

Municipalities with PAYT or FLEX+ systems collect more bio-waste and less residual waste compared to cities with flat rates or taxes. However, large cities with a high population density collect considerably less bio-waste per inhabitant than municipalities with fewer than 2,000 inhabitants per km², mainly due to problems regarding the quality of the material collected (see Figure 8). Technical measures to mitigate this problem are discussed in D3.1 (see sections 4.6 and 4.7). From an economic perspective, it is most important to charge individual households rather than large groups of residents in multi-family houses. Only in this case is it possible to increase motivation to sort waste through financial incentives. This is challenging in the case of large houses, as there is not enough space for individual bins. In large housing complexes, containers above or below ground are mostly used to collect bio-waste from households. In the latter case, it should be possible to identify those households, which dispose bio-waste in the containers, It is well-known that anonymity leads to more misbehaviour in sorting (see Bin2Bean's Guideline on Communication and Awareness Raising). Therefore, user identification is crucial for a successful PAYT scheme (for details, see [Friege & Hentschel 2026]). This can be ensured by locks, which are opened with an individual code. By this measure, the city can refer to a list of users who dropped waste into the container within a certain timeframe.

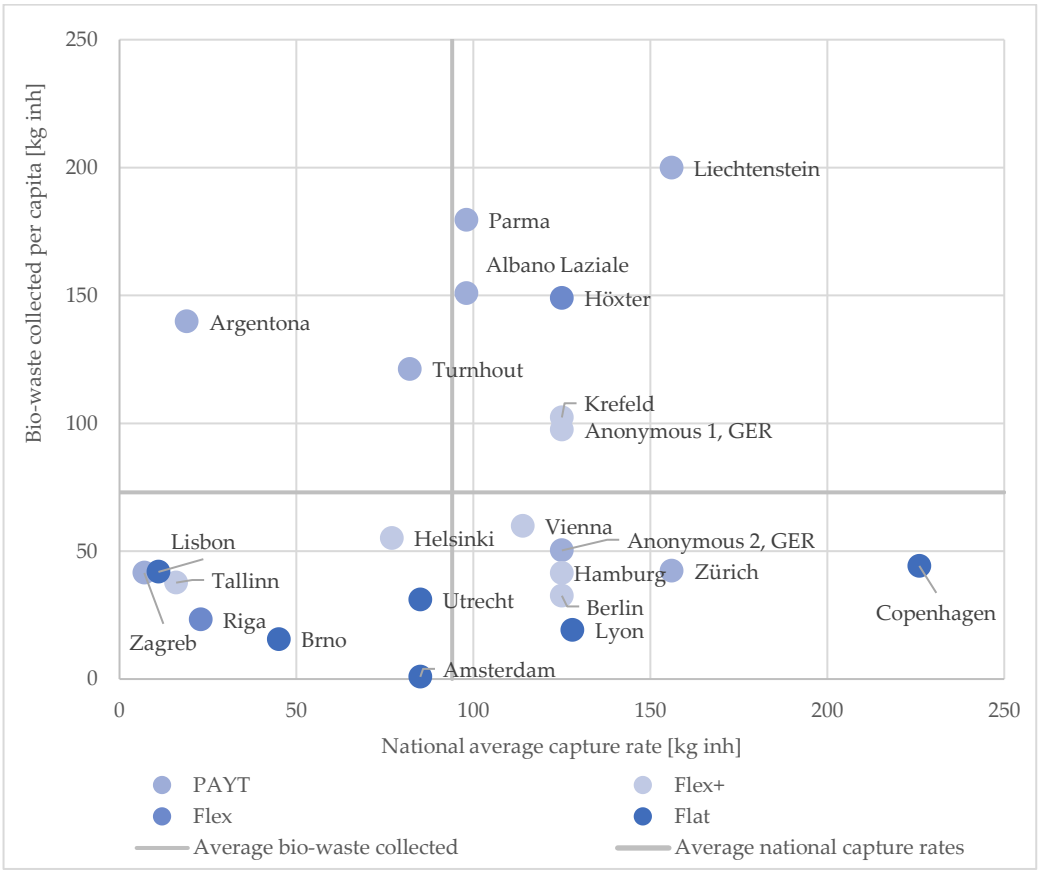



*Figure 8 Specific amount of separately collected bio-waste vs. population density (source: Maike Hentschel, Master Thesis)*

Although PAYT and Flex+ systems tend to be most effective in case of commercial waste producers and in areas with detached and semi-detached houses, but less effective in large apartment buildings, a link between the charging system and the quality of bio-waste can still be found in densely populated cities. Cities with PAYT or Flex+ systems produce bio-waste with lower contamination, as can be seen from Figure 9. According to the above-cited research, most of these cities monitor the quality of the bio-waste and have introduced fines for violations, which are stipulated in the local waste management statutes. By this combination of measures, they meet an input quality of 3% impurities or less. This indicates that financial incentives must be carefully structured to avoid unpleasant side effects.

As introducing tiered fees can lead to quality issues, monitoring bio-waste and taking action against polluters is highly recommended. The waste from commercial users, i.e. food industry, supermarkets, hotels, and partially also restaurants can be collected with bins, which are only used by the respective company. Therefore, the waste producer can easily be identified when emptying the bin. Large quantities of garden waste cannot be collected in bio bins, and are usually accepted by recycling centers. Even if a small fee is payable on delivery, there will be hardly any impurities for two reasons:

- Citizens who bring their garden waste to the recycling yard are clearly motivated.
- Recycling yards are not anonymous places.

Monitoring of impurities and enforcement of good sorting practice is far more difficult in case of private households, particularly in densely populated areas. A stepwise approach is recommended, e.g. the usage of “traffic light” tags. Details can be found in section 2.4 of Bin2Bean’s “Guidelines for Communication and Awareness Raising”.

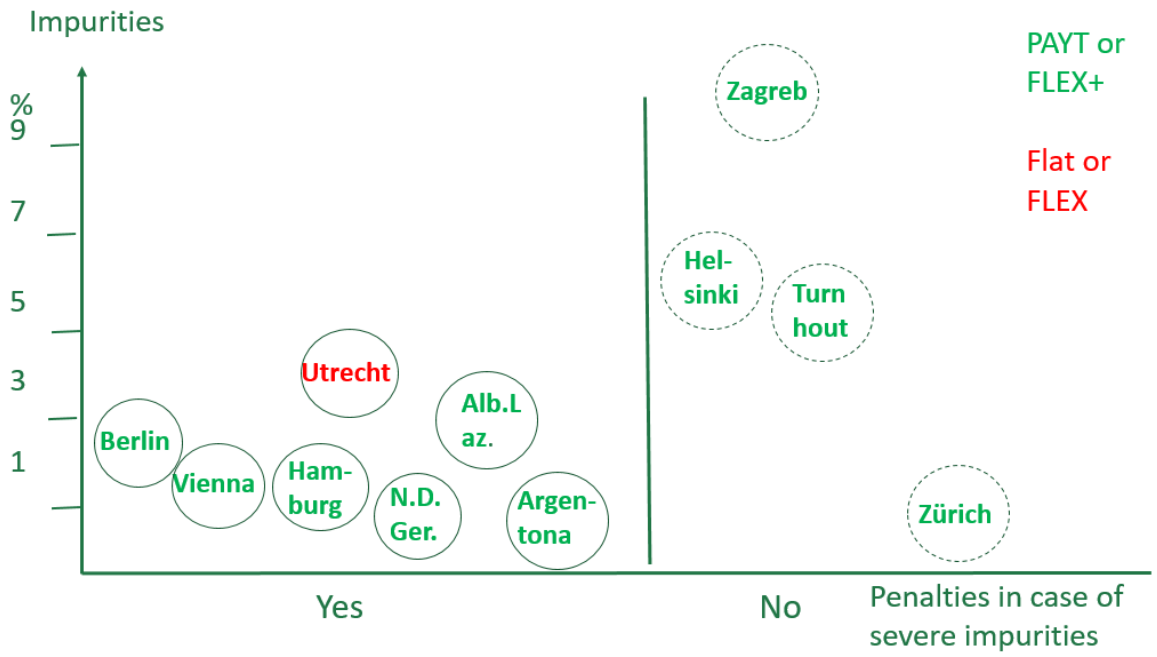



*Figure 9 Level of impurities in bio-waste in relation to the local fee system and enforcement measures (own source)*

## 4.4 Basic fees

As many services are used by all households and small businesses, independent of the amount of waste produced, such as recycling yards, waste advisory services and Christmas tree collection, many municipalities

- divide the charges into a fixed ("basic") part and a variable part depending on the weight or volume of waste,
- and / or define a minimum bin volume per person that must be used and paid for.

A basic charge can be directly linked to a specific residual waste bin, for example, with different fees for different volumes, which roughly correlates with the number of users. Alternatively, all households in a property could pay the same basic charge, regardless of the number of occupants or the size of their living space. In other words, this fee remains consistent for all households in a city. The relationship between the basic charge and the operational charge is an important issue for local policymakers.

- If the basic fee percentage is high, the financial incentive for waste sorting at source may be insufficient.
- If the basic fee percentage is low, large families may be at a disadvantage compared to single-person households.

It is therefore recommended that the administration starts the internal discussion with varied charging scenarios that take into account different household sizes and waste volumes or weights. These scenarios help to find suitable solutions that can be discussed in the council and with the public. If the testing of new charging

systems in small areas of the city is not possible, the results of these scenarios can be discussed at stakeholder meetings to find just, environmentally sound and socially acceptable solutions. The transparency of these discussions helps to ensure that political debates remain rational.

**Differentiated waste fees – best practice example from Münster (Germany)**

The waste charging system of the City of Münster (308,000 inhabitants; 1016 inhabitants per km²) consists of three factors:

- A basic fee of 36 € per year is due for each residential unit. This covers the recycling yards, the collection of bulky waste, green waste and some other services.
- Volume-based service fees must be paid for the residual waste, bio-waste, special lids for bio bins (to prevent odour) and barrel locks (to exclude misuse by third parties).
- A minimum volume of 15 liters per person per week per household (residual and organic waste) must not be exceeded.

