



# The circular bio-waste management handbook for local authorities

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# Executive summary

Bio-waste, constituted by food and garden waste, makes up from 30%<sup>1</sup> to 50%<sup>2</sup> of municipal solid waste generated in Europe. Disposal of bio-waste poses a challenge for the environment, as fermentation of organic matter generates greenhouse gases emissions as well as harmful substances. Additional negative impacts are also caused at earlier lifecycle stages, especially for food waste, which represents more than half of bio-waste. With food production being a major driver of the Earth system exceeding planetary boundaries, especially biosphere integrity and biogeochemical flows, land-system change and freshwater use, climate change... to name a few<sup>3</sup>. There is therefore a need to move away from the current “take-make-waste” approach, towards a circular system that would help us stay within planetary boundaries<sup>4</sup>.

Local authorities, from large cities to small villages, are essential to this transition, as they have at their disposal policy levers with the potential to narrow, slow and close<sup>5</sup> biological cycles and regenerate ecosystems. Nevertheless, shifting away from the linear economy presents several challenges. Hence, the purpose of this handbook is to illuminate the path forward, offering a comprehensive view of the challenges at hand. It also provides practical recommendations for enhancing the circular management of bio-waste.

This handbook is intended for a diverse audience of local government practitioners, including waste managers, urban planners, environmental protection officers, procurers, and politicians seeking a deeper understanding of the subject. Supported by various tools and methodologies and illustrated with concrete examples, the handbook is divided into two main sections. The first section focuses on how to implement circularity, while the second centres on enabling circularity, with a specific emphasis on bio-waste and biological cycles.

To make circularity a reality, local authorities must implement solutions and measures to slow, narrow and close biological cycles, just as Apeldoorn, Mikkeli, Porto and Seville did within CityLoops. These solutions and measures can be categorised based on their environmental benefits, following the waste hierarchy. As such, local authorities should prioritise bio-waste prevention (narrowing), and the redistribution of surplus food (slowing), to prevent it from becoming waste. However, it is important to acknowledge that food waste and garden waste will inevitably be generated. Therefore, local authorities also need to develop bio-waste valorisation (closing), prioritising decentralised treatment, especially home and community composting. In areas where decentralised treatment is unfeasible, such as city centres, separate collection systems and treatment facilities should be established.

The shift toward circularity represents a profound systemic change. While implementing circular solutions is essential, it alone is not sufficient. Municipalities must, through a series of cross-cutting actions, create an enabling environment that supports the adoption of circularity by all local stakeholders. These “enablers” have been used within CityLoops all along the implementation of demonstration actions (i.e. during but also before and after) and have been integral to its success.

This handbook must be seen as an entry point for understanding and getting involved into a complex waste stream. For those who would like to dig deeper, specific resources are referenced within each section. Ultimately, we sincerely hope that this document will be of great help and that experiences from CityLoops will inspire cities and towns across Europe (and beyond).

<sup>1</sup> European Environment Agency. (2020). Bio-waste in Europe — turning challenges into opportunities.

<sup>2</sup> Gilbert, J., & Siebert, S. (2022). ECN Data Report 2022. European Compost Network.

<sup>3</sup> Campbell et al. (2017). Agriculture production as a major driver of the Earth system exceeding planetary boundaries. *Ecology and Society*, 22(4).

<sup>4</sup> Elobeid, E. (2022). How the circular economy can help us stay within planetary boundaries. Ellen MacArthur Foundation.

<sup>5</sup> Bocken, N., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, 33(5), 308-320.



## A few words on CityLoops

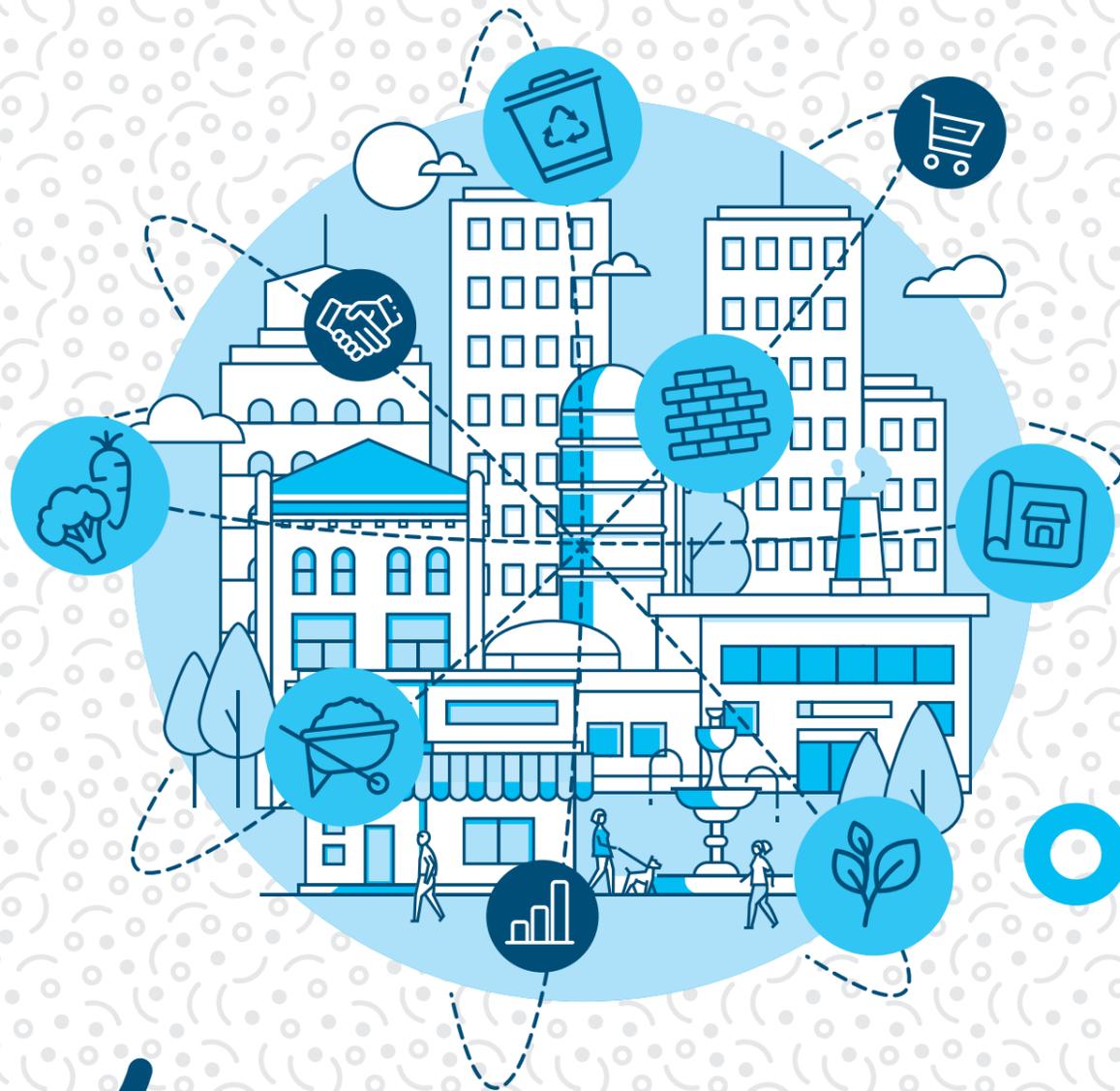
Cities throughout Europe are increasingly recognising that the transition from a linear to a circular economy is crucial for us to stay within planetary boundaries. In practice, this means that cities need to move away from the “take-make-waste” approach towards an economy based around closed material loops, where resource consumption is - to the extent possible - decoupled from economic growth. Aiming to address these challenges, CityLoops brought together seven European cities – Apeldoorn (The Netherlands), Bodø (Norway), Mikkeli (Finland), Porto (Portugal), Seville (Spain), and Høje-Taastrup and Roskilde (Denmark) to pilot a series of demonstration actions to “close the loop” in two material streams, respectively construction & demolition waste and bio-waste, identified in the EU’s Circular Economy Action Plan as two of the most important streams in Europe.

Over the past four years, these seven cities have implemented a total of ten demonstration actions, testing over 30 new instruments and processes. These range from instruments for predicting future excavated CDW and soil production, to awareness-raising campaigns, and from circularity decision making support tools, to procurement guidelines for bio-waste products. The wide variety of these solutions reflects the different needs and contexts of the cities participating in the project. While Bodø was demolishing its old military airport to build a new part of the city in the cleared area, Porto was focusing on making its social economy and tourism sector more circular. And while Apeldoorn was experimenting with soil improver bokashi, Seville was implementing waste collection awareness campaigns for school children. As such, CityLoops has highlighted the great potential of circular approaches, showing that they can be applied effectively in many different industries and with many different objectives.

Apeldoorn, Bodø, Mikkeli, Porto, Seville, Høje-Taastrup and Roskilde have the aim to become circular cities. After four years of work in CityLoops, they are not there yet, but the demonstration actions implemented during the project have brought them closer to that goal. These actions have contributed to the deeper integration of circular principles into municipal policy strategies, a greater utilisation of circular public procurement to stimulate market demand for circular products and services, and a more comprehensive understanding of the resource flows within their city.

The CityLoops handbooks aim to provide cities with a comprehensive overview of how the lessons learnt and main insights from the project can be most effectively applied in their own contexts. They feature practical examples outlining how cities implemented the tools they developed, why they made certain decisions, what they could have done differently, and how all this fits into the broader context of European circular strategies and policies. In doing so, these handbooks aim to bring the knowledge, experiences, tools and results of CityLoops to other cities in Europe and to contribute to the further implementation of the circular economy across the continent.

A table with the demonstration actions carried out by CityLoops cities is presented in the Annexes.



# The necessary transition to circular bio-waste management

Bio-waste is constituted by two main fractions: garden and food waste. This includes on the one hand biodegradable garden and park waste and, on the other, food and kitchen waste from households, offices, restaurants, wholesale, canteens, caterers and retail premises<sup>6</sup>. Industrial waste from food-processing plants is also considered as bio-waste, however this handbook focuses only on municipal bio-waste<sup>7</sup>, i.e. on the aforementioned two fractions.

As highlighted by the European Environmental Agency, “bio-waste represents a substantial share of municipal waste generation. In 2017, the EU-28, (28 EU Member States) generated 249 million tonnes of municipal solid waste, of which about 34 %, or 86 million tonnes, was bio-waste”<sup>8</sup>. Food waste is the most significant fraction of municipal bio-waste, at around 60 %, garden waste accounts for 35 %, while the remaining 5 % of municipal bio-waste is classified as ‘other’<sup>9</sup>. Municipal bio-waste can either be separately collected – which greatly facilitates treatment – or collected together with mixed waste.



Despite considerable progress made in treatment over the past decade, the way bio-waste is currently managed poses a great number of environmental issues. For instance, greenhouse gases (GHG) emissions from landfill sites (where close to 16% of waste generated in the EU still ends up<sup>10</sup>), generated by the decomposition of organic matter, accounted for nothing less than 3% of total EU emissions in 2019<sup>11</sup>.

Negative externalities associated with waste management extend beyond the treatment phase, encompassing the entire lifecycle of organic materials. This concern is particularly pronounced as the volume of municipal bio-waste in Europe continues to grow<sup>12</sup>. For instance, a significant portion of food waste remains perfectly edible<sup>13</sup> and could therefore be avoided. It means that lifecycle impacts of food waste should also be considered – and there are plenty, as agriculture production is a major driver of the Earth system exceeding planetary boundaries<sup>14</sup>. As such, food production requires land, water, and raw materials, all available in finite quantities, while the use of machinery and equipment, production of chemical fertilisers and pesticides, as well as livestock farming are all important sources of GHG emissions. Chemical fertilisers and pesticides, are causing irreversible damage to ecosystems and biodiversity<sup>15</sup>. Existing bio-waste management practices create a ‘metabolic rift,’ where a substantial amount of organic matter ends up in cities and towns, with only minimal recovery and the loss of essential nutrients like nitrogen and phosphorus<sup>16</sup>.

As we progress along the food supply chain, other processes like storage, transportation, and food processing introduce energy-intensive operations that generate additional GHG emissions. Furthermore, packaging contributes to the growing problem of plastic pollution. In addition to the environmental impact, the generation of food waste also carries social and economic impacts. These include economic losses for farmers, consumers and other stakeholders in the food value chain. Such losses ultimately lead to higher food prices for consumers, which increases food insecurity by making it less accessible to the poorest groups<sup>17,18</sup>.

This is why moving away from this linear “take-make-waste” approach – with negative externalities associated with extraction of resources, production and disposal of waste – appears as a necessity to stay within planetary boundaries; this is precisely what the circular economy can contribute to doing. A model of production and consumption based on closed material loops and substantial decoupling between resource consumption and economic growth<sup>19</sup>, the circular economy prevents waste, thus mitigating impacts associated with resource extraction and production processes. While complete waste elimination is impossible, the circular economy aims at better valorising remaining waste, with cleaner treatment options while producing substitutes to fossil-based products.