Münster's waste management company (AWM) provides a multilingual fee calculator in the internet, which makes it possible to calculate the fees for different waste fractions, volumes, and collection frequencies. An example (house with ten households) is given in the following figure.

*awm - everyone is involved!*

Calculation based on your information:

| Services | Annual fee (€) | Quantity | Result |
|---|---|---|---|
| Basic fee: | 36,00 € | 10 | 360,00 € |
| Residual waste, 660 l, every 14 days | 1.471,80 € | 1 | 1.471,80 € |
| Organic waste, 240 l, 1 time per week | 854,40 € | 1 | 854,40 € |
| Filter lid for organic waste bin, 35-240 l | 15,00 € | 1 | 15,00 € |
| Tonne locks, 35-240 l | 11,00 € | 1 | 11,00 € |
| | | Result: | 2.712,20 € |

Charges per year

10 households → 10 x basic fee
660 l bin for residual waste, biweekly collection → 1x service fee 1471.80 €
240 l bin for bio-waste, weekly collection → 1x service fee 854.40 €
Additional lid for odour suppression → 1x service fee 15.00 €
Additional lock for a bin → 1x service fee 11.00 €

The basic fee must not be identical with the fixed costs. But it should be high enough to cover the expenditures for services of this type and administrative expenses. The operational fees are related to

- the weight or volume of residual waste,
- the volume of bio-waste,
- the number of bulky waste collections,
- and the volume of other waste fractions.

The collection of bulky waste and fractions of valuables like used paper are also often included in the basic fee. The basic charge reduces the incentive to dump waste in the environment and also promotes high-quality waste separation when a minimum volume for residual waste is stipulated. An example for the combination of basic and operational fees can be found in the box above.

**Key messages for sections 4.3 and 4.4**:

- Decisions on charging systems are politically significant. Simulations of the fees that households would pay should be carried out before decision-making in order to achieve a compromise between technical effort, environmental protection and social balance.
- Differentiated fees that financially motivate households to separate bio-waste should be integrated into the local charging system to increase the amount of bio-waste collected separately. The economic tool must be carefully designed to avoid negative consequences, such as a decrease in quality alongside an increase in quantity – policy decision recommended
- Continuous quality monitoring of then bins and of the bio-waste, which is disposed at the processing plant, is warmly recommended.
- There is empirical evidence that combining economic incentives with enforcement against violations of the local waste statute is an effective way of achieving higher quantity and quality of bio-waste – policy decision recommended.

# 5. Experiences from the Living Labs

"Policy Forums" (PF) were organised in the three LL's aiming at a collection of expectations regarding the effects of fee systems on the quantity and quality of bio-waste, as well as reduced overall costs and the experience gained with different charging systems. Each format was designed individually because the status of bio-waste valorisation in the LLs is completely different.

## 5.1 Hamburg

The city of Hamburg has many years of experience in the valorisation of bio-waste. The first steps towards collecting organic waste and producing compost were taken more than 30 years ago. Stadtreinigung Hamburg AöR (SRH) is responsible for waste management for private households and public entities, as well as street cleaning. SRH does not accept orders from private companies. According to German law, commercial waste producers are responsible for the correct separation and treatment of their waste. Since the close-down of 'Biowerk' (SRH's two-stage fermentation plant), SRH has not managed bio-waste of commercial origin. Food

waste from restaurants and hotels, as well as residues from the food industry, is collected and processed exclusively by private companies. According to Hamburg's official waste statistics, 27,615 tonnes of commercial bio-waste was collected in 2024. Based on Bin2Bean's data collection, it is estimated that over 80% of gastronomy businesses have an additional bin for organic waste. It is likely that only very small entities, such as 'to go' kiosks, misuse the residual bin to dispose of their kitchen waste. Food waste from ships and aircraft is generally disposed of in accordance with the Regulation on Animal By-Products. (Cat. 1 material, see also EC Regulation 1069/2009, chapter 1).

In the following, we will focus on bio-waste from private households. In 2024, SRH collected 75,471 t bio-waste from households and additional 25,055 t green waste, which is dropped at the recycling yards (see ). The capacity of SRH's facility for processing bio-waste is presently expanded (see Figure 10) and will be completed at the end of this year.

It is remarkable that SRH controls the complete value chain from separate collection to sales of soil improvers. Therefore, the participants of the Policy Forum represented the responsible managers of each step of the value chain.

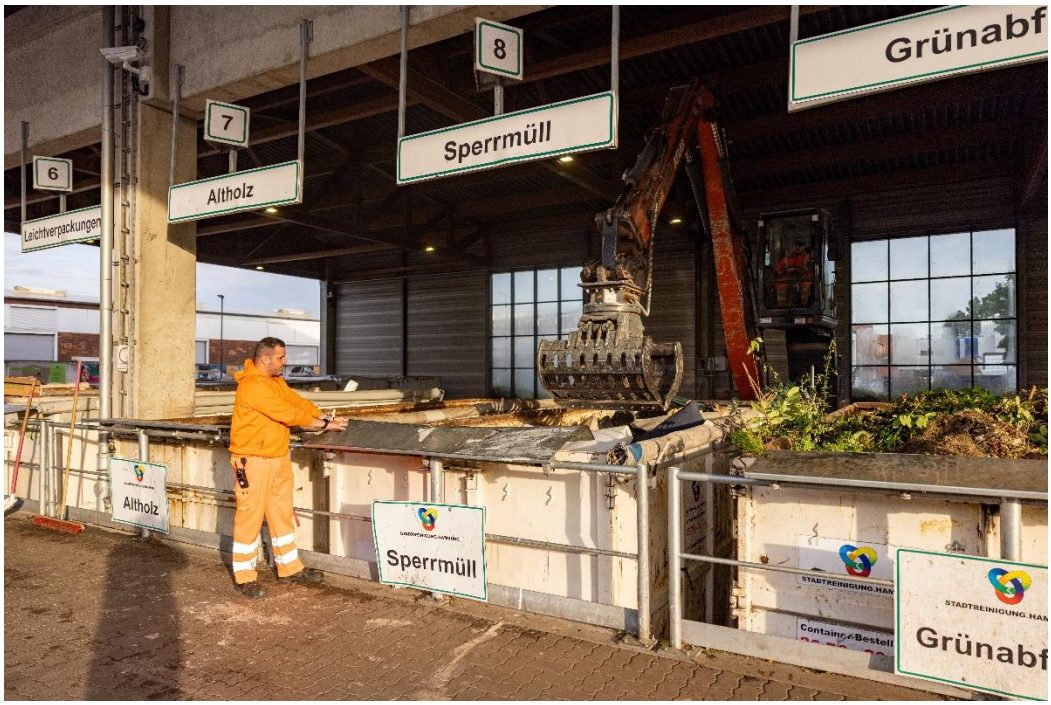



*Figure 10 Recycling yard accepting green waste among about twenty waste fractions (source: SRH)*

## *5.1.1 Business model for compost and biogas production*

About 20 years ago, SRH made the strategic decision to take complete control of the most important value chains, namely residual waste and bio-waste. This was supported by its supervisory board, which is chaired by the responsible member ("Senator", "Senatorin") of Hamburg's government thus ensuring a link to the local

council (“Bürgerschaft”). To this end, SRH invested in new plants or bought shares in companies that processed its waste streams. This approach facilitates a way of thinking about and managing the value chain that starts with the products, i.e. soil improvers and methane in the case of bio-waste. While increasing the amount of bio-waste collected separately is an important goal, the current quality of bio-waste (i.e. 2% impurities) must be maintained. The following conclusions can be drawn from the policy forum:

- Which additional financing is needed to get high-quality bio-waste?

Advertising and campaigns for organic waste separation are integrated into the SRH's overall public relations work and are therefore difficult to estimate financially, but they are not a significant factor. The 'bio-waste bag' (“Biotüte”), on the other hand, is a relevant cost factor, but it saves a lot of effort in pre-sorting (further information see below). Households often use plastic 'organic waste bags', which can rupture during pre-sorting at the facility, leaving residues in the compost. Even bags made of supposedly compostable plastic must not be put into the compost as they only break down in laboratory conditions and decompose slowly in composting plants, so are considered contaminants. “Biotüten”, however, have proven themselves very well in composting and have been well received by consumers because they do not tear, even when the bio-waste is very wet.

- Are new products with higher valorisation on the horizon?

For farmers, the main benefit lies in the humus and fertilising properties of the compost, which they apply to their fields professionally and in accordance with nutrient requirements. It is therefore concluded that only targeted, customer-oriented processing is an option, with the higher costs potentially offset by higher yields. Cooperating with earthworks can be beneficial, as it enables higher prices to be achieved for compost, particularly green compost as an alternative to peat. However, transporting compost over distances of more than 10 km is a significant cost factor.

Pine needles (from Christmas trees), which are sieved out before the usual composting process and sold as a special fertiliser for blueberries, were identified as a promising business opportunity.

Furthermore, producing compost for end consumers proved to be sensible. To this end, an agreement was concluded with a company that bags the mature compost (less than 10 mm) and prepares it for sale at a retail price of €4 per 30 litres. However, the relatively high yield is offset by numerous cost factors, such as bagging equipment, multiple transports, licensing of sales packaging and increased liability for possible contamination and marketing.

As farmers require different quantities of compost depending on the season, it is sensible to have sufficient storage space at the composting plant, as the best prices are achieved when demand is high during the fertiliser season.

- Which marketing activities have proven to be successful and can be recommended

Compost is marketed by VKN, a company that is shared by SRH. Many years of hard work have helped to build trust in the products. The following measures have proven effective to convince farmers of the quality of the products:

- Targeted approach: Which farmers actually need compost?
- Publications in trade journals that all farmers subscribe to,
- Involving customers (i.e. farmers) in events
- Cooperation with organisations of organic farmers ('Bioland'), chambers of agriculture, etc.
- Joint 'field days' with organic farmers

Compost is now widely accepted by many farmers. An increasing number of farms are now opting for gentle soil cultivation and refraining from deep soil intervention, this makes marketing easier.

- Could biochar become a new option?

Biochar could be used to recycle green waste because it plays a role in emissions trading (see below). However, due to numerous cases of fraud involving alleged carbon storage in East Asia, the quota-based business model is no longer viable.

It was concluded that integrating the entire value chain enables SRH to consider customers' needs at every stage of the process. In the context of separate bio-waste collection and processing, the fulfilment of quality demands should be the first priority. SRH observes this target at all levels of the value chain, e.g.

- Awareness raising with respect to the role of bio-waste for soil
- Monitoring of bio-waste and compost at critical control points
- Financial motivation for separation of bio-waste at source
- Convenient opportunities for citizens to bring their kitchen waste to the bin
- Pre- and post-sorting of impurities in the facility

### *5.1.2 Optimizing the collection of bio-waste*

Hamburg's environmental authority and SRH have set ambitious targets for the valorisation of bio-waste. Containers for organic waste have therefore been installed even in densely populated areas. As outlined in section 4.3 (see also D3.1, section 4.5), this is a challenging task. SRH has gained extensive experience in communication

activities, particularly in multi-family housing, and has tested various collection and charging systems to improve bio-waste quality.

*Figure 11 Installation of the 1000th underground container in Hamburg (source: SRH)*

- What about financial incentives?

Hamburg has a “Flex +” charging system (see section 4.1.1): Fees are based on the type and volume of waste bins, as well as the collection frequency. These options can be varied by the waste producers. The bio bin is much cheaper than the residual waste bin (see section 4.3), which encourages sorting at source. The prescribed minimum volume for residual waste is 30 litres per household per week, in order to prevent the misuse of bins for organic or packaging waste. Exceptions from the prescribed volume for residual waste can be made for households that compost at home, meaning they pay lower residual waste fees. When the separate collection of bio-waste was introduced, households could opt for home composting without providing proof and reduce their waste collection volume. In future, this may be linked to a minimum garden size. At the request of the supervisory authority, SRH is considering encouraging households to order a bio waste bin, even if they claim to compost their own waste, since kitchen waste is often disposed of with residual waste rather than being composted.

The waste disposal fees are paid by the property owners who pass the waste charges on to their tenants according to German law, usually on a per-person basis. It was concluded that the introduction of a PAYT charge is very difficult as the charges are not directly paid by the households (see also below).

*Figure 12 Dispenser for water-proof bags attached at the bio-waste container*

- How to communicate with focus on quality?

Numerous support activities and training courses were carried out on large housing estates. (Details can be found in D3.1, section 6.3). Unfortunately, information campaigns do not have a long-term effect. Many households in densely populated urban areas have more pressing concerns than correctly sorting waste. The introduction of 'biological waste bags' (sturdy, nearly waterproof paper bags – "Biotüte", see Figure 12) has been very well received by households, which are motivated for sorting at source. However, this does little to combat incorrect waste disposal by other households.

Assistance from caretakers or committed neighbours, where available, who ensure that waste is sorted correctly and address misconduct, has generally proven very effective.

At container locations near large residential buildings, it has been shown that incorrect disposal can be reduced if the organic waste bin is at the end of the row: lazy people use the first bin they come across, while conscientious people take their organic waste to the correct bin, even if it is further away.

- What about the identification of users?

It is well known from scientific literature and practical experience that sorting performance depends inter alia on the number of users (See D3.1, section 4.6 and Bin2Bean's Guideline for Awareness Raising an Communication, section 2.4) . Therefore, the identification of users in case of contamination would partially overcome this problem. In many (mostly smaller) cities and counties, identification systems are in place, which can be combined with a quality check of the bio-waste when electronic detection systems are used at the tipping point (see section 4.2 and D3.1 section 4.6). Coded waste bins that identify the respective households were tested on a trial basis in a less densely populated district of Hamburg. While the technical process worked it was not pursued further as it is not possible to switch from volume measurement to weighing in Hamburg's waste charging system. In any case, this would only make sense in single-family homes in purely theoretical terms. The pilot project showed that the investment costs for installation and maintenance exceeded the waste collection service costs.

It is well known that even the perception of a lack of anonymity can reduce incorrect waste disposal. Therefore, the use of cameras to monitor the waste disposal points was discussed, However, implementing such a system would incur high costs even if concerns regarding personal data protection can be overcome. In many cases, it would also not be technically possible to use the recordings to identify individuals.

- Will access control to bins be helpful to increase the quality?

If the access to bio-waste containers shall be limited to those households, which are willing to separate their waste carefully, the installation of locks or electronic access systems is necessary. Lock systems for residual and organic waste were introduced on a trial basis at a large residential complex around 2007, but were discontinued in 2013 at the request of the relevant housing company. As outlined above, fees are charged for residual and organic waste depending on the volume of bins and collection frequency (residual far more expensive than bio-waste), but paper and packaging waste are free of charge. Bio-waste proved particularly susceptible to quality issues. Unfortunately, when in doubt, too many households chose to throw their residual waste into the organic waste bin because of the lower fees.

According to local waste regulations, lock systems that use chip cards are expressly permitted for households. However, SRH does not introduce or maintain these systems, but rather the property owners do so.

- How does local policy support the valorisation of bio-waste?

SRH's work is highly valued politically and recognised as a contribution to sustainable development. However, continual stimulation of public and political

interest is essential, which is achieved through announcements about changes to the collection system, construction progress at plants, and so on.
Connections are sought between topics such as good waste separation and the presentation of SRH employees in order to better address groups within the population.

SRH's department for environmental education also deals with the topic of bio-waste to soil (e.g. the 'Energieberg' model, activities for children, see also D3.1). As part of the Bin2Bean project, a new flyer on this topic was developed and has proven successful. Compost samples in bags are a usual give-away for citizens e.g. on occasion of neighbourhood events or clean-up days.

The expansion of the Bützberg plant (see Figure 13) and the hydrogen project in Bützberg have been presented to the press several times. Completion of the expansion of the Bützberg plant will be celebrated with a public event.

*Figure 13 Work on the expansion of the Bützberg facility (source: SRH)*

As outlined above, SRH is shared by the City of Hamburg; the supervisory board, which includes political and administrative leaders, decides on the budget and important investments. The board is regularly informed about relevant activities, changes of the logistic system etc. 'Innovations' are also politically supported (e.g. personal involvement of the responsible Senator, i.e.member of the City Government). Cooperation with political bodies is less relevant in day-to-day business. There is generally no intervention from the City Council (“Bürgerschaft”) as the system as a whole works. District politicians are particularly interested in waste

sorting when bins have to be placed in public spaces due to a lack of space in houses or on properties, such as in former or still-used basement locations.

- Which new ideas for collection of high-quality organic waste are being explored?

In new locations, “Quartiershöfe” (neighbourhood courtyards) will be constructed. A courtyard of this type combines underground waste containers and logistics hubs (e.g. with a cargo bike rental station and parcel station) for large new residential complexes. The combination of supply and disposal systems as well as logistics in one place is not only convenient for residents, but also sends a signal about the quality standards for separate waste collection. SRH is providing construction consultancy services for this project. The concept of neighbourhood courtyards was first introduced at IBA 2013 in Hamburg and is now recognised as an innovative approach to urban development.

It was concluded that the effectiveness of persuasion and financial incentives is ultimately limited in large residential complexes. Personnel costs and expenses must be proportionate to the ecological benefits. Hamburg's long-standing experience shows that setting a high quantitative, binding target for bio-waste collection in large cities carries the risk of severe quality issues alongside increased costs for communication and monitoring. Therefore, if European or national targets are introduced for the amount of bio-waste to be collected per person, the problems of densely populated areas should be taken into account.

### *5.1.3 Potential improvements of the regulatory frame*

The collection, processing and use of products from organic waste are regulated by European and national legislation. The following amendments are recommended to improve the marketing of soil improvers from bio-waste, reduce unnecessary costs and simplify processes.

- End-of-waste status for compost

At the end of the composting process, the product is still “waste” according to European legislation. There are different ways in which it can overcome the waste and achieve product status, depending on its subsequent use or recovery. This leads to confusion among the potential users and hampers the marketing of soil improvers. Therefore, the product status should be met when the compost leaves the plant for recovery purposes (rather than landfill).

All amendments of the Waste Framework Directive should clearly prioritise quality over quantity. It does not make sense to collect large amounts of bio-waste, as long

as we are not in a position to eliminate all impurities including microplastics to meet the quality requirements for soil improvers.

- Facilitating the CE mark for compost

The CE mark is necessary for soil improvers made from bio-waste if the product is to be traded within the EU. It is not required for national or local marketing. To obtain the CE mark for compost from a bio-waste processing plant, a quality seal from an approved QA/QC organisation should suffice instead of the complicated process set out in current EU regulations. However, it is important to monitor the plants and products! The CE mark must, of course, be withdrawn if quality control is infringed.

- Addressing the impediments posed by the German fertiliser regulation

In addition to the EU Fertilising Products Regulation (FPR), there are many national fertiliser laws that target different objectives. In countries with over-fertilised agricultural soils (e.g. Germany and the Netherlands), limits have been introduced for the further use of fertilising agents. This is in line with ecological targets, such as groundwater protection. However, current fertiliser legislation in Germany, particularly the Fertiliser Ordinance (Dünge-Verordnung, DüV), does not adequately consider the nitrogen actually available to plants in compost. According to German law, compost is primarily evaluated based on its total nitrogen content for nutrient balancing, even though a significant portion of this nitrogen is organically bound and becomes available to plants slowly. Compost's primary function is to reproduce humus in the long term rather than providing acute nitrogen fertilisation. Due to short-term nitrogen surpluses (Nitrates Directive), positive effects such as humus formation and improved nutrient and water retention capacity are overlooked. Furthermore, the ban on applying bio-waste compost to grassland (BioAbfVO) is a marketing problem that should be lifted.