<sup>6</sup> European Commission, Directorate-General for Environment. (2018). Waste Framework Directive.

<sup>7</sup> Municipal waste includes household waste and similar waste. For more information, look at: Eurostat. (2016). Guidance on municipal waste data collection. European Commission.

<sup>8</sup> European Environment Agency. (2020). Bio-waste in Europe — turning challenges into opportunities.

<sup>9</sup> Interreg Europe. (2021). The biowaste management challenge.

<sup>10</sup> European Environment Agency. (2022). Diversion of waste from landfill in Europe.

<sup>11</sup> European Environment Agency. (2020). Bio-waste in Europe — turning challenges into opportunities.

<sup>12</sup> Since MSW has increased by 12% from 1995 to 2021, one can safely assume that its organic fraction has also increased. Eurostat. (2023). Municipal waste statistics. European Commission.

<sup>13</sup> United Nations Environment Programme. (2021). Food Waste Index Report 2021.

<sup>14</sup> Campbell et al. (2017). Agriculture production as a major driver of the Earth system exceeding planetary boundaries. Ecology and Society, 22(4).

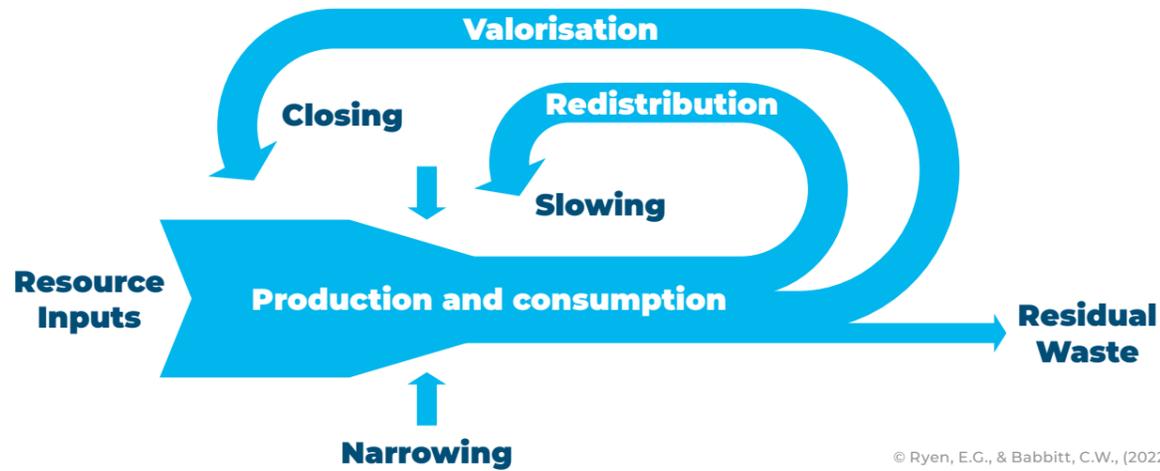
<sup>15</sup> European Environment Agency. (2023). Agriculture and food system.

<sup>16</sup> Ellen MacArthur Foundation. (2017). Urban Biocycles.

<sup>17</sup> Food and Agriculture Organization of the United Nations. (2011). Global Food Losses and Food Waste – Extent, Causes and Prevention.

<sup>18</sup> Manfredi et al. (2015). Improving Sustainability and Circularity of European Food Waste Management with a Life Cycle Approach. Publications Office of the European Union.

<sup>19</sup> Does not imply absolute decoupling. See European Environment Agency. (2021). Growth without economic growth.



Several conceptual frameworks have been developed about the circular economy, though a comprehensive description of all of them is beyond the scope of this handbook. Nevertheless, we consider that the essence of circular economy can be captured into four key principles namely **narrowing, slowing and closing resource loops**<sup>20</sup>, all of them contributing to **regenerating ecosystems**<sup>21</sup>.

→ **Narrowing loops** refers to the reduction of resource use associated with production processes. For bio-waste and biological cycles, this includes the adoption of more sustainable farming and gardening practices, both aiming at reducing life cycle impacts and at preventing waste.

→ **Slowing loops** refers to extending the useful life of products, materials and resources, thereby reducing the frequency of replacements and new production. However, biomass is not like other materials and decomposes over time, reducing possibilities to slow loops. Actions like food redistribution nevertheless contribute to slowing loops; instead of being discarded, food that might otherwise go to waste is reused for human consumption by passing surplus food on to food banks or redistribution networks. In the context of green space waste, slowing loops could involve choosing plants that require minimal pruning and trimming, reducing the amount of green waste generated.

→ **Closing loops** involves the reintegration of the waste generated into the system as a valuable resource, rather than being disposed of as waste. Closing the loops for bio-waste would involve for instance, composting, biogas production, as well as the production of biochar.

→ **Regenerating** – often overlooked – means that the circular economy must contribute to regenerating natural ecosystems. This must be taken into consideration and should additionally be the outcome of the three previous principles, through the adoption of cleaner production processes, to avoid any pollution or generation of harmful substances. Regenerating is at the core of biological cycles as organic matter should ultimately be returned to the soil.

Applying those principles to bio-waste management and more largely to activities related to biocycles would contribute to staying within planetary boundaries<sup>22</sup>, and would additionally bring social and economic benefits, such as creating jobs from new economic activities or improving public health.



## European policy...

The circular economy has become a strategic priority for the European Union (EU), with the Circular Economy Action Plan<sup>23</sup> constituting a cornerstone of the EU Green Deal and a pathway to climate neutrality. With this plan, the European Commission has intended to promote and enable the circular transition, targeting production, consumption and waste management in a number of material streams, including bio-waste<sup>24</sup>.

Key policy initiatives in this sector at EU level include the revised Waste Framework Directive, which makes separate collection of bio-waste mandatory by the end of 2023, and the Landfill Directive, which aims to drastically reduce landfilling in the EU. Other important strategies are the Farm to Fork strategy, which aims to tackle food waste, and the Bioeconomy Strategy which intends to develop bio-based fertilisers. More information on the EU regulatory framework can be found in the Annexes.

To support local authorities and help them achieve these and other targets, the European Commission also provides guidance, technical support and funding, through the Circular Cities and Regions Initiative (CCRI) or through calls for projects under programmes such as Horizon Europe or INTERREG.

<sup>20</sup> Bocken, N., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, 33(5), 308-320.

<sup>21</sup> Konietzko, J., Bocken, N., & Hultink, E. J. (2020). Circular ecosystem innovation: An initial set of principles. *Journal of Cleaner Production*, 253.

<sup>22</sup> Elobeid, E. (2022). *How the circular economy can help us stay within planetary boundaries*. Ellen Macarthur Foundation.

<sup>23</sup> European Commission. (2020). *Circular Economy Action Plan: For a cleaner and more competitive Europe*. Publications Office of the European Union.

<sup>24</sup> European Commission. (2020). *Circular Economy Action Plan: For a cleaner and more competitive Europe*. Publications Office of the European Union.

## ... and the role of local authorities

On the other end of government, local authorities across Europe are playing an increasingly important role in closing and shortening organic cycles, often pioneering new solutions, ahead of regulatory changes, as illustrated by examples coming from signatories of the Circular Cities Declaration<sup>25</sup>.

As a result of our work within CityLoops, **we believe that local authorities are in a unique position to accelerate the circular transition.** Through their multiple competences and statutory duties<sup>26</sup>, they have an unparalleled influence over a number of sectors and material streams, and they can leverage this influence to narrow, slow and close material loops. In relation to bio-waste, local authorities can use the following roles:

→ **Waste management:** local authorities in Europe typically handle waste management, either directly or indirectly through collaboration or delegation to higher government levels. Waste managers can initiate projects to promote material circularity, plan new collection systems, and run educational campaigns on waste reduction and recycling. Waste management relies on various economic models, from municipal services

to private sector outsourcing, in which local authorities always maintain a certain degree of control. This field encompasses activities like waste collection, treatment, and communication with waste producers.

→ **Urban planning:** local authorities across Europe are usually responsible for developing spatial plans and for granting planning permissions. As such they play a crucial role in shaping the fabric of the city, influencing future consumption and production patterns – i.e. how waste will be generated – while also determining space and locations for collection and treatment facilities, whether they are decentralised or centralised.

→ **Public procurement:** public procurement – the purchase of works, goods and services by the public sector, which represents no less than 14% of European GDP every year<sup>27</sup> – is essential to local authorities' activities and can be harnessed to prevent bio-waste and improve valorisation across any of its activities, with the inclusion of circular criteria. As public procurers, local authorities can also support innovative products, services or processes in relation to bio-waste management.



→ **Local economic development:** cities and towns are often in charge of local economic development, i.e. of developing economic activities and boosting job creation. As economic developers, cities and towns can create connections and foster networking, they can support local businesses through technical support and grants, or build capacity within the local workforce and develop new skills needed for a circular economy.

→ **Green space management:** local authorities oversee green spaces and public gardens. As such, they can prevent waste by adopting sustainable gardening practices, while also opening new outlets for locally produced compost and biofertilisers.

→ **Education and provision of social services:** local authorities manage school facilities and do have some influence on school curricula. In many countries, they also provide social services to citizens. This offers many opportunities for awareness raising and for “educating” the community on bio-waste prevention and sorting.

On top of meeting European requirements, preventing and valorising waste must be seen as a way for local authorities to achieve their own targets, be it reducing GHG emissions, improving air quality<sup>28</sup>, regenerating local ecosystems and biodiversity, supporting local businesses and job creation, improving local resilience... Benefits are numerous, as exemplified by the table below, which captures Sustainable Development Goals (SDGs) to which circular bio-waste management could contribute.



<sup>25</sup> Circular Cities Declaration. (2023). Circular Cities Declaration Report 2022. ICLEI - Local Governments for Sustainability. European Secretariat.

<sup>26</sup> For more information on local authorities statutory duties and competences in Europe: CCRE - CEMR. (2016). Local and Regional Governments in Europe: Structures and Competences.

<sup>27</sup> European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs. (2022). Public procurement. European Commission.

<sup>28</sup> With the HungAIRy project, Budapest is promoting community composting as an alternative to incineration. HungAIRy. (2019). Improving air quality at eight Hungarian regions through the implementation of air quality plan measures.

## Circular bio-waste management and SDGs



### SDG 2: Zero Hunger

Redistribution programs can have an impact in reducing the amount of food disposed of, increasing the amount of food that is available to others, while supporting vulnerable people.



### SDG 7: Affordable and Clean Energy

Bio-waste can be used as a renewable energy source through the production of biogas and biofuels (as well as heating), reducing dependence on fossil fuels and contributing to the transition to clean energy.



### SDG 8: Decent work and economic growth

The circular bio-waste sector can create new job opportunities in waste collection, processing, and management, leading to local economic growth and improved livelihoods.



### SDG 9: Industry, innovation and infrastructure

Circular bio-waste practices boost the adoption of innovative and environmentally sound technologies for the production of high and low value bio-based products, such as biogas, bio-based chemicals, biofuels, compost, etc. The production of the mentioned bio-based products comprises the installation of different types of infrastructure. Bio-waste can additionally be a relatively cheap resource compared to bio-based crops.



### SDG 11: Sustainable cities and communities

A circular bio-waste sector can contribute to reducing landfilling practices in urban areas and promoting a more sustainable waste management system, while also regenerating ecosystems, leading to cleaner and healthier cities and communities.



### SDG 12: Responsible Consumption and Production

The production of bio-based products from bio-waste reduces the amount of waste generated and disposed of, and promotes a more sustainable production of, for example, energy and compost, compared to their traditional fossil fuel based alternatives. Nutrient recovery substitutes for energy-intensive chemical fertilisers while cutting down eutrophication. Moreover, food waste prevention campaigns promote a more responsible consumption of food.



### SDG 13: Climate Action

The circular bio-waste sector can contribute to reducing greenhouse gas emissions by diverting organic waste from landfills and incinerators, reducing methane emissions and air pollution.



### SDG 15: Life on Land

The circular utilisation of bio-waste through the production of bioproducts like bokashi, compost, and biochar can enhance soil health and biodiversity, contributing to more sustainable and resilient ecosystems. Moreover, the implementation of certification systems for the sustainable management of green public spaces can aid in soil and biodiversity preservation. Finally, employing bio-waste as a resource for bio-products, as an alternative to wood and crops, can contribute to the reduction of deforestation.



### SDG 17: Partnership

The circular bio-waste transition depends on collaboration among citizens, institutions like restaurants and hotels, and local authorities who manage public spaces and their waste. Public-private partnerships are also crucial to develop and implement innovative solutions, invest in infrastructure, and drive circular initiatives.

## How to use this handbook?

We believe that local authorities are in a unique position to accelerate the circular transition. With this handbook, we want to **provide practical guidance** to any European local government on how to do this in the bio-waste sector within their territory.