It was concluded that European law and the German legal framework, especially fertiliser law, must be streamlined and made more flexible to allow the use of bio-waste compost as a soil improver.

## 5.2 Amsterdam

The City of Amsterdam has so far only collected a small proportion of bio-waste separately. This is partially due to the extremely limited space available for waste containers, high population density and the high proportion of canals and waterways. Bio-waste is collected only in Weesp (lower population density), IJburg and Amsterdam Zuidoost. Thus, 11% of all households inhabiting high-rise buildings and 30% of all households in less densely populated areas participate in organic waste collection [City of Amsterdam 2025]. The city must reorganise its waste

management system for a number of reasons (section 5.2.1). Therefore, Amsterdam serves as an example for rebooting the collection, processing, and charging system. Usually (see sections 3.2 and 4.3), the quality of separately collected bio-waste is often not satisfying in multi-family buildings. Other Dutch cities such as Rotterdam, Arnhem, The Hague and Nijmegen, but also Hamburg (see section 5.1) are also faced with densely populated quarters. Therefore, there is considerable interest in alternatives to traditional separate collection via bins and containers and / or other processing systems, which are less vulnerable with respect to the quality of the input material (sections 5.2.2 – 5.2.4).

These ideas were discussed in a Policy Forum (entitled "The European Bin2Bean Project: Collection of food waste from densely populated areas"), which was organised as a side event on occasion of the AMS Scientific Conference (on 15 April 2026) with participants from national agencies, the City of Amsterdam, and experts from Dutch and British universities.

### *5.2.1 Approaches for the valorisation of bio-waste*

According to an investigation by WUR-UEC (Bin2Bean), the amount of food waste from households in Amsterdam is estimated at 59,000 t/yr. based on the amount of food consumed and the eating habits of the nationalities living in Amsterdam. This fits with new data published by the city, i.e. 60,000 t [City of Amsterdam 2025]. Former studies estimated higher values, e.g. 65,000 t/yr. [Coudard 2019] or 70,700 t/yr. (COLLECTORS project), may be due to the integration of commercial waste and / or green waste.

According to Dutch statistical data [CBS 2024], the amount of separately collected bio-waste increased from 2019 to 2023, but was far higher twenty years ago[2] as can be taken from the following table.

*Table 3 Amsterdam waste statistics, all figures in kg per inhabitant*

| | 2001 | 2014 | 2020 | 2021 | 2022 | 2024 |
|---|---|---|---|---|---|---|
| Residual household waste | 341,0 | 287,1 | 249,7 | 246,1 | 243,7 | 230,3 |
| Bulky waste | 50,2 | 56,3 | 61,0 | 56,4 | 53,7 | |
| Kitchen and green waste | 12,8 | 0,7 | 0,6 | 1,0 | 3,2 | 4,2 |
| Coarse green waste | 0,5 | 2,7 | 1,3 | 1,6 | 1,9 | |

[2] According to AMS (Email by Yannick, 24-03-2024), earlier efforts in the 90ies resulted in very low quality of collected waste. This might be the reason for the high amount of organic waste which is indicated in Table1 for 2001.

**Households: Big ambitions – little success.** In a recent publication, the City announces the following goals: "The target is to collect organic waste from 30% of Amsterdam's households by 2026 (in 2022 this was just 5%). Our ambition is to extend this to 75%, provided sufficient funds are available." The least target shall be met in 2030 [City of Amsterdam 2022]. According to data provided by WU-UEC (as part of this project), the specific amount of separately collected bio-waste from households in 2023 was in the range between 1.9 and 2.2 kg. Processing facilities for organic waste only accept bio-waste, when it is of suitable quality.[3] About 95% of the estimated amount of organic waste is incinerated [City of Amsterdam 2025]. According to an information by a responsible member of the city administration, the municipality serves 15.500 households with aboveground containers and 48.000 households with rolling bins (about 15% of the population).

**Community composting – a small-scale success story:** There are 4500 households who participate in community based composting [City of Amsterdam 2025].

- Community gardens, city farms, and greeneries accept vegetable and fruit scraps for composting in tumblers for some weeks to ensure hygienisation followed by windrow composting. An initiative registers citizens who want to drop their food waste at the collection points and educates people to separate bio-waste correctly. The compost is used as soil improver in the gardens of the communities. Based on the municipal data published [City of Amsterdam 2026], there are 24 communities with tumblers, and one bokashi location.
- 150 "Wormenhotels" (vermicomposting) support local recycling of food waste, which are managed by neighbourhoods.

Despite the enormous engagement of some citizens (about 4,500 households), the amount of decentralised bio-waste processing is rather small: about 450 t per year compost [City of Amsterdam 2025].

**HoReCa – could do far better:** 4,186 t organic waste are collected from hotels, restaurants etc. The amount of food-waste from restaurants and hotels is estimated at 32.000 t/yr. [City of Amsterdam 2025].

**Industry and commerce – significant success.** 53,364 t are collected from supermarkets, e.g. out-of-date products and from industry, particularly food production. Organic waste from industry and commerce is estimated at 84,000 tons and is thus collected at a very high rate. Most of this waste is processed together with food residues of restaurants and hotels in a wet digester in the Western part of the harbor yielding biogas, $CO_2$ (which is partially captured and sold as a liquid to industrial users) and a residue with a high amount of nutrients, which can be used as fertilizer.[4]

[3] "The nearer to Amsterdam, the more contaminated the bio-waste." (Snippet from an talk with a representative of a composting company)

[4] Data on commercial bio-waste are available for the Amsterdam Metropolitan Area (AMA) with 2.4 Mio inhabitants. The amount of food waste generated by the manufacturing sector, the wholesale and retail sector, and the service sector was estimated at 120,000 t in 2016 (REPAIR project). Most of these residues are fermented (85,300 t), incinerated (11,800 t) or sorted (6,200 t) for other recovery measures (REPAIR D3.3).

Summing up, these figures do not support the assumption of reaching the targets for the collection of bio-waste from households (i.e. about 43,500 t in 2030). The success story of community composting cannot be increased by a factor of hundred or more due to lack of engaged citizens and space. Even if the “roll out” of bio bins and containers aiming at a 20- or 50-fold increase of separately collected organic waste within five years works, the city administration should be aware of quality problems.

**No financial incentive.** As outlined in chapter 4, fees based on the mass or volume of waste encourage citizens to reduce the amount of waste in the relevant category. According to experiences collected in many cities, as well as scientific publications, these instruments lead to lower amounts of residual waste and more recyclable waste, including bio-waste.

Citizens of Amsterdam pay fees for waste services on a per-person basis, i.e. a flat fee (see section 4.1.1) of 352 € per year for a household with one person and 469 € per year for households with two or more persons. The service includes door-to-door collections and containers (above or below ground) in the Old City and highly populated areas for all types of waste. This means that it is currently not possible to incentivise separate waste collection using economic tools. Bio-waste containers accessed using cards assigned to each resident were introduced in some apartment buildings. These cards make it possible to identify users of the containers and thus attribute any incorrect waste disposal to the respective resident or group of residents. Identifying those who misuse the containers or violate local statutes is essential for taking action against the resulting loss of quality.

**Small commerce:** While large hotels, supermarkets and industrial companies contract private companies for the collection, disposal and recycling of waste, many snack bars, bakeries, small restaurants and other small businesses use public containers for residual waste, because they can save money. Furthermore, bio-waste containers are not everywhere available.

**Regulatory frame**: According to the local statute for waste charging, the income from waste fees does not cover the cost of waste management in Amsterdam. The total costs amount to €202.76 million, whereas the total revenues amount to around €166 million, plus sales revenues from recyclates (€7.4 million). Approximately €24 million will be contributed from budget funds, i.e. tax money, and €5 million from a reserve [Amsterdam 2024].

**Summing up**: The city has clearly made efforts to collect organic waste separately. This is difficult due to the urban structure in many districts. Further initiatives are not only sensible, but also required under national legislation. The City’s charging policy does not align with the 'polluter pays' principle and neither motivates citizens to reduce waste nor rewards those who separate waste at source. It is also not meaningful to subsidise the waste service for the citizens from tax money instead of balancing the costs and the revenues. A political, technical, and regulatory reset seems unavoidable.

**Leading questions**: As the valorisation of organic waste contributes significantly to waste reduction and climate protection, as well as leading to soil improvers, the following questions should be answered:

- How can the collection of bio-waste using bins and containers be optimised in densely populated areas, including through the use of economic tools?
- Which technical alternatives can provide similar benefits without door-to-door or kerbside collection? Are these economically viable compared to usual waste collection?

### *5.2.2 New approaches – which ones are promising?*

Two alternative technologies are checked in detail:

- The "kitchen waste grinder system" and a "wet/dry separation". In the first case, food waste is to be separated and shredded directly in the kitchen sink (for details, see D3.1, section 6.2). This material is screened to receive a mostly solid fraction, which is suitable for anaerobic digestion, and a liquid phase going to the sewage system. An extra pipe system is necessary. Therefore, this system can only be installed when new building areas are erected or extensive renovation of large housing complexes occur.
- In the latter case, citizens must only separate their wet waste (i.e. mostly organic waste) and dry waste (i.e mostly residual waste) as well as glass and paper. After collection, the bio-waste will be shredded and mixed with water to receive a pumpable slurry, which is screened to separate impurities. The throughput is suitable for a liquid fermentation process. This system can introduced in densely populated areas in general.

Within the Bin2Bean project, a **kitchen sink grinder** is under development aiming at a suitable solution for bio-waste collection in high-rise buildings. Some years ago, the city announced considerable interest in "voedselrestenvermalers" that should be installed in high-rise buildings from 2020 on [City of Amsterdam 2019]. The kitchen waste shall be grinded in the sink and the resulting slurry would be transported via pipe to a storage tank. This material is screened to receive a mostly solid fraction, which is suitable for anaerobic digestion, and a liquid phase going to the sewage system.. (For more details, see D3.1, section 6.2). Assessment: Grinder systems are technically feasible, but will be only considered for new buildings. Research on the technical, social, and financial aspects of a grinder system are presented in the next section in more detail.