It presents evidence-based advice on reducing bio-waste generation, improving collection, and finding alternative valorisation pathways to recycle bio-waste, supported with clear examples and case studies, which aim to provide the reader with the information and tools to act. The objectives of this handbook are:

- To provide context and insight on the current state of bio-waste management in Europe and the importance and benefits of a circular bio-waste sector.
- To provide information on the measures local governments can take that can foster circular transition and system change.
- To support decision making on the most suitable valorisation options.
- To provide best practices for the different stages from planning towards implementation.
- To strengthen and foster the collaboration between European local and regional governments by sharing the recommendations of CityLoops cities.

The handbook is intended for local authorities, including practitioners and politicians. While waste managers are the primary audience, other departments within local authorities are also encouraged to read it, as outlined above. Additionally, private entities and citizens interested in learning more about the transition toward a circular economy in the bio-waste sector may find it relevant.

The handbook is structured as follows:

- **Section 1: Implementation - providing advice on 12 key actions which local authorities can implement to promote, facilitate and enable the circular transition of the bio-waste sector.**
- **Section 2 corresponds to the implementation of circular solutions and measures in the bio-waste sector, following the waste hierarchy.**

This handbook is intended to be hands-on and to support implementation as much as possible. To make reading easier, a visual distinction has been made between three main types of information:

- **Definitions and general recommendations:** they constitute the core text, which is intended to combine an overview of the issue at stake with general guidance for implementation.

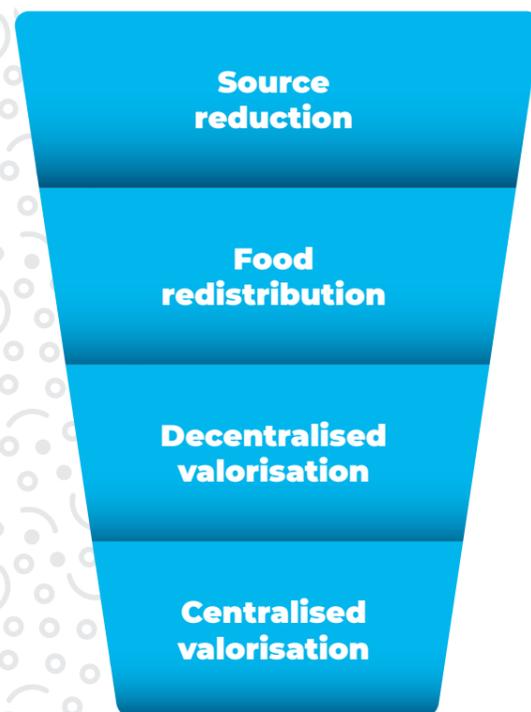
→ **Practical examples and “tips”:** practical examples from CityLoops and beyond can be found in green boxes and illustrate each section. They often include practical “tips” coming from related demonstration actions.

→ **Instruments:** description of instruments developed within CityLoops can be found in those blue boxes, with links to the instrument in question.

# Implementing circularity in bio-waste management

Drawing on CityLoops, this section introduces a series of circular solutions and measures aiming to narrow, slow and close biological cycles in cities, including recommendations for their implementation. Solutions and measures have been grouped into four categories or steps, in

accordance with the bio-waste hierarchy, which ranks waste management options according to their environmental benefits, as developed by the Institute for Local Self-Reliance<sup>29</sup>. We chose ILSR's as it put the emphasis on small scale solutions and communities. These four categories are:



## 1. Source reduction:

the most favoured option, encompassing the whole life-cycle of organic matter to reduce the generation of waste at the source, as well as the extraction of virgin materials and negative externalities associated with production processes. This corresponds to the narrowing of biocycles.

## 2. Food redistribution:

focusing mostly on food, solutions in this option explore how to get the most of surplus food before it actually becomes considered as waste. This corresponds to the slowing of biocycles.

## 3. Decentralised valorisation:

a series of valorisation solutions that reduce cost, while increasing environmental benefits. Just as the next category, this corresponds to the closing or biological cycles.

## 4. Centralised valorisation:

a series of valorisation solutions for denser cities and districts, which are not able to set up decentralised solutions.

The waste hierarchy usually comprises two other steps, waste-to-energy and disposal. We have chosen to deliberately exclude them, as they are no longer considered viable options due to the mandatory separation of bio-waste and the growing restrictions on landfilling recyclable materials.



<sup>29</sup> Platt, B. (2017). Hierarchy to Reduce Food Waste & Grow Community. Institute for Local Self-reliance.

## Toolbox – Identifying the best valorisation option (Apeldoorn)

In CityLoops, the municipality of Apeldoorn carried out four demonstration actions to develop and pilot valorisation options for various types of green spaces waste, such as leaves, grass, and pruning, while involving key stakeholders. This bio-waste valorisation decision tool was developed and used to identify the most sustainable options, assess their feasibility and more strategically determine which ones should be pursued by the municipality's own service and which ones should be outsourced to the private sector.

This decision tool enables Apeldoorn to decide how to select, collect, store and treat biowaste to be able to deliver optimal bio-waste to different users (e.g. producers of bokashi, fibre or chemical industry). The main emphasis is on the possibilities of supplying bio-waste for upcycling and applications that are beyond biogas production. By connecting the desired properties from industry with the bio-waste handling of Apeldoorn, the influence of different decisions becomes clear.

The tool is available [here](#)

## Understand your territory

Numerous factors should be considered when determining the most appropriate solution(s) for a particular city or town. These factors encompass, but are not limited to:

- Compliance with existing policies and regulations
- The city's characteristics and existing waste management system
- Quantification and characterisation of bio-waste

## Compliance with existing policies and regulations

Waste management is a highly regulated sector, where mismanagement can lead to environmental hazards. That is why local authorities should have a clear picture of the regulatory framework, of what is possible and especially of what is not, before developing and implementing any circular solutions.

Mandatory targets set at EU-level determine which treatment options should be preferred by local authorities. A glimpse of the EU regulatory framework has already been given in the previous section, with more detailed information in Annexes. EU regulation is complemented at the national level by additional norms, shaping the context and framework within which cities

determine optimal approaches for treating bio-waste, be it through prevention or valorisation strategies. While bottom-up influence on national policies is possible, non-compliance may currently hinder the adoption of specific solutions. A case in point is Apeldoorn, where leaf-derived bokashi production was piloted, yet remains restricted until regulations adapt to facilitate its scalability.

Additionally, identifying national policies relevant to the sector is important because they may **allocate resources, funding, and incentives** for bio-waste treatment, such as subsidies or tax breaks. Cities can leverage these resources to implement local solutions.

### City's characteristics and existing waste management system

The **geography of cities and towns**, including climate or urban development patterns, as well as waste management infrastructure and operations are crucial factors to consider when developing and implementing circular solutions. Anaerobic digestion's effectiveness relies on specific temperature ranges. Cold regions may need extra heating for optimal digestion, impacting environmental performance and favouring other methods without temperature constraints. Likewise, in humid, rainy areas, excess moisture hampers composting, making strategies like anaerobic digestion or energy-recovery incineration more suitable. Moreover, the average temperature in the city and the change in temperatures throughout the year has an influence on the amount of times bio-waste needs to be collected (e.g. once every week or once every month).

Additionally, urban development patterns, including factors such as population density, typology of the buildings and the road network, are also relevant. For instance, buildings without private gardens are not suitable for home composting, whereas buildings with a public area available (community courtyard), are

suitable for community composting. Moreover, small streets in (historical) city centres require the use of smaller collection trucks for waste collection<sup>30</sup>.

Lastly, understanding the current waste management system in the city is essential for designing an effective circular bio-waste management system. For example, waste management systems rely on existing infrastructure and equipment, such as treatment facilities, garbage trucks and bins, as well as established operational processes, including waste collection schedules, sorting protocols, and disposal methods. Existing infrastructure conditions future investment options, while any investment decision in new infrastructure is capital-intensive and can additionally lead to a knock-in effect<sup>31</sup> if sustainability is insufficiently considered. When introducing new collection and treatment solutions, it is important to consider how these processes will be adapted or modified to accommodate new practices. Integration with the existing operational processes ensures smoother implementation and effective coordination between different waste management activities.

### Quantification and characterisation of bio-waste

#### Assessing volumes of bio-waste generated locally, identifying the main sources and determining its composition across seasons

are prerequisites for setting up the right circular solutions. It allows cities and towns to prioritise and direct preventive and valorisation efforts effectively. Additionally, it enables ongoing monitoring of bio-waste reduction and treatment progress. By quantifying post-intervention quantities, a comparison of "before and after" scenarios becomes feasible. Quantitative methodologies like Material Flow Analysis (MFA) are particularly useful in this context.

In the context of the CityLoops project, Metabolism of Cities (MoC) developed the **Urban Circularity Assessment Method** and the **Sector Wide Circularity Assessments (SCA)**, which consists of three main parts: (1) (a) material flow and (b) stock accounting (MFSA), (2) indicators and (3) circular economy assessment. While the **UCA** looks into multiple material streams of a city, a **SCA** focuses on specific sectors, in this case bio-waste.

It is important to emphasise that conducting such a study, while recommended to enhance well-informed decision-making, is not mandatory and should not impede taking meaningful action in the field.

Additionally, **understanding waste composition** is crucial for assessing the resources and environmental risks associated with specific material flows. This understanding also helps in the decision of the most suitable valorisation strategy. For instance, the carbon content in organic waste directly influences energy production (e.g., biogas) as it converts to

methane and carbon dioxide during anaerobic decomposition.

The **main challenges** related to the quantification and characterisation of bio-waste are:

→ **Data availability:** One significant challenge lies in obtaining precise data on bio-waste generation, composition, and disposal at the city level. This task is complicated by potential data withholding by waste management companies, impeding accurate insights into bio-waste generation. Furthermore, the difficulty intensifies when seeking information about treatment methods and the production of value-added products. This is particularly true for bio-based products used or sold in the industry, as such data is often not openly shared due to its sensitive economic nature. In CityLoops, insufficient city-level data forced reliance on national data downscaled, proxies, and assumptions, potentially distorting the accuracy of the results.

→ **Complexity of waste management systems and lack of standardisation:** Waste management involves diverse stakeholders - producers, collectors, transporters, and treatment facilities. Varied data collection and reporting methods complicate data integration for coherent MFA. This lack of standardisation can lead to inconsistencies and make the development of an MFA very challenging.

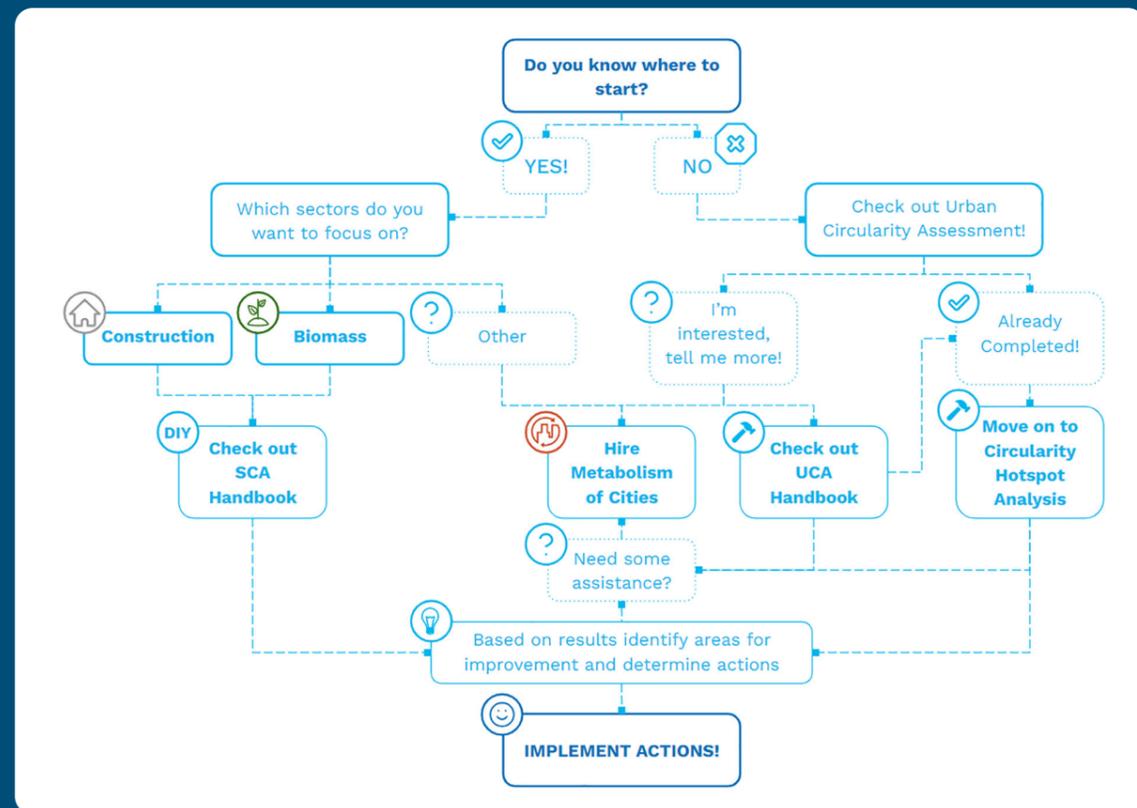
→ **Technical expertise:** Expertise in waste management, data analysis, and modelling is essential for sound assessment. Some organisations lack this, necessitating outsourcing and incurring extra costs.