In few European areas, a **"Wet / dry Waste Separation"** has been introduced: If the mostly high contamination of separately organic waste from densely populated areas is accepted as a starting point, it is necessary to look for alternative processing instead of aiming at soil improvers. Based on experiences with outdated packaged food, residues of the food industry and retailers could be mixed with organic waste from the bio bin ("wet waste"). This mixture is shredded and filled up with water to yield a pumpable slurry. The contaminants would be widely separated by sieving (e.g. 6 mm mesh) and the remaining liquid processed in a fermenter. The main products are biogas from anaerobic digestion and a nitrogen-rich slurry. Further

information can be taken from D3.1, section 5.2.3. The slurry, due to its high nitrogen concentration, cannot be readily converted into a stable soil improver without further treatment. Its agricultural application may be restricted, particularly in the Netherlands with strict nitrate content regulations. Assessment: This alternative might be tested in cooperation with facilities, which use processes of this type for the valorisation of commercial bio-waste. It is necessary to identify regions with a demand for nitrogen-rich fertilisers. It is not clear whether the "dry" residual waste can be used for sorting out plastics and other packaging materials or a separate collection of this waste is yet necessary.

An advanced version might be deducted from anaerobic digesters for processing manure with bio-waste from households and other organic residues as co-substrate. The liquid fraction can be processed with sulphuric acid to separate phosphorous and nitrogen aiming at the production of a low-nitrogen and low-phosphorous slurry for nearby fields and marketable fertilizers like ammonium sulphate. Anyway, it is necessary to get rid of plastics and cullet – this is technically easier with wet digestion processes than in the dry anaerobic digesters, which are often used for municipal bio-waste.

### *5.2.3 Comparison of the different systems: Convenience, ecology, economy*

Based on the valorisation technologies brought in by stakeholders involved with the Amsterdam LL, four alternative valorisation strategies were articulated and scored on their agro-ecological, circular, global warming potential en socio-economic performances. The safety of the produced soil improvers was also assessed but based on the results (no presence of salmonella in either of the soil improvers) this indicator was omitted.

The four scenario are based around 1) regular above- or underground collection of source separated food waste, 2) Kitchen Sink Grinder based separation with a pre-treatment consisting of separating the liquids from the solids in which the liquids are discharged on the sewer and the solids are valorised, 3) a so called WET/DRY system in which bio-waste is source separated and collected in underground bins to be pre-treated with a depacking line to limit physical pollution and 4) organized community based composting.

Firstly, the performance of each valorisation strategy was ranked based on their performance indicators. The performance scores were based on empirical modelling of mass balances and Life Cycle Inventories. Where possible, site- and/or context-specific data was used to increase the representability of the outcomes. The outcomes were validated by a discussion in the Amsterdam LL. Due to data availability and quality constraints, the scores were then normalized into a relative ranking expressed on a scale from + to ++++.

The resulting performances are shown in *Table 4Table 4*.

*Table 4 Preliminary ranking of mulitple indicators per valorization strategy*

| Separation | Collection | Processing | Agro-ecoligical | Circu-larity | GWP | Socio-eco-nomic | Legal | Potentially strategy capacity |
|---|---|---|---|---|---|---|---|---|
| Kitchen bin | Above or under-ground collection | AD | ++ | ++++ | ++++ | ++++ | Yes | ++++ |
| Kitchen Sink Grinder | Post-treatment | AD | ++++ | ++ | ++ | + | No | ++ |
| WET/DRY | Under-ground collection | AD | ++ | +++ | +++ | ++ | Yes | ++++ |
| Kitchen bin | - | Community composting | +++ | +++ | + | +++ | Yes | + |

Secondly, during the Policy Forum meeting organized on 15 April 2026, the legal and policy context of each valorisation strategy were presented and discussed. The goal was to establish to what extend valorisation strategies are stimulated or hindered by legal and policy frameworks. Ultimately, the outcome of this legal and policy assessment is expressed by stating the legality of the valorisation strategy.[5]

Lastly, to understand how much a strategy could contribute to the collection of bio-waste in the city of Amsterdam, an assessment of the compatibility of the strategy with the composition of the dwellings in the city was made. For example, KSG based separation and collection can only be implemented in newly build high rises, only a limited amount of people are willing to participate in community composting and not all neighbourhoods have the spatial characteristics to harbour underground bins.

[5] For more context on the legal status of the KSG valorization strategy: during pre-treatment relative high quantities of process water is created which is discharged on the sewage. Right now, discharging what is legally considered waste on the Dutch sewage system is not allowed. Therefore in the form of which the KSG valorization strategy is include in the Amsterdam LL, it is not a legal valorization strategy.

### 5.2.4 The regulatory frame – overcoming legal restrictions

EU legislation, such as the WFD and the Landfill Directive, requires Member States to collect certain types of waste separately, such as organic waste, but not cities. Currently, Member States are not fined for failing to meet recycling targets. In the Netherlands, national legislation stipulates that cities must connect households to separate bio-waste collection systems. However, this regulation is not strictly enforced. The technical alternatives described above face challenges from several competing environmental protection regulation.

- Agricultural soil in many European regions (e.g. the Netherlands, Denmark, northern Germany and Belgium) is saturated or even oversupplied with nutrients. Groundwater is endangered by high nitrate losses from the soil. Therefore, digestate with high nitrogen and/or phosphorus concentrations cannot be used directly or is banned as fertiliser (e.g. in the Netherlands).
- In the case of the kitchen waste grinder, the solid and liquid phases must be separated. Only the solid phase (containing about 20% dry matter) can be transported to a large digester or processed in a small on-site facility. The effluents from this process cannot be passed into the sewage system because this residue is classified as waste.

This illustrates the need for several regulations to be harmonised in order to address the technical challenges of advanced systems for bio-waste valorisation.

### 5.2.5 Consequences for Amsterdam's waste management fees

Until now, charges for waste services for private households and small businesses have been based on the number of people living in the household. Therefore, there has been no financial incentive to separate waste with the aim of increasing recycling. This holds also true fro bio-waste. It is necessary to make the fee system more flexible – technically and economically. In areas with less than around 1500 inhabitants per km², the conventional system can be applied according to the experience of the City of Hamburg. There are several options either already available or as pilot projects, which can be combined by the City to install two or more systems, which are each suitable to a certain housing structure from a technical viewpoint. Once new technologies suitable for large housing complexes and/or high-rise buildings have been installed in large pilot areas, the costs, revenues and charges must be based on a new financial model (see above). Nevertheless, a differentiated charging system that includes financial incentives for waste sorting at source would significantly contribute to sustainable waste management.

### 5.2.6 Summary of political implications

European and national legislation and policy is clearly defined and appear to be strong driving forces for the implementation of bio-waste separation and collection schemes. However, binding targets are necessary on the European and the national level. Without enforcing of the legislation and policy level on any of the three

governmental levels there are no consequences of not adhering to the legislation and policy.

Enforcing separation rules and goals on an individual, household, or building level as well could promote the separation of bio-waste better then enforcing these rules only on governmental levels.
Enforcing these rules on individual, household or building level will be increasingly more challenging when multiple individuals dispose their waste in a communal container. Frequent quality control on the bin level might be a good alternative to enforcing rules when signalling of low-quality results into communication with the pollution source (on a individual, household or building level).

In conclusion: European and Dutch legislation and policy are well articulated and developed for implemented bio-waste valorisation technologies. Implemented technologies are on principle able to meet European and Dutch policy goals and legislation. The example of Hamburg (section 5.1) proves that it is possible to collect a considerable amount of bio-waste of suitable quality. It would be helpful for Amsterdam to take a closer look at the system, which has grown over 30 years in Hamburg. However, in case of very densely populated areas it is really challenging to reach the goals of bio-waste valorisation based on available technology within the legislative boundaries.

Novel bio-waste separation and collection methods like kitchen sink grinder-based separation and collection and the 'WET/DRY' system do not fit yet with European and Dutch legislation. In the case of the KSG this is in principle due to the unit in which the collection rate is expressed (wet weight). In the case of 'WET/DRY' separation and collection the low TRL makes it unclear if it adheres to European and Dutch legislation. It is necessary to continue the research to improve these techniques and to discuss their potential merits with regard to amendments of the present legal frame.

## 5.3 Egaleo

The main waste fractions collected in Egaleo are residual waste and a mixture of plastics, paper, and other dry recyclable materials. The residual waste is processed in an MBA, producing a high-caloric fraction that can be used in cement kilns, for example. The organic fraction is composted; however, due to contamination, this product can only be used for the filling of former quarries or must be landfilled. As outlined above, the City of Egaleo began collecting bio-waste as a pilot project in late 2024. This section presents the current situation and the next political steps, focusing on raising awareness, collecting bio-waste from different target groups, the charging policy and the use of compost in the city. The results presented here are based on:

- The results of two policy forums: the first one (December 2025) covered responsible city administration employees, and the second (March 2026)

included a deputy mayor and the secretary general of the city, the director of the waste management department, a driver of the bio-waste collection truck among others.
- Some results of a 'sense-making workshop' (held in February 2026 as part of Task ) are also included. This workshop was organised to facilitate information exchange with two Attica municipalities that are already involved in bio-waste valorisation.
- An ongoing information exchange between the LL leader and all Bin2Bean team members engaged in relevant working packages (monthly jour fixe since November 2024).

### *5.3.1 Analysis of the current situation and experiences gained so far*

The Municipality of Egaleo began installing bio bins at the end of 2024. With the introduction of bins for restaurants, food stores, etc., and the roll-out of the collection in a pilot area of about 100 houses, Egaleo is on its way to meeting European and national requirements. Currently, there is a lack of a specific waste fee. The costs of street sweeping, waste management, etc. are included in a service tax charged via household electricity bills, as is often the case in Greek municipalities. The amount of this tax depends on the size of the property. However, this type of waste fee does not coincide with the WFD; furthermore, national legislation allows the introduction of PAYT systems and other financial motivations for cities.
Due to the Greek administrative system, municipalities are responsible for waste collection, but not for processing. Cities must deliver waste to the facility assigned to them by the supervising authority. In the case of Egaleo, bio-waste must be transported to the EMA facility (ANO LIOSIA), which is owned by the responsible authority of the Region of Attica (EDSNA).
According to EDSNA's website [EDSNA 2026] compost is produced from pre-sorted organic waste from municipalities in the Attica region yielding "a high-quality soil improver suitable for both professional and domestic use. It is certified for use in organic farming, as well as for vineyards, outdoor and greenhouse crops, tree cultivation, horticulture and applications in urban green spaces" (translated with DeepL) The plant can process 60,000 t bio-waste and 40,000 t green waste per year according to the operator [Helector 2026[. Further information about details of the facility and the quality certificate could not be found.
The LL leader involved all relevant administrative departments in or informed about the project, e.g. the planning and transparency department, waste management and recycling, the environment and green spaces department, and nursery schools.
During the pilot phase,
- citizens, restaurant owners, etc. were given the opportunity to share their opinions,

- their behaviour was observed in order to test possible measures to support pre-sorting, such as small bins (5 litres) or wet-strength paper bags for the kitchen.

It is clear that a fundamental political decision is necessary for the installation of the system in the whole city after the evaluation of the pilot project.
By the end of 2025, 200 brown bins (240 l each) had been installed, yielding 20–30 tons per month. The quality remained poor, with about 20% impurities such as plastics or household waste, particularly in the case of restaurants. This was obviously largely caused by the installation at the kerbside (see Figure 14).

*Figure 14 City of Egaleo: Bio waste bin at the kerbside*

The containers can be used by passers-by to leave their trash. Therefore, it was recommended that the bins in the test area be locked, with only the restaurant owners and households actively engaged in separating bio-waste provided with keys. Furthermore, the city should consider offering financial incentives and/or transforming the service tax into waste charges, introducing a differentiated fee system depending on the type and amount of waste in stages.
The city recognises that raising awareness among children and parents is crucial for success, and that education from an early age plays an important role. Therefore, nurseries and schools were engaged in the communication and awareness raising activities from the very beginning, which were supervised by the green spaces department and the LL leader. 11 schools in Egaleo have been involved in composting processes. The schools were given a composting device, and the students and teaching staff are responsible for mixing the contents, adding the

appropriate bio-waste and green waste, and completing the process after around three months (see also D3.1). The compost will undergo chemical and biological testing to analyse its suitability for the parks. 3 of the 11 schools producing compost will be rewarded by the municipality for producing the best compost.

### 5.3.2 Taking the value chain into account

As we can see in Figure 2, there are two value chains based on municipal bio-waste as raw material. The first starts with the collection of bio-waste by the city, while the second is restricted to home composting. This also includes composting at schools, public spaces and more for the demand of public services, e.g. parks and school yards. The city can only oversee the second value chain. According to the results of the policy forums, activities involving schools and other public entities will continue and be enhanced, for example through courses for students and teachers. Bio bins will be installed in the Grove, the largest park in Egaleo. Compost derived from these activities, as well as compost which can be ordered from EDSNA, will be used in municipal parks and open spaces, and distributed to citizens (see below). Despite the city's involvement in collecting bio-waste, the city administration has no insight into the processes in the plant, which is operated by Helector (commissioned by the regional authority, EDSNA). Effective management of the value chain requires continuous data exchange. From the composting facility's perspective, an overview of the municipalities' activities aimed at increasing the quantity and quality of separately collected bio-waste should be of interest. Therefore, the Bin2Bean team recommends setting up a working group to facilitate information exchange and discussion of experiences.[6] It is important to check the experience of the Municipality of Vari-Voula-Vouliagmeni, which is collaborating with a private company. This facility provides compost in bags either from green waste or from kitchen waste plus green waste, which is sold to private and commercial clients; this is free of charge for citizens of Vari-Voula-Vouliagmeni.

### 5.3.3 Egaleo's strategy for bio-waste valorisation

Due to national legislation, the landfill tax will increase to a maximum of €60/t by the end of 2027. This represents a threefold increase compared to previous years. Furthermore, from 2027 onwards, compost from MBAs will not be classed as 'recycled waste' resulting in higher fines for landfilling. These fines will effectively be an additional local tax for citizens. This development is a key incentive for separating organic waste at source. According to the results of the policy forums,

- Increasing the amount of bio-waste separated at source is the first priority.
- Improving the quality of separately collected bio-waste is the second priority.

[6] Despite several approaches of the LL leader EDSNA did not cooperate up to now.

Therefore, waste producers should be incentivised to support the city. However, the so-called service tax cannot be used for this purpose because it is linked to property size. This means the tax policy should be changed:

- The service tax should be separated from the electricity bill
- so that a PAYT strategy can be employed.

The introduction of a charge depending on the amount and type of organic waste produced per household/business will be evaluated, i.e. a reciprocal incentive for citizens. Besides PAYT or similar approaches, citizens could get compost free of charge as remuneration.

Composting activities in the education sector will be continued due to the expected long-term motivation of citizens with regard to waste separation. It is well known from literature and practical experience of other cities that engaged citizens are good “ambassadors” for separation at source.

As Egaleo is unable to sell compost through agricultural markets, a small 'closed-loop' system could be designed that uses bio-waste compost in parks, public spaces and school yards.

Furthermore, the regulation of the waste management department (municipal statute) shall be revised in order to improve efficiency, adapt to modern needs, and align with current environmental standards and practices.

### *5.3.4 Collection of bio-waste from different waste producers*

Introducing a reciprocal charge, which is indirectly proportional to the amount of bio-waste collected separately, would afford bin weighing and waste producer identification. The policy forum recommended starting with restaurants, as pay-as-you-throw (PAYT) systems are easier to introduce for commercial clients than for private households. The participants were in favour of fitting the containers with locks particularly those used by restaurants at the kerbside. The trucks for bio-waste collection used in Vari-Voula-Vouliagmeni are equipped with weighing systems and should be able to identify the owners of the bins by RFID tags or barcode scanners. This is not (yet) the case in Egaleo.

The amount of bio-waste that can be separated can easily be increased by installing bio bins at open-air grocery markets (see Fig.  ). High-quality organic waste is expected. Packaging material must held separately by the traders.

The policy forums did not discuss a timeframe for the distribution of bio bins to all private households. In any case, it would be advisable to secure these containers to prevent public access and avoid contamination. Households participating in the bio-waste collection scheme would receive keys and would be required to identify themselves when filling the containers. They would also be subject to the reciprocal charging system, meaning they could be remunerated for suitable quality bio-waste.

The forum made it clear that the city needs an efficient monitoring system for the collection of bio-waste. This could be carried out by city employees who are supported by interested citizens, such as those passionate about organic farming,

organic food or soil health. All these ideas must be discussed in the coming months aiming at clear decisions by the city council as far as necessary.

### *5.3.5 Awareness raising*

A targeted information campaign for the public, with a particular focus on residents, accompanied the collection of organic waste in the pilot areas. Despite measures for convenient separation at source, such as small kitchen bins and one-way paper bags, the quality of the waste is still not suitable. Cigarette butts, plastic bags, tins and food packaging are the primary sources of contamination in Egaleo's current bio-waste stream. Containers and bins in the streets are accessible to passers-by. Therefore, the participants of the forum discussed to lock the containers aiming at less contamination (see above). However, it is also necessary to address misthrows by households, restaurants, etc., without overburdening citizens. For the next months, the following communication measures are planned:

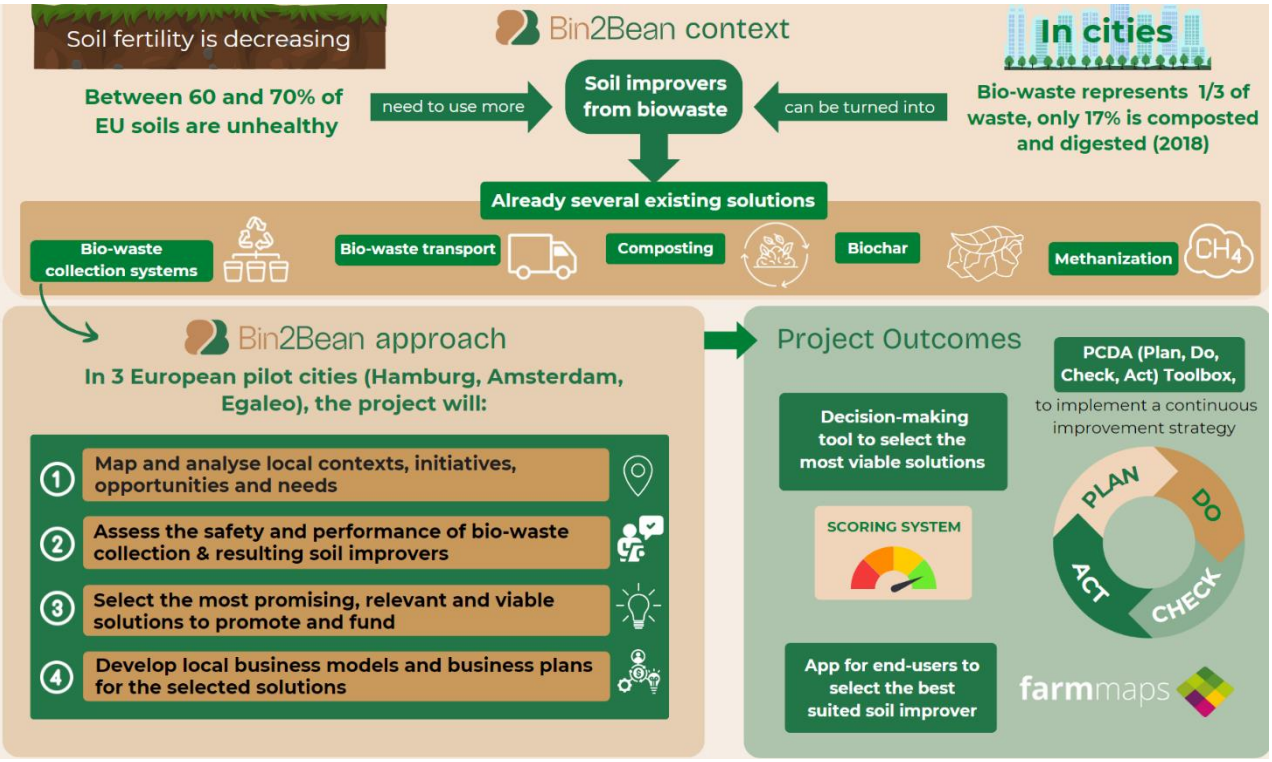
- Awareness campaign covering actions and activities, news and updates regarding the quantity and quality of the bio-waste, e.g. an information kiosk in the Grove on occasion of the flower exhibition.
- Follow-up of the composting activities at schools and nurseries.
- Education of all the students in schools, i.e. not only the ones whose schools have a composting device
- Provision of kitchen bins together with biodegradable bags for all users who are willing to separate bio-waste at source (financing is not clear)