<sup>30</sup> Interreg Europe. (2019). *Collection of Good Practices for Waste Management in Urban Heritage Sites*.

<sup>31</sup> IPCC. (2007). *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

### Toolbox – Assessing Urban Circularity (MoC)

The **Handbook for the Urban Circularity Assessment (UCA)** is meant to introduce and to provide practical, hands-on description of the UCA steps. It builds on experiences and examples of cities that have already conducted the UCA within CityLoops. The UCA is a combination of an urban material flow and stock accounting method and indicators that evaluate the “circularity of a city”. The handbook can be found [here](#).



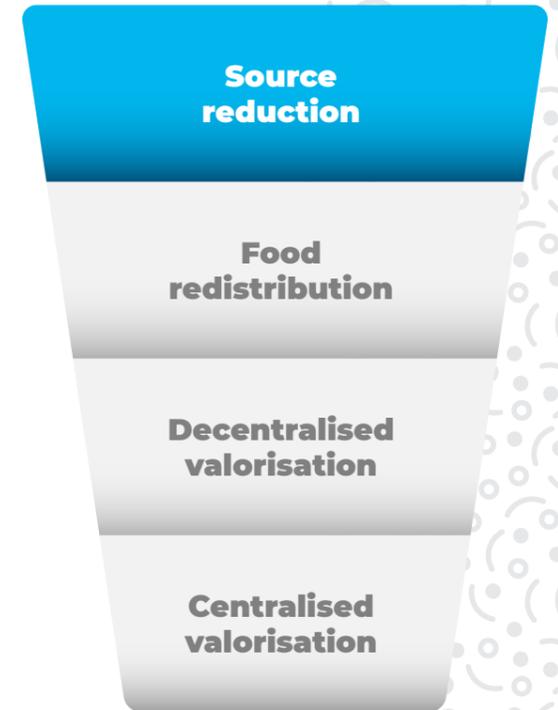
### Example – Understanding the Circularity of the Bio-waste Stream in CityLoops

As part of the CityLoops project, the cities of Apeldoorn, Mikkeli, Porto and Seville have carried out an SCA with MoC in order to illustrate how circular the sector is, and understand the efforts that are needed to be carried out in order to achieve their sector specific circularity objectives and goals. The outcomes of the studies can be found [here](#).

## Source reduction

Source reduction (or waste prevention) is at the top of the waste hierarchy, and as such should always be the most preferred option<sup>32</sup>. As opposed to other options, waste prevention does not tackle waste directly, but rather aims to prevent its generation by looking at earlier stages of products' life cycles, including primary production, processing and distribution. By doing so, source reduction mechanically reduces impacts and resource consumption generated upstream by “unnecessary” products - i.e. these products that would otherwise become waste. Applied to food systems, source reduction allows to satisfy food and nutrition needs while cutting down on impacts generated by excess production and consumption. Often overlooked, waste prevention is nevertheless crucial for the transition to a circular economy, and requires thinking beyond waste, reinventing the way we extract raw materials, the way we produce and the way we consume.

The nature of organic matter and biological cycles means that preventing bio-waste is different than preventing waste in other material streams, and especially that options such as re-use, re-pair or re-furbish are simply not possible here. With 59 million tonnes produced across the EU in 2020 only<sup>33</sup>, tackling food waste is the most pressing issue, as it accounts for about 16% of the total GHG emissions from the EU food system<sup>34</sup>. Aside from climate change, conventional agricultural practices in Europe are also responsible for substantial biodiversity loss, chemical pollution, nutrient flows alteration and water scarcity<sup>35</sup>. Tackling food waste would therefore mechanically reduce impacts of food that ends up being lost or wasted, that is the reason why food waste prevention has become a strategic priority for the European Commission, and member states are invited to set targets, monitor and reduce food waste<sup>36</sup>.



Local authorities do have several levers at their disposal to contribute to tackling food waste. Taking inspiration from CityLoops, but not only, the section below highlights actions that cities and towns can undertake to prevent food waste, by engaging with actors at different stages of the food value chain. It is also worth noting that bio-waste also includes garden waste. Here, local authorities can also play a role in promoting more sustainable gardening practices.

<sup>32</sup> European Commission, Directorate-General for Environment. (2018). Waste Framework Directive.

<sup>33</sup> Eurostat. (2023). Food waste and food waste prevention - estimates. European Commission.

<sup>34</sup> European Commission, Directorate-General for Health and Food Safety. (2023). Food Waste.

<sup>35</sup> Stockholm Resilience Centre. (n.d.). The nine planetary boundaries.

<sup>36</sup> European Commission. (2023). EU Food Loss and Waste Prevention Hub.



## What can local authorities do to reduce food waste?

Source reduction focuses on preventing or reducing food waste at its source, primarily through measures that minimise the generation of food losses and waste all along the value chain.

Here, local authorities can play two main roles: reducing food waste that they generate directly, mostly in schools or municipally managed canteens, and preventing food waste generated by other actors in different settings: at home, in food services... In both cases, source reduction aims to prevent food waste from occurring in the first place by addressing inefficiencies and behaviours throughout the food supply chain.

→ First, local authorities can **prevent food waste from school meals and catering**. This can be achieved through capacity building or procurement, depending on whether those activities are outsourced. In both cases, **effective planning and inventory management practices** should be promoted, involving demand forecasts, optimising ordering and stocking practices, and implementing just-in-time inventory systems to minimise overstocking and expiration of perishable items. Promoting **more sustainable diets**, which includes less animal proteins, organic and pesticide-free, as well as more seasonal and local products is also a way to reduce life cycle impacts of food. Finally, **adjusting portion sizes** also appears as a powerful lever to prevent waste.

→ As 53% of food waste generated in Europe in 2020 comes from **households**, local authorities should raise awareness and promote waste reduction towards citizens. Altogether, educating consumers about the impact of food waste and providing practical tips on food storage, portion planning, and utilising leftovers can empower households to reduce waste at home. Raising awareness can be achieved by combining different levers, as explained above (cf. Awareness-raising).

→ Local authorities can also engage with the HORECA<sup>37</sup> sector to **reduce waste generated in food services**. Just as for school meals or catering, practices such as improving planning and inventory management, adopting more sustainable diets, and adjusting portion sizes,

as well as providing doggy bags for patrons can be promoted. The approach however changes considerably, as local authorities have no way to make waste prevention mandatory for food services; they rely on measures such as voluntary agreements, municipality-sponsored training or certification schemes. Patience is key and they will have to maintain their engagement over time, as high personnel turnover, changing consumption patterns and the fragility of small businesses can quickly erase progress made.

→ Local authorities can also **play a role in promoting and enabling sustainable food production**. The goal is twofold: reducing food losses generated when food is produced and processed, but also leading to a change of mindset in the entire value chain, from farmers to consumers. Through tenders and direct support to farmers they can support regenerative practices such as polyculture, organic farming, or seed saving. By promoting urban gardening and granting allotments to citizens they can bring nature back to cities and educate the public about sustainable food production.

→ Beyond production, supply chains are also responsible for generating food losses and local authorities can contribute to reduce those losses on their territory by **promoting shorter supply chains**. A shorter supply chain in the context of food refers to reducing the distance and number of intermediaries involved in the process of getting food from the producer to the consumer. It involves minimising the transportation and handling of food by bringing it closer to its point of consumption. In a traditional long supply chain, food may travel long distances, passing through multiple stages such as harvesting, processing, packaging, distribution, and retail before reaching the consumer. Each step adds time, costs, and potential opportunities for food waste or spoilage. Therefore, it is believed that by shortening the food supply chain, food waste can be prevented. In practical terms, this can be done by supporting local distribution cooperatives, community-supported agriculture schemes<sup>38</sup> or simply farmers markets. Shortening supply chains also allows better distributing and reinvesting profits locally.

### Example – Reducing Food Waste in Restaurants in Porto with Dose Certa and Embrulha Initiatives

As part of the CityLoops project, the **Dose Certa** initiative strives to reduce food waste and promote the adoption of nutritious and more sustainable menus. This initiative emphasises the use of seasonal and local ingredients while considering the variety, quantity, and nutritional value of food. Moreover, by carefully assessing and characterising the food waste generated by restaurants and canteens, it becomes possible to identify areas of waste and adjust serving sizes accordingly, leading to a significant reduction in food waste of approximately 30%. The more efficient utilisation of ingredients ultimately leads to a reduction of meal costs.



Additionally, the produced information helped raise awareness among chefs, cooks, and staff members, who developed a greater sense of consciousness around meal planning.

An additional measure is Embrulha (Wrap it), an initiative that comprises the use of biodegradable packaging for taking home leftovers. This type

of packaging was distributed to restaurants interested in participating in this initiative. A digital dashboard tracks restaurants involved, packages distributed, and food waste and CO<sub>2</sub>e emissions avoided. In Porto Municipality, 56 restaurants received the stamp recognition, reducing 3.1 tonnes of food waste in 2021 and 6.8 tonnes in 2022.

### Ecochef Program Promotes Responsible Consumption and Zero Waste in Seville

Lipasa's **Ecochef program**, launched last year, aims to promote responsible consumption, circular economy, and zero waste. Over 600 participants, including children and adults, joined the workshops in July 2022 through the summer schools of the Seville City Council. The program focuses on raising awareness about the impact of food consumption, reducing organic waste, and promoting recycling. Sustainable cooking workshops involve preparing three recipes with seasonal and healthy ingredients, emphasising waste separation and composting. A sustainable purchasing workshop utilises new technologies and a dedicated app for selecting eco-friendly and healthy food options. The program also includes activities on recycling container usage and Lipasa's role in street cleaning. Lipasa's educational efforts, including



Ecochef, have received recognition with the Platinum Escoba award from Ategrus, highlighting their commitment to waste management and urban cleanliness.

<sup>37</sup> Acronyms for HOTels, REstaurants and CAFes.

<sup>38</sup> Community Supported Agriculture for Europe. (2015). European handbook on Community Supported Agriculture.

### Driving Food Waste Reduction in Healthcare: Bruges' Success Story

In 2017, Bruges initiated a focused effort to reduce food waste in specific sectors, with healthcare being the primary target. The city's involvement played a crucial role in assisting hospitals in developing food waste reduction plans and securing funding from OVAM, the Flemish waste agency. FoodWIN also played a fundamental role in the successful implementation of the project. The initiative supported two hospitals, a residential care centre for the elderly, and an industrial kitchen for residential care centres. The process involved measuring food waste, creating action plans, testing solutions on a small scale, measuring the impact, and scaling up successful approaches.



© unsplash.com / Hanny Naibaho

The participating organisations successfully reduced food waste by implementing changes in communication processes, portion sizes, and menu offerings. This resulted in a significant reduction of food waste, with one organisation achieving a 43% reduction. The project's success

led to the development of a manual to assist other healthcare organisations in Bruges in their food waste reduction efforts. The project received a special mention award for Food Waste at the Milan Urban Food Policy Pact conference in 2017.

### Shortening Food Supply Chains while Increasing Food Security and Resilience in Belo Horizonte

As part of their Food Security Program, the city of Belo Horizonte has established a unique system that fosters direct trade between local producers and consumers within the city. This is achieved through fixed sale points that ensure regulated quality and prices for the benefit of both parties. The city has also taken proactive steps by organising numerous farmers markets, providing a platform for producers and consumers to connect.

Moreover, the city's support of urban agriculture has led to the establishment of over a hundred community and school gardens.

As a result of these and other policies, the city has almost eliminated hunger, reduced poverty, created price stability and generated rural sustainability and a thriving urban and local agriculture sector<sup>39</sup>.



© pexels.com / Uriel Mont

### Toolbox – Forecasting food demand in food services (Porto)

The food demand management model aims to prevent food waste in the social and tourism sectors by forecasting food demand based on historical data. In the City of Porto, the social economy and the tourism sectors are major producers of food waste that could be avoided. To provide them with better tools to reduce food waste, this model has been developed to predict food waste in these two sectors. The food demand management model is a mathematical model for predicting food waste flows in the social and tourism sectors. Using machine learning algorithms, the tool was fed with

historical data from partners from previous projects that have the historical records needed for the algorithm. The model is intended to be used to form the basis of a dashboard for the daily management of food demand and supply fluctuations in restaurants and/or canteens, whether they are part of hotels, social institutions, or independent entities. This will also allow purchase procedures to be adjusted to the needs of the market based on the forecast provided by the tool.

The tool can be [downloaded here](#)

### Toolbox – Embedding circularity in decision-making for food services (Porto)

The circularity decision making support tool is designed to assist social institutions, hotels, restaurants, citizens, and tourists in assessing the circularity impacts of their catering decisions. It relies on a multicriteria analysis method which encompasses environmental, technical, and economic criteria. It shows users their level of circularity and guides them towards the most circular choice of what to do in the several steps

where organic matter is used, bought, eaten, or discarded, following the Lansink Ladder. Users can insert measures framed in 5 distinct stages in the management of organic flows in their business model: product acquisition, storage, cooking, customer contact and surpluses elimination.

The tool can be [downloaded here](#)

### Toolbox – Circular procurement to prevent waste in the social economy and tourism sector

The set of guidelines focuses on canteen and catering services by social institutions and the tourism sector on one side, and the maintenance of urban green spaces by the municipality, on the other. The Porto Circular Procurement Guidelines are based on an integrated vision for circular economy for school meals & catering services and green spaces maintenance. At a more practical level, the guidelines help in finding the relevant actors to achieve the objectives set with the procurement action, identifying possible gaps and consequently the need for new products and services. At the micro level, the tool includes information on how to

define and develop criteria along the stages of the procurement procedure, including a comprehensive set of example criteria to implement circular procurement in these sectors (criteria available in the tool). These procurement guidelines, specific for bio-waste flow (food services and green spaces) were developed, and are now available, to be also used by other cities. They can do so by applying the presented sets of example criteria that promote circularity in the food and public space maintenance sectors.

The guidelines can be [downloaded here](#)

<sup>39</sup> WWF. (2015). *Pioneer in food security and resilience*.

### Toolbox – Promoting sustainable green space management (Porto)

The Green Space Certification System has a clear mission: to ensure sustainable management of freespaces and raise awareness of its importance. It achieves this objective by promoting the adoption of best practices that prioritise biodiversity and maximise the benefits offered by ecosystems. Additionally, it recognizes spaces that are already addressing these critical issues. This comprehensive approach aims to enhance citizens' appreciation of and access to more

natural urban spaces. In the city of Porto, this system has been successfully applied to four green spaces of varying dimensions within the municipality. To ensure the success of this transformation process, active communication and information-sharing with citizens and users is paramount.

**The certification methodology can be downloaded here**

#### Resources

- [European Commission Assessment of Food Waste Prevention Actions, Patinha Caldeira, C., De Laurentiis, V. & Sala, S. \(2019\)](#)
- [Milan Food Policy actions on food losses and waste management, Interreg Europe \(2019\)](#)
- [Urban Food Waste: A Framework to Analyse Policies and Initiatives, Daniele Fattibene, Francesca Recanati, Katarzyna Dembska, Marta Antonelli \(2020\)](#)
- [How to Prevent Food Waste in Health Care Guidance, FoodWIN](#)
- [A Policy Brief from the Policy Learning Platform on Environment and resource efficiency, Interreg \(2018\)](#)

#### Example of resources produced by local authorities encouraging waste prevention amongst citizens:

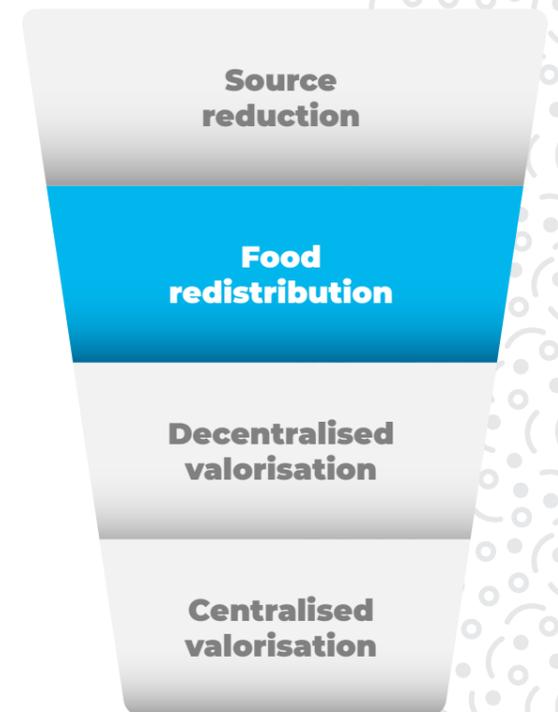
- [A Leftovers Cookbook of Recipes for Citizens](#)
- [12 Christmas Leftover Recipes](#)
- [Too good for the bin!](#) app

## Food redistribution

Food redistribution focuses on redirecting surplus or unused food to those in need. Instead of allowing edible food to go to waste, efforts are made to redistribute it for consumption through various channels, including:

- **Food donation:** Redistributing surplus food from farms, manufacturers, retailers, restaurants, and households to food banks, shelters, community programs, and individuals facing food insecurity.
- **Food recovery:** Collecting and repurposing surplus food that may not meet certain market standards (such as cosmetic imperfections), but is still safe and nutritious for human consumption.
- **Food sharing platforms:** Utilising technology and platforms to facilitate the sharing and exchange of excess food among individuals or within communities.

The focus of this strategy is to salvage and repurpose edible food that might otherwise be wasted, thereby addressing food insecurity and reducing the environmental impact associated with food waste.



### What can local authorities do to support the reuse of edible food?

Local authorities can take several measures to redistribute food surplus in cities. The most common measures are:

- **Supporting food recovery initiatives and programs:** facilitating the establishment and expansion of food recovery initiatives, such as food banks, food rescue organisations, and donation networks. Cities and towns can provide support in terms of infrastructure, logistics, and public awareness to ensure surplus food is efficiently redistributed.
- **Fostering partnerships and networks:** Additionally, by facilitating collaboration and information sharing among stakeholders, including local businesses, community organisations,

nonprofits, and research institutions, local authorities can leverage expertise, resources, and best practices in food redistribution.

- **Providing economic and financial incentives:** Economic measures are employed to curb food waste by utilising incentives and other market signals. These measures, including fees, taxes, and subsidies, are believed to be a potent tool for promoting sustainable food practices and changing consumption habits. For instance, Milan implemented a 20% waste tax reduction for food businesses that donate food losses to charities. This initiative involves multiple municipal departments and aims to support and expand existing food donation initiatives in the city<sup>40</sup>.

<sup>40</sup> Magarini, A., De Cunto, A., & Porreca, E. (2018). Food Losses and Waste in European Cities. Comune di Milano.

### Examples – The collaboration between the city of Porto & Zero Desperdício to Expand Porto's Food Donation Network

In the context of the CityLoops project, the municipality of Porto established a **partnership with Zero Desperdício** to expand the food donation network. This network does not only comprise the Porto Municipality (involving municipal services related to social and school canteens and to events promoted by the municipality), but also small, medium and large companies as food donors. These include restaurants and similar, hotels and companies in the wholesale and retail sector. As social organisations are receivers, the donors can redistribute food with quality to citizens in unfavourable living conditions.



### Empowering Bari Citizens to Fight Food Waste

The Avanzi Popolo 2.0 project, led by the volunteering association "Farina 080" Onlus, strives to mobilise citizens in Bari to combat food waste. It involves various activities, including operating a **web-platform** for sharing information on unconsumed food, rescuing food at risk of being wasted, establishing community fridges and public social stores in suburban areas to provide virtual currency-based food access for needy families, and conducting educational and advocacy initiatives on food waste. The project aims to support and nurture individual initiatives by managing the logistics of a new web platform.



© Aps Farina 080 Onlus - Avanzi Popolo 2.0

### Achieving Genoa's Zero Waste Vision through Municipal Food Surplus Recovery and Redistribution

The RICIBO project, initiated in 2016, aimed to facilitate the municipal recovery and redistribution of food surpluses with a focus on solidarity, contributing to Genoa's aspiration of becoming a zero waste city. The project has specific objectives: 1) to enhance collaboration and coordination among public entities, nonprofit organisations, and donor companies, while promoting best practices; 2) to utilise technological tools for efficient food surplus recovery, storage, and redistribution; 3) to raise awareness among citizens about existing successful projects in the area and promote the fight against food waste. What sets RICIBO apart is its systemic approach, which encompasses governance, logistics, and communication to achieve its goals.



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### Resources

- [DIRECTIVE \(EU\) 2018/851 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL 2008, as amended \(requirement for food waste reduction\)](#)
- [EU Platform on Food Losses and Food Waste](#)
- [Voluntary Agreements as a collaborative solution for food waste reduction, EU Horizon 2020 REFRESH \(2019\).](#)
- [Farm to Fork Strategy](#)
- [Sustain Alliance](#)
- Framework/methodology to measure food waste impact:
  - [Food Waste Footprint \(FWF\), FAO \(societal cost of environmental impact of food wastage\)](#)
  - [FUSIONS framework \(social, environmental and economic aspects\)](#)
- [Key facts on food loss and waste you should know!, FAO \(2014\)](#)
- [Reducing food waste through social innovation, EU-Fusions \(2016\)](#)

## Decentralised valorisation

Decentralised bio-waste valorisation (or treatment) involves managing and processing biodegradable waste near its source. Local treatment solutions for waste management include home composting, community backyard composting, and small-scale options like onsite composting, anaerobic digestion, and vermicomposting. Taken individually, these solutions handle lower volumes of biomass, producing biogas, compost, or biofertilisers for local use.

Two solutions were demonstrated within CityLoops:

→ **Home composting:** households use their own food waste and garden waste to make composts at home. Bins can be self-made or provided by the local authority, which can also dispense training and guidance on how to best make compost. Home composting is probably the most circular way to treat households bio-waste, as compost produced can be used directly in gardens, improving soil health, fostering biodiversity and water retention. The traditional method is aerobic composting – where decomposition happens with oxygen – but it requires some maintenance and enough space in backyards. In cities, this makes home composting particularly suited for lower-density areas like suburbs.

→ **Community composting:** similar to home composting, the main difference being that bio-waste generated by an entire block or neighbourhood is treated together. It can also be set up in schoolyards, in hospitals... Benefits are similar to backyard composting as it closes organic cycles at the local level. Maintenance can be done by professionals, “master composters”, or by trained residents, improving quality, while compost is then distributed to contributing residents for their gardens or houseplants. In addition, community composting fosters community participation. It is extremely versatile and can be set up in really different areas, particularly denser areas, where residents do not have backyards.



Decentralised valorisation offers many benefits<sup>41</sup>, including:

**1) Cost-effectiveness:** as decentralised valorisation greatly reduces considerable investment and operational expenses related to waste collection systems and treatment facilities.

**2) Reduction in GHG emissions:** (uncontrolled putrefaction/decay of biodegradable waste due to extended collection and transportation chains), as well as pollution and nuisance associated with centralised valorisation facilities (smell/bad odour at the premises/storage points and roads and streets, uncontrolled leachate...)

**3) Better buy-in from citizens and more community involvement:** decentralised compost producers are more likely to use the compost themselves or develop strong off-take arrangements, while community-composting fosters communities locally.

The main challenges related to implementing decentralised valorisation of bio-waste are:

→ **Feedstock availability and quality:** Ensuring a consistent and sufficient supply of biomass feedstock can be a challenge for decentralised systems. For decentralised composting for example, it is important to have a balanced mixture of carbon-rich materials like garden waste and nitrogen-rich materials like food waste. However, while kitchen waste constitutes a significant portion of household, restaurant and hotel waste, not everyone has the luxury of a backyard garden for composting and not all of them produce garden waste, which poses a challenge for the correct decomposition of the waste.

→ **Placement considerations:** In addition to assessing the composter’s physical dimensions when determining its placement, space availability is just one of several key considerations. Equally important are meeting the necessary environmental conditions, including factors such as shade and proximity to water sources, to ensure the success of the composting process.

→ **Social acceptance and training:** Social acceptance plays an important role in the implementation of a certain decentralised valorisation method given that it often requires the active participation and cooperation from individuals and communities. However, not everyone may be familiar with or willing to adopt these practices.

→ **Operational and maintenance expertise:** Decentralised systems often require skilled operators who understand the intricacies of biomass treatment technologies. Availability of trained personnel and ongoing maintenance support can pose challenges, particularly in remote or underserved areas.



<sup>41</sup> CPHEEO. (2018). *Advisory on On-Site and Decentralized Composting on Municipal Urban Waste*. Ministry of Housing and Urban Affairs, Government of India.



## What can local authorities do to implement decentralised bio-waste treatment solutions?

Local authorities can play two main roles: investing in the development and management of decentralised infrastructure, and educating the community about the benefits of decentralised biomass treatment, training them to acquire the necessary knowledge and skills to successfully dispose and compost bio-waste.

To address the mentioned challenges, they can take the following measures:

- **Managing feedstock:** This is crucial for the effective production of compost. This can involve establishing partnerships with local agricultural or forestry operations to ensure a steady supply of biomass. In this regard, the Revitaliza project in Pontevedra has taken the initiative to establish designated sites where citizens can bring their surplus garden waste<sup>42</sup>. This carbon-rich material is then distributed to residents across the region, ensuring access to essential composting resources and promoting a healthy composting process.
- **Raising awareness:** Promote source separation of bio-waste and local treatment of bio-waste through awareness campaigns and education programs. Under the CityLoops project, multiple communication strategies have been implemented to actively engage with different stakeholders, and particularly citizens. These campaigns help to educate the public not only about the role they play, but also about the importance of recycling and the added value of the products that can be produced through the recycling of bio-waste. In this regard, the city of Porto has distributed the first batch of compost produced in the community composting spaces, among the citizens, with the aim of showing them first-hand the results of their effort and the utility of the product.
- **Capacity building and training: Capacity building and training:** Providing training programs and capacity-building initiatives for operators and technicians in decentralised biomass treatment facilities is essential. This can ensure that there is a skilled workforce capable of operating and maintaining the systems effectively. In this regard, the city of Porto has provided training for its inhabitants, so they can guarantee the maintenance of the community composting process, and the Compost Master, who will have the responsibility of maintaining and monitoring the community composters.