The city administration can take advantage of the Municipality's website, social media, and posters on the trucks providing a QR code that leads to the bio-waste website. Furthermore, the Novoville smartphone app is available that citizens can use to get informed about the city's activities.

The discussions in the policy forums and in the workshop together with some neighboured cities underlined the need for cooperation. It is also very important to get support from regional or national institutions in terms of raising awareness in the public, to install measures aiming at higher quality, and to exchange experiences about suitable charging systems.

# About Bin2Bean

Bin2Bean is a research-action project, co-funded by the European Commission under the Mission Soil, which aims to optimise the performance of bio-waste collection and transformation into soil improvers. It started in September 2023 and will last 3 years.




Bin2Bean collaborates with 3 City-Region Living Labs (*Amsterdam*, *Egaleo*, *Hamburg*), which have different states of progress and levels of experience on the topic, to implement a series of activities:

1. **Map local contexts**, in terms of state-of-progress, existing initiatives, needs, material and monetary flows.

2. **Design a tailored evaluation framework** to demonstrate the safety, environmental and socio-economic performance of bio-waste collection systems and soil improvers.

3. **Develop a scoring system**, fed by data from the evaluation framework, to help cities select the most effective and market-ready solutions adapted to their context.

4. **Develop tailored and viable business and/or community models** for the highest scored solutions, according to stakeholders' willingness-to-adopt.

5. **Draft local, national and EU policy roadmaps**, including waste charging policies and citizen awareness campaigns.

All this will feed into a **PDCA (Plan, Do, Check, Act) toolbox**, enabling any city-region to create a continuous improvement loop towards effective bio-waste recycling and regenerative soil systems.

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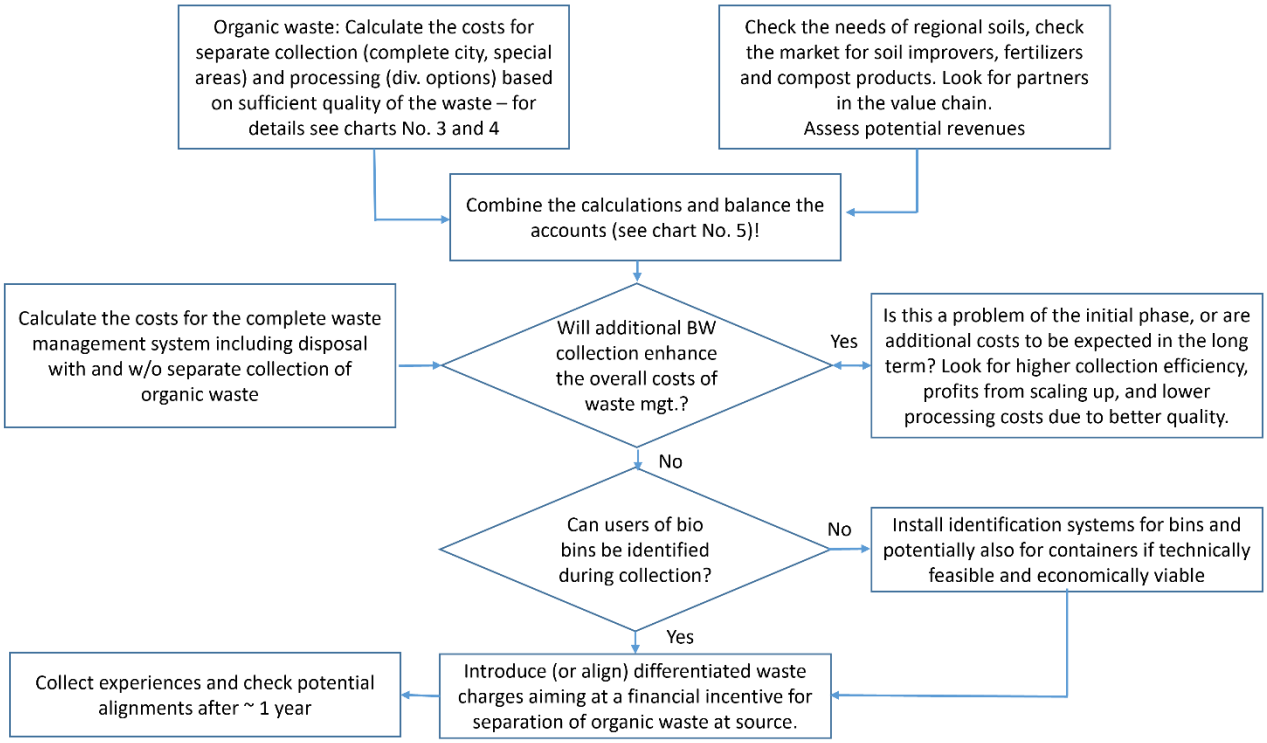
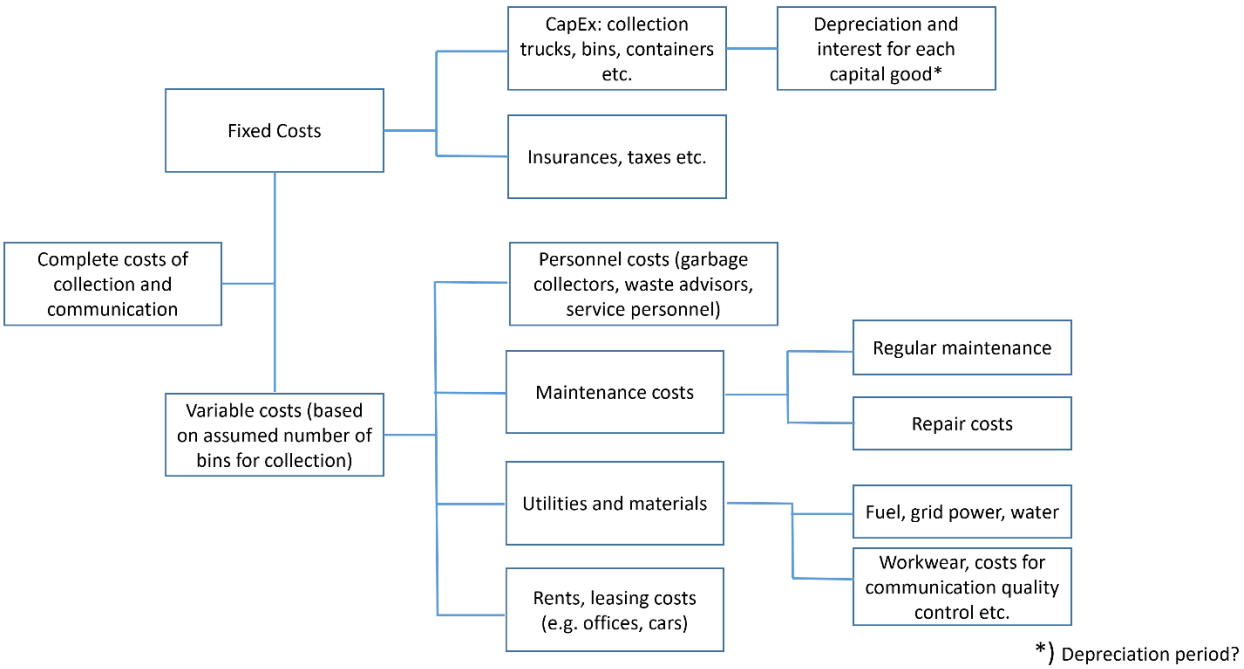
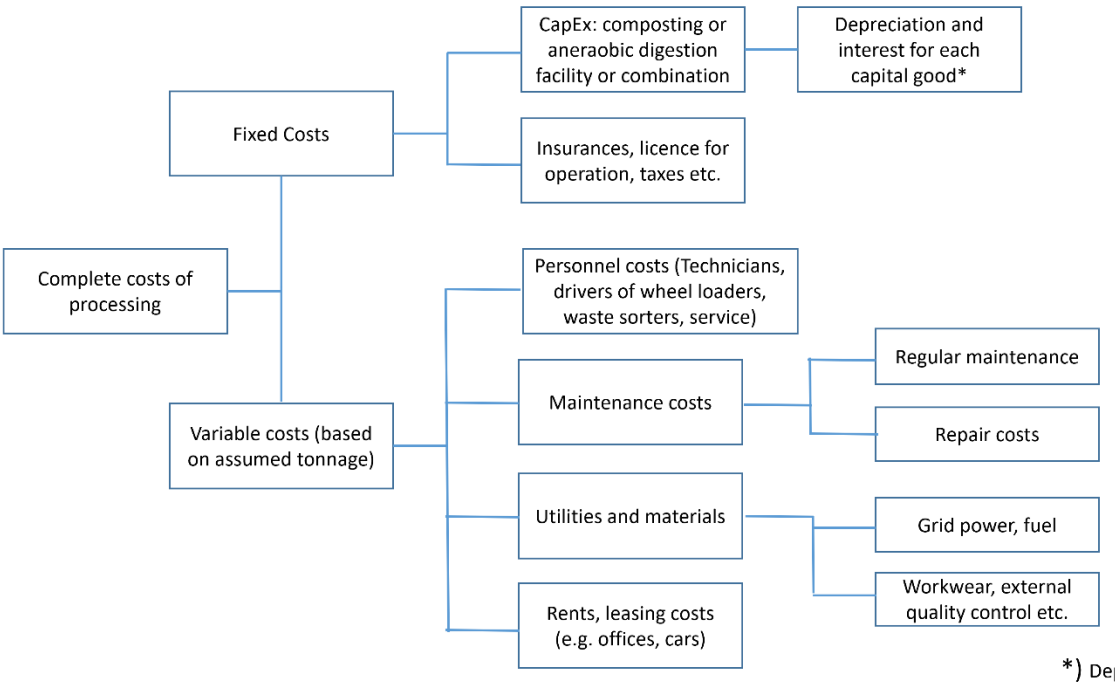
# Annex I: Introduction of the „brown bin“: Costs, revenues, charges



# Annex II: Costs of separate collection and supporting activities

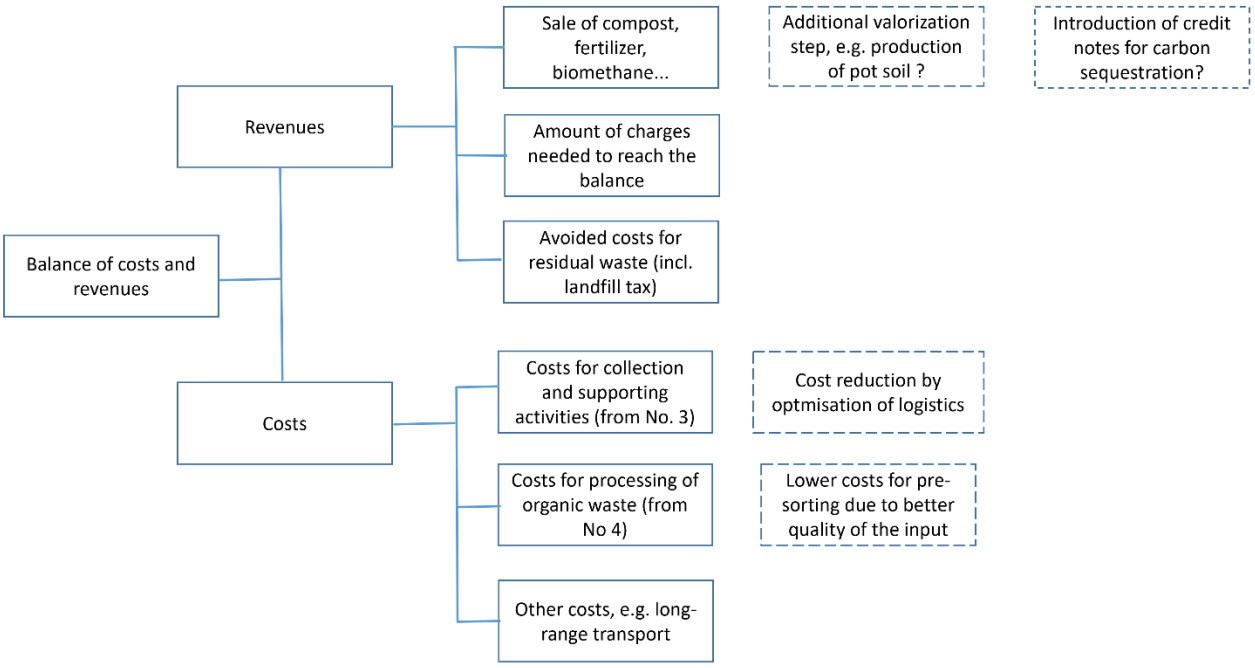


# Annex III: Costs of processing of bio-waste

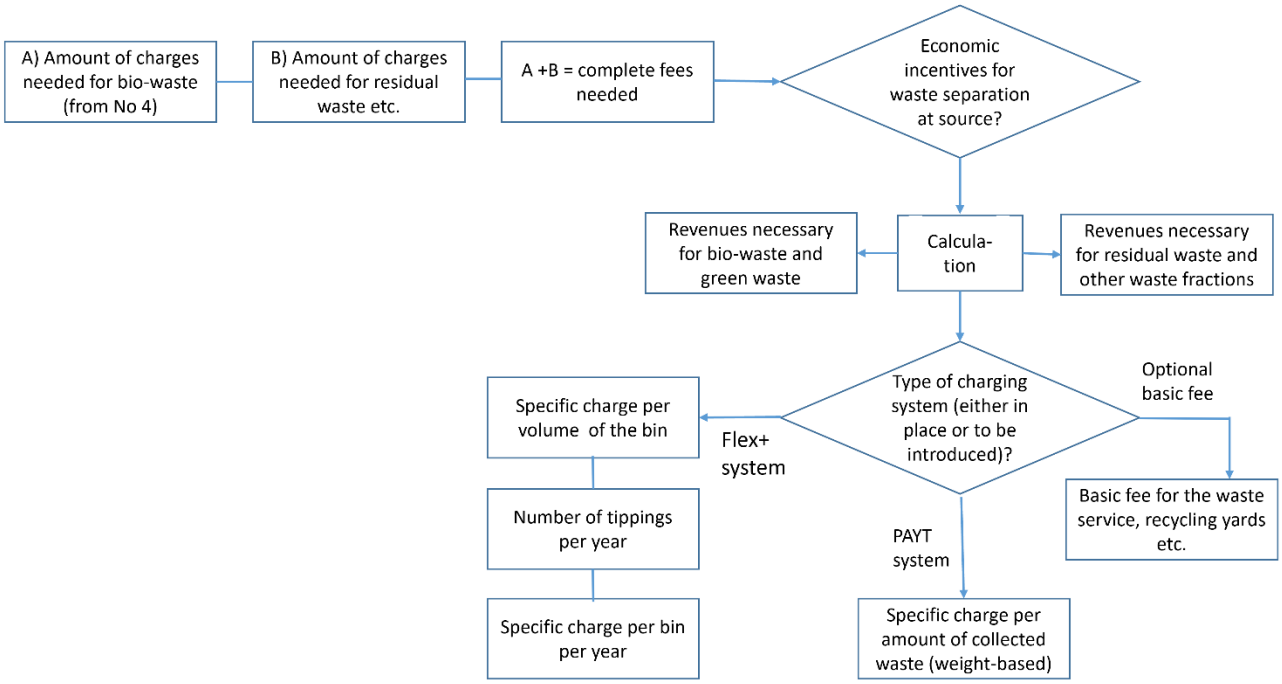



*) Depreciation period? Replacement value or acquisition value?

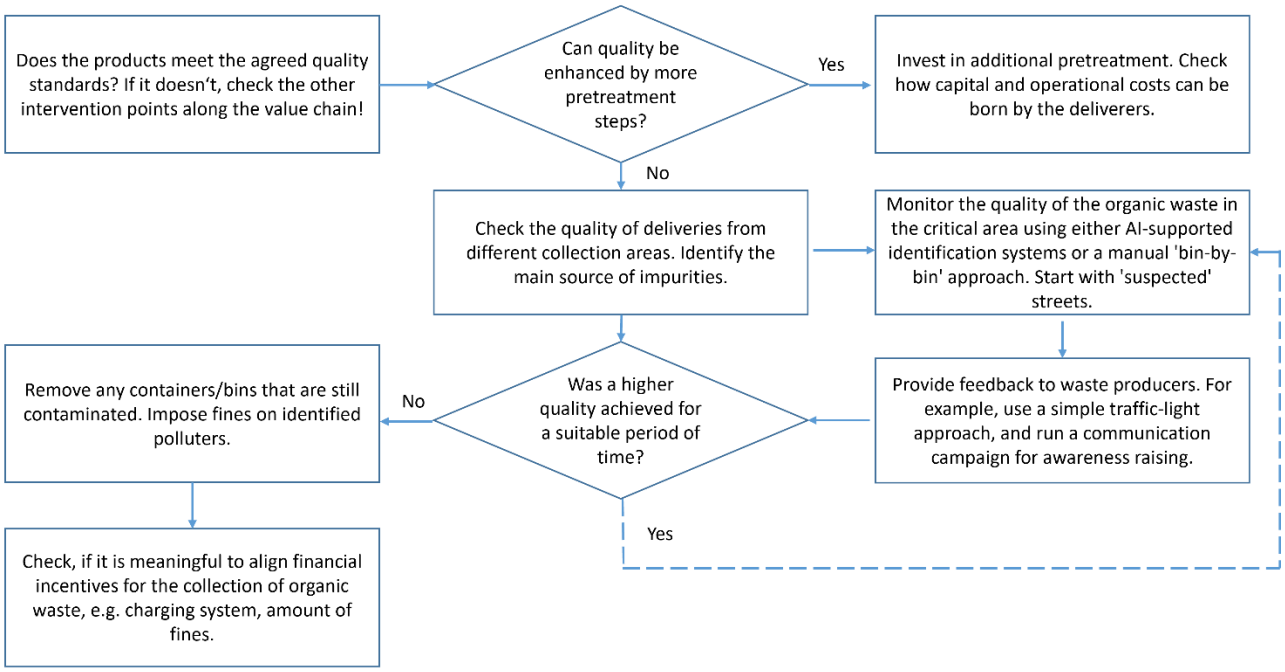
# Annex IV: Valorisation of organic waste: Balance of costs and revenues



# Annex V: Calculation of charges and charging policy



# Annex VI: Management of quality problems at different intervention points



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