### Examples – Pontevedra, a Frontrunner in Decentralised Composting Systems<sup>43</sup>

The Revitaliza project in Pontevedra, Spain, implements a decentralised composting system for bio-waste management. It offers individual composting for households with space, community composting sites for densely populated areas, and small-scale composting plants for areas with high density.



© unplash.com / Simon Wiedensöhler

Monitoring and data collection processes have been implemented to track the progress and quality of composting. Professionals and master composters oversee community composting, ensuring proper maintenance, and addressing any issues that may arise.

The Revitaliza project covers not only households but also entities such as restaurants, coffee shops, hotels, hospitals, and schools that generate a significant amount of bio-waste. Municipalities have the option to participate voluntarily, have Revitaliza manage the entire process, or integrate the project into municipal

ordinances, making it mandatory and extending it to include waste collection systems.

After three years of implementation, the project has allowed a total of 2,052 tonnes of bio-waste to be composted, therefore diverting this same amount away from either incineration and landfilling. Two thirds of the 2,052 tonnes was kitchen waste, with garden waste making up the final third. Moreover, it is foreseen that the implementation of a decentralised composting system in the city of Pontevedra will lead to 4 to 5 times lower costs per tonne of treated waste than the centralised system.

### Community Composting in the Cities of Porto, Budapest and Besançon

Under the CityLoops project, the city of Porto has taken proactive measures by establishing community composting spaces dedicated to the separate processing of household bio-waste. These initiatives have been complemented by comprehensive awareness campaigns and informative composting training sessions conducted within the neighbourhoods where the community composting spaces were implemented. Additionally, a “compost master” role was introduced, designating the person responsible for weekly monitoring, logistical coordination, and administrative management of the composters.



To commemorate the significant milestone of the first compost production in these two community composting sites, a special event was organised, bringing together residents to share the initial yield of compost. Within the initial year of implementation, a noteworthy 8.4 tonnes of bio-waste underwent local treatment, resulting in the production of 2.5 tonnes of high-quality compost.

available community composting sites in the city. The aim of the initiative is to educate and enable citizens to compost their organic waste as an alternative to burning green waste. Consequently, community composting does not pollute the air with the emissions associated with transport, and can also provide nutrient replenishment for the residents' gardens.

In the city of Besançon, an extensive system of decentralised composting has been put in place with outstanding results. Today, 70% of the citizens of Besançon and surrounding municipalities compost their food scraps at home or have a community composter in their building or a small-scale composting site next to their house. The diversion of the organic waste from the incinerator has saved €800,000.

Similarly, Budapest has installed 12 publicly

<sup>42</sup> Zero Waste Europe. (2019). The Story of Pontevedra.

<sup>43</sup> Zero Waste Europe. (2019). The Story of Pontevedra.

### Decentralised Anaerobic Digestion Systems for Energy Production in Lyon

As part of the DECISIVE project, decentralised management scheme for innovative valorisation of urban bio-waste through micro-scale anaerobic digestion (AD) and solid-state fermentation (SSF) have been piloted. The purpose of the project is to change the urban metabolism for organic and energy flows into a closed loop through technological and non-technological solutions for the creation of a regenerative circular economy based on bio-waste management.

In the region of Lyon, in the city of Ecully, local restaurants contribute with approximately 50 tonnes of bio-waste annually to fuel a micro anaerobic digester and solid-state fermentation processes, which aim to produce valuable products for urban farms.

The electricity generated will primarily be consumed on-site, powering various systems such as pumps, lighting, and ventilation. Any excess electricity will be stored in batteries for future use. Additionally, surplus heat will be harnessed to warm the greenhouse and potentially nearby buildings.



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#### Resources

- [Decentralised management of organic waste Webinar, ZW Live! \(2020\)](#)
- [Deliverable D 3.7 Scenarios for decentralised bio-waste collection chains with a waste collection database for representative situations, EU Horizon 2020 DECISIVE.](#)
- [Institute for Local Self-Reliance and Highfields Center for Composting, Growing Local Fertility: A Guide To Community Composting](#)

## Centralised valorisation

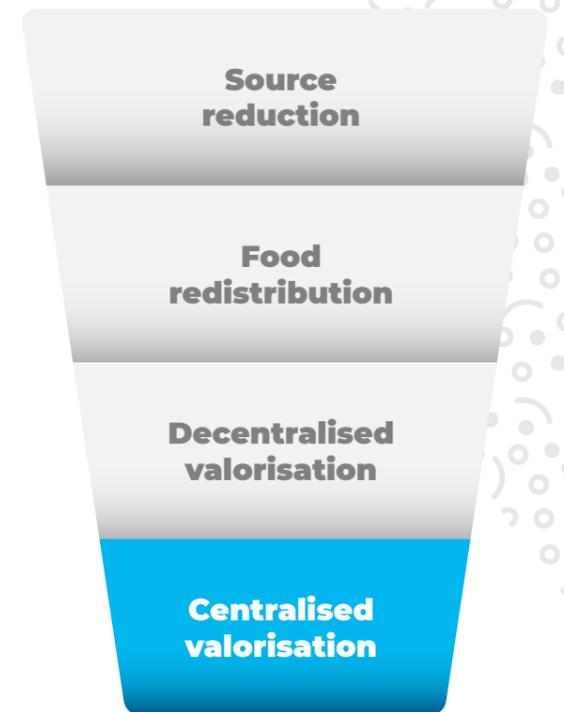
Centralised bio-waste valorisation (or treatment) systems are large-scale facilities designed to process and treat bio-waste from various sources in a single location. These systems are typically located in urban or industrial areas and handle vast quantities of bio-waste.

In a centralised bio-waste treatment system, bio-waste is collected from multiple sources, such as households, restaurants, or industrial facilities, and transported to the treatment facility. At the facility, bio-waste undergoes different treatment processes, such as anaerobic digestion or composting. Also the production of higher added-value products typically consists of centralised and decentralised solutions, depending on the specific context and approach.

Centralised bio-waste treatment systems offer several advantages. They provide efficient management of large volumes of bio-waste, efficient resource recovery and they benefit from economies of scale due to their larger capacity and higher throughput. Additionally, these systems can generate renewable energy, and reduce GHG emissions by diverting bio-waste from landfills.

However, centralised bio-waste treatment systems also face some disadvantages compared to decentralised systems, requiring significant infrastructure and investment costs, including collection systems, transportation networks, and processing facilities. Moreover, these large systems comprise high operation and maintenance costs and a high degree of specialised skills to operate and maintain.

Regarding the social aspect, a centralised system requires less interaction with and involvement of citizens, who might not be informed about what is done with their waste and the importance of source separation, often leading to lower feedstock quality. Centralised bio-waste treatment may cause lock-in effects due to significant investments and specialised infrastructure, limiting future flexibility. That is why local decision-makers should consider long-term implications when implementing centralised solutions. Lastly, control, noise management, and potential community concerns can be additional challenges that need to be addressed in the design and operation of these facilities.



The main challenges associated with the implementation of a centralised valorisation of bio-waste are:

- **Infrastructure and space:** Establishing and maintaining centralised facilities for bio-waste treatment requires substantial infrastructure and space. Acquiring suitable land and constructing the necessary facilities can be a significant challenge, especially in densely populated urban areas where land is limited and expensive.
- **Cost and financing:** Establishing and maintaining appropriate infrastructure and technologies for bio-waste valorisation can be capital-intensive and require ongoing investments. This includes facilities for composting, anaerobic digestion, or other conversion processes, as well as transportation and storage infrastructure.
- **Community acceptance:** Locating centralised bio-waste treatment facilities near residential areas can face opposition from local communities due to concerns about odour, noise, traffic, and potential impacts on property values.
- **Market demand and economics:** The availability of markets and demand for the end products derived from bio-waste can be a challenge. The economic viability of valorisation processes heavily depends on the market value of the products.



## What can local authorities do to implement a centralised bio-waste treatment solution?

Local authorities can play three main roles: identifying an appropriate location for the centralised bio-waste treatment facility, securing adequate funding and allocating resources to build the necessary infrastructure. Moreover, to address the mentioned challenges, they can take the following measures:

→ **Strategic planning and site selection:** Public authorities can engage in long-term strategic planning to identify suitable locations for centralised bio-waste treatment facilities. This involves considering factors such as proximity to waste sources, transportation infrastructure, and community acceptance.

→ **Improve collection and treatment systems:** Implementing optimisation strategies and monitoring systems are crucial for increasing the efficiency of bio-waste collection and valorisation processes. This ensures the financial feasibility of recycling plans and maximises the production of valuable by-products. The city of Mikkeli focuses on optimising biogas production and its resulting products, while Porto and Seville concentrate on optimising logistics, such as collection routes. These efforts contribute to greater efficiency, sustainability, and economic viability in bio-waste recycling, unlocking its full potential in the circular economy.

→ **Market development:** identifying and creating markets for the end products derived from bio-waste valorisation, such as compost, biofertilisers, biogas, or bio-based chemicals. Public authorities can also promote the use of these products in agriculture, landscaping, energy generation, and other sectors to create demand and economic viability. As part of the CityLoops project, the city of Porto is actively working towards expanding the local market for compost, targeting local farmers. This initiative aims to foster sustainable agricultural practices by providing a reliable source of high-quality compost derived from bio-waste. Furthermore, the city of Mikkeli has implemented a noteworthy strategy where the biomethane produced through bio-waste valorisation is utilised to power waste trucks and buses. This innovative approach not only reduces greenhouse gas emissions but also showcases the practical application of biogas in the transportation sector, contributing to a cleaner and more sustainable urban environment.

→ **Public engagement and communication:** Building trust and gaining community acceptance is crucial for the success of centralised bio-waste treatment projects. Public authorities should engage with local communities, provide transparent information about the benefits and environmental safeguards of the facilities, address concerns, and involve residents in the planning process.

Centralised valorisation encompasses various valorisation options, which all rely on **separate collection** of bio-waste and **pre-treatment**.

# Separate collection

While in decentralised valorisation transportation is unnecessary as treatment occurs at the source, centralised valorisation requires transportation to the treatment facility. To enable streamlined recycling and composting processes, a **dedicated bio-waste collection system** that gathers bio-waste separately from other waste types is crucial.

The most common collection system methods are door-to-door or kerbside collection, drop-off points and the pneumatic system. **The door-to-door collection model for bio-waste has been proven to provide the best results**, both for the quantity of material collected and the quality of such bio-waste, and its costs, thus being the recommended system for municipalities wishing to collect high quality (low contamination) bio-waste<sup>44</sup>.

A description of the most common types of collection systems follows below:

→ **Door-to-door or kerbside collection** (e.g. bags or containers): Differentiated waste collection occurs at the user's home, with various waste fractions collected on different days using different containers and frequencies. Waste is collected by municipal workers and loaded into collection trucks. In some urban areas, conventional door-to-door collection faces challenges due to topography, climate, and limited space. It has the largest environmental impact due to longer collection routes. This collection system is common in countries such as Germany and Italy.

→ **Drop-off points or road container system:** Method that involves the presence of containers of different shapes and volumes, where users dispose of various types of differentiated waste. In this case, users can dispose of the different types of waste separately 24h a day. The containers are lifted automatically and emptied inside the truck.

→ **Pneumatic system:** Users throw their waste into inlets. The waste is transported through the pneumatic underground pipes to the waste collection station, where the waste containers, the vacuum-generating unit and the control centre are located. When the container is full, it is hauled away. It is sometimes argued that this method is

superior to traditional collection methods since it decreases the negative amenity impacts of vehicle-based waste collection and makes source-separation more attractive for households.

Pneumatic systems lower waste collection costs for households in new residential areas relative to a traditional door-to-door waste system, as they require less staff for operation compared to the traditional method of collecting waste using trucks. In doing so, pneumatic systems save money on wages, but also on vehicle expenses such as fueling, maintenance and purchasing the vehicles themselves. However, in ready-built areas, the implementation of pneumatic systems can be up to six times more expensive than door-to-door systems due to large investment costs. Additionally, this collection system is not cost effective in low density areas, and in areas where the pneumatic system is in use not everything can be collected through the tubes, such as bulk waste.

The **main challenges** related to the separate collection of bio-waste are:

→ **Collection efficiency:** The frequency of bio-waste collection needs to be carefully determined to ensure timely removal of waste without causing odours, attracting pests, or leading to overfilled containers. Finding the right balance between frequent collection to maintain hygiene and avoiding unnecessary collection trips can be challenging. Moreover, bio-waste generation can vary seasonally during certain periods (e.g., holidays, warmer months, or seasonal produce peaks).

→ **Collection infrastructure:** Proper collection infrastructure, such as dedicated bins or containers for bio-waste, needs to be in place and strategically located to ensure convenient access for residents and businesses. Ensuring an adequate number of collection points and appropriate bin sizes can be challenging in densely populated or geographically dispersed areas.

→ **Waste contamination:** Bio-waste collection can be contaminated with non-biodegradable materials, such as plastic or metal, which can reduce the quality of the collected waste and create difficulties in processing and composting.

<sup>44</sup> Zero Waste Europe. (2022). [How to best collect bio-waste.](#)





## What can local authorities do to set up a separate collection system?

Setting up a separate collection system for bio-waste involves several steps. Based on existing guidance<sup>45</sup> and on CityLoops' experience, the most common steps for setting up a separate bio-waste collection system are presented below.

Local authorities play a significant role in establishing a separate waste collection system, primarily by creating the necessary infrastructure for waste separation and collection. They also develop strategies and regulations to enforce waste separation and establish recycling targets. Setting up a separate collection system for bio-waste involves the following key steps:

**1) Policy and regulatory framework:** Develop or update waste management policies to include provisions for bio-waste collection. Set clear targets and guidelines for recycling and coordinate with relevant government agencies and stakeholders.

**2) Selection and evaluation of implementation area:** Analyse suitable locations for bio-waste collection based on demographics, waste generation patterns, and infrastructure availability. Position collection points conveniently alongside other waste collection points.

**3) Collection system design:** Assess existing infrastructure and invest in enhancements for bio-waste collection. Provide separate containers, determine collection schedules, and design treatment facilities for bio-waste.

**4) Stakeholder engagement:** Engage local authorities, waste management companies, and customers. Foster collaboration and raise awareness about the benefits of bio-waste recycling. Listen to stakeholders' suggestions.

**5) Public education and outreach:** Conduct public awareness campaigns to educate residents and businesses about bio-waste separation and recycling. Use credible sources, align recommendations with existing beliefs, and emphasise the advantages of the new approach.

**6) Monitoring and improvement:** Implement monitoring mechanisms to track performance, participation rates, and progress towards targets. Analyse data regularly to identify challenges and areas for improvement. Enforce compliance with penalties if necessary and utilise appropriate technology for intelligent management of information.

To address the challenges related to the frequency of collection and collection infrastructure, local authorities can take the following measures:

**→ Use technology and data:** Implementing waste management software and tracking systems can optimise collection routes, reduce fuel consumption, and improve operational efficiency. Analysing data on waste generation and collection patterns can help make informed decisions about collection frequency and infrastructure needs. Among the most common technologies implemented in waste collection are smart bins with identification systems, weighing systems, level sensors and software for optimising logistics. Particularly the fill-level sensors help determine the fullness level of bins. The user has the possibility to dispose of waste 24h a day, and depending on the technology, the disposed waste can be associated with the user. Moreover, the smart bins collection method is environmentally more effective in comparison with door-to-door and street bins. The transportation phase alone corresponds to an impact reduction of about 60% compared with the door-to-door system.

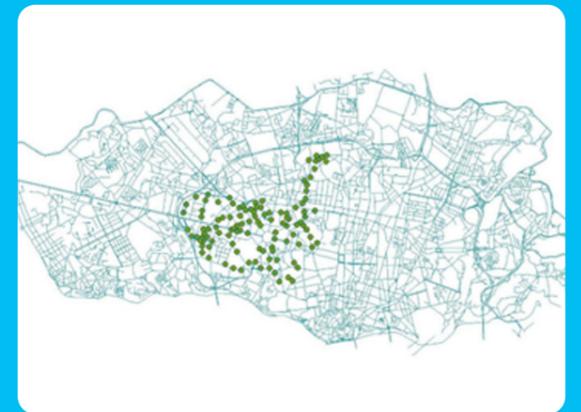


**→ Selection and evaluation of implementation area:** Evaluating the existing waste management infrastructure helps identify areas where additional infrastructure enhancements or investments may be required. This includes providing separate collection containers, designing appropriate facilities for waste treatment and recycling, and determining the most suitable collection vehicles.

**→ Awareness raising and education:** Local authorities play a crucial role in promoting bio-waste separation and collection. They should communicate clear guidelines and instructions to residents and businesses, outlining proper waste separation procedures. Public awareness campaigns are vital to educate the community about the significance of bio-waste recycling and its benefits. To encourage bio-waste recycling, local authorities can provide kitchen bins for separate collection and distribute biodegradable or plastic bags to prevent contamination. Contamination can have significant consequences during the valorisation process, making this step essential to ensure the effectiveness of bio-waste recycling efforts.

### Examples – Effective Implementation of Separate Collection in Porto: A Geographic Information-Based Approach

In the city of Porto, the selection of the implementation areas for the separate collection system using street containers was based on thorough analysis utilising geographic information tools. Several key factors were considered, including areas with high population density and areas with high potential for food waste generation. Operational conditions played a crucial role in the decision-making process, with emphasis on selecting locations adjacent to existing street bins and ensuring accessibility for waste collection trucks. Ultimately, the areas chosen were the Boavista and Bonfim areas.



A total of 120 smart street containers were installed in the new two areas, creating a new collection route, and consequently hiring 3 employees. The truck used for the collection has specific features for the food waste collection, including a washing system that allows the containers to be collected and maintained at the same time.

To raise awareness and engage with citizens, door-to-door campaigns were carried out, where each household was provided with a "kit" comprising a 7-litre bin, 2 electronic cards for street container access, informative brochures, and promotional gifts related to the project. In addition to distributing these kits, people were

educated on the proper separation of food waste, with a specific emphasis on not using plastic or biodegradable plastic bags. Additionally, street activities were organised in high population density areas, featuring a banana mascot with the purpose of engaging the younger audience. Furthermore, informative counters were set up in supermarket and commercial areas to reach those who may have missed the door-to-door campaign.

Monitoring activities are conducted to control the quantity and quality of the collected waste. Additionally, annual satisfaction surveys are distributed to citizens.

<sup>45</sup> CEN-CENELEC. (2022). Key factors for the successful implementation of urban biowaste selective collection schemes.

### Seville's Approach to Implement Separate Collection: Benchmarking, Implementation and Communication

In Seville, a comprehensive assessment was carried out to evaluate waste management regulations, available resources, waste production data, and future trends. This included a comparative analysis of waste collection and treatment systems from other locations. Parque Alcosa and Santa Clara neighbourhoods were chosen for implementing separate bio-waste collection through 2,200-litre containers with electronic locks and citizen access cards. To maintain the existing system, surface containers were introduced for compostable waste. These collection containers were grouped with other selective collection units. Collection occurred every 3-4 days, with data collected to monitor progress. Communication efforts encompassed



door-to-door campaigns, brochures, posters, digital marketing, and information points in public areas.

### Container Bins to Door-to-Door Collection in Altamura, Italy, and Argenton in Spain

The city of Altamura, a mid-sized town in Southern Italy, adopted in June 2018 a door-to-door collection system in replacement of the community bins collection method. This transition has shown to increase the participation of users in sorting and collection of waste, compared to street bins. Also the percentage of recyclable waste as separate fractions using specific containers rose from about 25% to roughly 70% in a span of just a couple of months. Similar results were obtained for the city of Argenton, which implemented a container system, the most common waste collection system in Spain in 2014. However, organic waste would not be collected separately, usually resulting in significant contamination of the recyclable and residual waste streams, with



recycling rates below 20%. The implementation of the door-to-door system increased the recycling rate to 68%.

### Underground Containers in Historical Centres, a Typical Approach

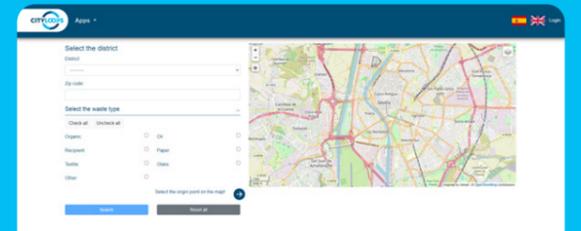
Underground containers can be preferable in historical centres and densely populated urban areas due to limited space and the need to maintain the historical and architectural integrity of the area. In Florence, Italy, the high concentration of economic activities, the small size of the roads and the high number of tourists most of the year, doesn't allow to place an appropriate number of road bins for the different waste fractions, leading to the installation of underground containers.



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### Optimisation of Separate Waste Collection Using Digital Technologies

As part of the the CityLoops project, the city of Seville developed the OW flow optimisation tool, a digital tool designed to optimise the logistics of bio-waste collection with the aim of rationalising operating costs as much as possible. The data collected from the tool present optimised OW collection routes and future locations where new OW could be placed.



Similarly, the city of Nitra, in Slovakia has implemented IoT technology to enhance their waste management system. By deploying sensors on garbage collection bins, they can monitor the fill levels in real-time. This data is then integrated into their analytics software, enabling the automation and optimisation of waste collection processes throughout the city.

In Bergen, Norway, the city has adopted an innovative waste management platform called WastelQ, developed in collaboration with BIR (Bergen's municipal waste management organization) and the digital startup WastelQ. This system integrates IoT-enabled smart bins,

data analysis, and an incentive system to create a holistic approach. The platform gathers data from various sources, including disposal volumes and fill levels of waste containers, to provide insights and enable customized waste pricing models and individualised payment systems that incentivize waste reduction. Additionally, nudging strategies, such as providing free sorting bins for plastics and cardboard, encourage proper waste sorting. This integrated approach has led to a 10% reduction in general waste levels and a 29% increase in plastics collection, demonstrating its effectiveness in optimising waste management and promoting sustainable practices.

### Toolbox – Optimising bio-waste collection (Seville)

The Bio-waste Flow Optimisation App has two main goals: the identification and selection of potential districts to implement new bio-waste collection routes; and the optimisation of both location of bins and routes. It targets two main categories of users: waste management practitioners and the public. **The app for waste management practitioners combines economic, social, and demographic data with waste data on current waste collection routes.** This allows the app to help the decision-making process on the identification of districts in which to implement new collection schemes, the optimal location of new bins, the optimal design of new collection routes, and the optimisation of current collection routes. It can be used to model possible scenarios for separate

collection of bio-waste based on the data on bio-waste material flows and quality collected in the report described above and develop the optimal collection route. In addition, **the app also contains a tool for citizens, providing them with data about bio-waste collection impact on city/district, bin locations, routes implemented, and benefits for the city.** It is essential to Seville's push to raise awareness about separate collection and communication campaign to encourage producers to sort their waste. The app can be [found here](#). Seville's Demonstration Report will soon be published on this website. That will include an annex with a technical report on the development of the tool, including requirements, functionalities and a list of components.

#### Resources

- [Guide for Municipalities on How Best to Separately Collect Biowaste, Zero Waste Europe \(2022\)](#)
- [Guidance for separate collection of municipal waste, The European Commission \(2020\)](#)
- [Policy Brief on separate waste collection, Interreg Europe \(2020\)](#)

# Sorting and pre-treatment

There are different sorting and treating methods which can be applied to make bio-waste suitable as a feedstock to produce bio-based products, given that the preconditions differ among them (e.g, moisture content, purity level, etc). Bio-waste might need to be cleaned or purified prior to its conversion. Potential contaminants found in bio-waste are plastic, metal, glass paper and sand, particularly in public green space waste. However, depending on the final product and required input feedstock, in some cases organic components may be considered as pollutants, such as leaves and twigs (in grass), twigs (in leaves) and fruits.

The most typical sorting methods to separate bio-waste from other materials and contaminants are:

- **Manual sorting:** People manually separate and segregate waste based on its composition. This method is particularly useful for recovering specific materials or removing contaminants from the waste stream.
- **Mechanical sorting:** Technologies are utilised to separate waste based on physical characteristics such as size, shape and density. Some mechanical sorting techniques that are explored to separate bio-waste effectively are:
  - Sieving and screening
  - Density separation: Including filtration, sink-float separation, hydrocyclone, fluidised moving bed separation, inclined vibration screening, and electrostatic separation.

After bio-waste has been separated from other materials, there are waste compaction techniques that aim to decrease the waste volume and improve treatment efficiency, such as grinding, drying, cutting and pressing.

The **most common challenges** related to bio-waste sorting and pre-treatment are:

- **Bagged waste:** CityLoops cities have reported some challenges related to the processing of bio-waste disposed of in plastics or biodegradable plastic bags mainly due to 1) plastics bags that get stuck in the shredder when wanting to reduce the size of the bio-waste before it is processed for composting or anaerobic digestion, and 2) plastic, but also biodegradable plastic bags can contaminate the bio-waste recycling stream and hinder the quality of the final product or its acceptability given that even biodegradable plastic bags can take longer to degrade than the compost to be produced.
- **Cost considerations:** Implementing effective contaminant removal processes can be costly. Advanced sorting technologies and equipment may require significant upfront investments, maintenance costs, and skilled operators. Moreover, to reduce the environmental impact, electric or hydrogen powered machinery can lead to higher investment costs compared to traditional machinery.
- **Equipment compatibility:** The sorting and pre-treatment equipment must be compatible with the specific characteristics of bio-waste, such as particle size, density, and moisture content. Finding suitable equipment that can effectively handle bio-waste variations can be challenging, and costly.



## What can local authorities do to set up an effective bio-waste sorting and pre-treatment method?

For waste sorting and pre-treatment, local authorities could think of investing in suitable sorting technology. However, it is essential to remember that prevention is better than cure, and **reducing the level of contaminants at the source can lead to fewer problems upstream.**

An important role that local authorities need to take is the role of educators. Therefore, local authorities are encouraged to educate and raise awareness for avoiding the use of plastic bags for collection purposes.

### Examples – Bio-waste Sorting and Pre-Treatment in CityLoops: Apeldoorn and Mikkeli

In Apeldoorn, within the CityLoops project, the leaf sorting and bokashi production included manual litter removal, followed by magnet use to eliminate metal fragments. For biochar production, pruning waste underwent sorting via a vibrating screen, separating small wood particles (<5mm) from larger ones (<15mm) for biochar. In paper production, the sink-float method separated grass from sand effectively, optimising resource use due to water addition in papermaking.



In Mikkeli, bio-waste pre-treatment involved three steps. Bio-waste was crushed for size reduction, ensuring efficient reactor space use. Material streams were mixed for uniformity,

reducing feed fluctuations. Sieving eliminated non-degradable materials, stones, and soil clumps, enhancing biogas production efficiency in the reactor.

### Biodegradable plastic bags please, or no bags at all!" The Cases of Mikkeli, Seville and Porto

In Mikkeli, the city aimed to enhance the collection of bio-waste both in terms of quantity and quality. Many residents were still disposing of bio-waste with mixed waste, and the use of plastic bags hindered the biogas plant's processing. To address this, Xamk and Miksei Mikkeli organised events to distribute compostable bio-waste paper bags and sorting information, leading to successful outcomes. The campaign lowered bio-waste in mixed waste from 35% to 27% and increased separate bio-waste collection to 53%. After CityLoops, improving the sorting of bio-waste will be continued in the regional spin-off project Biovirtaa, and will also be upscaled to a wider area.



In Seville, residents accessing containers received 10-litre aerated buckets and biodegradable plastic bags. In Porto, door-to-door campaigns informed citizens that all bag types were prohibited for bio-waste disposal, improving collection quality but impacting participation.



### Toolbox – Optimising bio-waste collection (Seville)

A list of technologies was created that describes different sorting and treating methods which can be applied to make bio-waste from public spaces suitable as feedstock to produce bio-based products. The technologies were physically assessed in the facilities of Wageningen Food and Bio-based Research. For each of the demonstration cases methods were selected and used either on site in Apeldoorn (Bokashi) or in Wageningen. Treatment options assessed and presented include selectively removing

components and/or drying the material, optimising the bio-waste by mechanical or biological pre-treatment, or tailoring the fibre properties. The technologies listed are suitable to be performed at small scale and minimal impact. It is envisaged that they could be performed in a city/agricultural like environment rather than e.g. at a chemical site.

**The tool can be [downloaded here](#)**

# Valorisation options

Centralised treatment includes various valorisation options, some of them the same as for decentralised treatment, with nonetheless a major difference: their industrial scale. Valorisation options are approaches used to extract value from waste materials by converting them into useful products or maximising their utility in a sustainable manner. These strategies aim to reduce waste, conserve resources, and contribute to a circular economy. Centralised valorisation strategies encompass various techniques, including biological conversion methods such as composting, vermicomposting, anaerobic digestion, and fermentation. These methods produce compost, animal feed, biogas/

biomethane, and bokashi, respectively. Additionally, thermal conversion methods like pyrolysis are employed to produce biochar.

Moreover, in biorefineries, various conversion processes can be utilised within the same facility to produce a wide range of products from multiple biomass feedstocks. These can include biofuels, biochemicals, materials, and energy.

Lastly, the production of higher value-added products includes chemical processes and the blending of organic waste with binding materials to create valuable products.

## Biogas production

Anaerobic digestion produces biogas, which can be refined into biomethane<sup>46</sup> and utilised as a renewable energy source for electricity generation or heat production. It also produces digestate, a nutrient-rich by-product that can be used as a fertiliser. Anaerobic digestion allows for a quicker turnover of waste materials compared to composting and can lead to a higher waste diversion rate, as it can also process other bio-waste streams, like sewage sludge, as demonstrated in Seville.

However, it is typically associated with higher initial investment costs compared to composting. Thus, this technology might be more suitable for cities that are interested in both local energy production and the creation of a nutrient-rich material for use as a soil conditioner. Additionally, this is relevant for cities with larger budgets and access to the necessary technology and expertise for maintaining anaerobic digestion facilities.

### Examples – Biomethane Production for Waste Collection Vehicles and Public Transportation in Mikkeli, Seville and the Capitals Berlin and Prague

The city of Mikkeli started with the production of biogas in the year 2021. The biorefinery treats sewage sludge, bio-waste and agricultural and industrial by-product streams generated in Mikkeli and the surrounding areas. The end-product of biorefining is biomethane processed into transport fuel and fertilisers. At full capacity, the plant can produce around 1,5M m<sup>3</sup> biomethane, which is equivalent to the annual consumption of 2000 passenger cars.



Moreover, the city of Sevilla has produced biomethane from bio-waste in co-digestion with sludge in a WWTP, as an alternative to the current collection and transportation of bio-waste for composting. The capacity of the biodigester is 200kg. The studies carried out for this demonstration action showed that as the amount of bio-waste co-digested increases, so does the production of biomethane. In fact, the production of biogas is the highest when the feedstock is 100% bio-waste.

or diesel) used in collection vehicles, and as an alternative to composting. Consequently, the city is less subject to fuel prices and minimises the amount of open composting that is necessary. At the same time, it saves 9000 tonnes of CO<sub>2</sub> emissions annually while generating biogas that is not in competition with food production over land and resource use.

In the **Ruhleben district of Berlin**, 70,000 tonnes of bio-waste are processed through anaerobic digestion into biofuel that powers the city's collection vehicles. In this way, the city can substitute the consumption of fossil fuel (i.e., gas

Similarly, **Prague**, the first Czech city implementing bio-waste separate collection, is converting the collected food waste into biogas to power waste management trucks. Any surplus energy generated is seamlessly fed back into the grid, while excess waste is repurposed as fertiliser for nearby agricultural use.

### Enhancing Self-Sufficiency of a wastewater treatment plant through Local Energy Production

The energy needs (electricity and heat) needed to run **Dél-pest Wastewater Treatment Plant in Budapest** are generated in house through the treatment of collected sewage sludge and food waste. The city of Budapest is currently evaluating the viability of processing collected bio-waste to further augment local energy production for local usage.



© unsplash.com / Juho Luomala

Similarly the VEAS facility a wastewater treatment plant, located south of Oslo also valorises sewage sludge into biofertilizers and soil improvers whilst also producing biogas for energy production, which accounts for 50 percent of **VEAS's electricity** consumption, in addition to using the heat from production to heat up the plant.

**Gryaab, in the city of Gothenburg**, functions as a wastewater treatment facility that utilises digestion to convert sludge into biogas. To maximise biogas production, Gryaab collects grease and food waste from local restaurants, schools, and food producers in the region. The generated gas is then used for local vehicle fuel.

**In Turku, Finland**, prior to 2009, wastewater was collected separately, but the capture of nutrients was inefficient. As a result, the marine area of Turku was contaminated with phosphorus and nitrogen, adversely impacting the river and drinking water quality. To address this issue, the city began processing sludge from wastewater treatment through anaerobic digestion. This process not only produces biogas for transportation and agricultural applications, reducing reliance on fertilisers, but also helps improve the marine and water quality concerns that had previously affected the region.

### Biogas Production in Mikkeli and Tested Optimisation Techniques

The BioSairila biogas plant in Mikkeli has been operational since 2021 and currently produces approximately 1.5 Mm<sup>3</sup> (1000 tons, 15 GWh) of traffic biofuel. This output is equivalent to the annual consumption of approximately 2000 passenger cars.



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As part of the CityLoops project, Xamk collaborated with local companies to explore new treatment and final product optimization techniques. These efforts spanned both laboratory and pilot-scale testing with the goal of optimizing biogas production and assessing enhancements to fertilizer properties. Biochar was employed for these purposes.

The results have indicated that the incorporation of biochar into the biogas process effectively mitigated the effects of harmful or inhibiting materials and improved the overall quality of biogas. Additionally, it was found that the properties of the digestate could be enhanced through this process. However, it should be noted that both the quantity and quality of the biochar used are crucial factors in achieving these outcomes.

#### Resources

- [Manual for National Biomethane Strategies in the EU-27, Gas for Climate \(2022\)](#)
- [Biomethane Production and Grid Injection: German Experiences, Policies, Business Models and Standard, Energypartnership \(2020\)](#)
- [Categorisation of European Biogas Technologies, Digital Global Biogas Cooperation \(2021\)](#)

## Industrial composting

Composting yields nutrient-rich soil amendments that find applications in landscaping, agriculture, and gardening. Furthermore, composting demands less specialised infrastructure, technology, and incurs lower initial investment and maintenance costs compared to anaerobic digestion.

Consequently, industrial composting emerges as an attractive option. In summary, composting proves to be an optimal solution for cities aspiring to generate valuable soil amendments for local agricultural and landscaping requirements, particularly for those operating on tighter budgets.

### Examples – Nutrient Recycling for Municipal Parks and Gardens in Porto and Izmit

Out of the total bio-waste generated in Porto, 24% is collected separately and composted at a centralised facility. The compost produced at the plant is partially used for gardening practices and is also integrated into the Green Space Certification System initiative. This initiative awards certificates to green spaces that adopt sustainable practices, including the reuse of compost generated from bio-waste to enrich urban soil. This practice enhances urban soil quality, returning valuable nutrients to the environment.



LIPOR Composting Plant, © 2023 Lipor - All rights reserved

Additionally, in the city of Izmit, Turkey, the municipality has implemented a green waste composting program. This program involves the separate collection of green waste from the region, which is then utilised to produce compost. In the Durhasan Neighbourhood, for instance, tree branches collected during the maintenance

of local parks and gardens are converted into compost fertiliser. The resulting compost serves as a valuable soil enhancer, benefiting the Municipality's parks and gardens. This practice ensures the creation of sustainable and nutrient-rich soil, contributing to the thriving green spaces within the community.

#### Resources

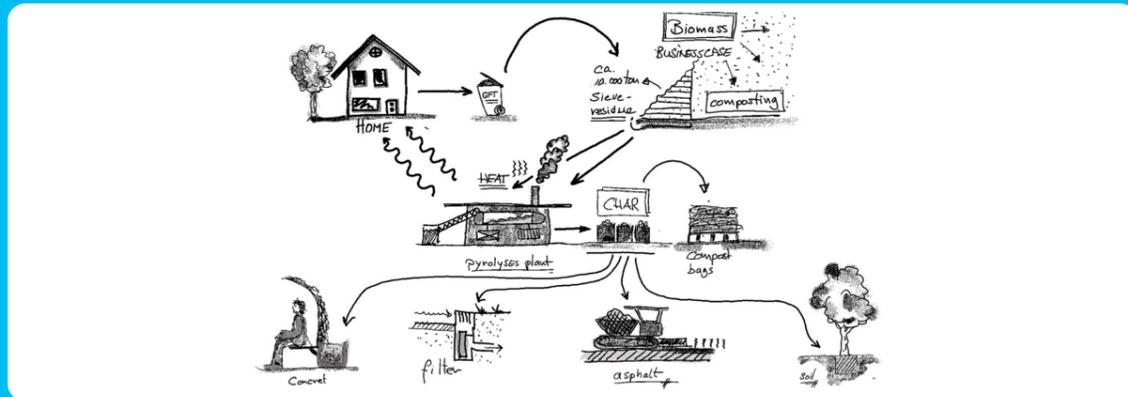
- [European Compost Network](#)
- [Community Composting: A Practical Guide for Local Management of Biowaste, Zero Waste Europe \(2019\)](#)
- [Composting 101 Video, An Taisce Biodiversity Week 2022](#)

## Bokashi

Bokashi is an alternative to traditional composting. It relies on a fermentation process that converts bio-waste into a soil amendment which adds nutrients to the soil and improves soil texture.

Therefore, it is a more suitable solution for cities with green spaces that want to take action to improve the quality of their soil, and by doing so promote healthy growth of greenery.

### Examples - Bokashi production in the cities of Apeldoorn in the Netherlands and in Saint-Omer in France



As part of the CityLoops project, the city of Apeldoorn produces bokashi from leaves collected from municipal green spaces. Bokashi is high in nutrients and has a positive effect on the soil quality, moisture management, carbon storage and plant growth. Two pilot areas were selected, namely the Filosofen park and the Prinsen park on which the effects of the application of bokashi were tested. The results show that the produced bokashi contains more organic materials (45%-50%) than locally produced compost (32%) and certified produced compost (26%). Moreover, bokashi contains comparable amounts of macronutrients while meeting the amounts of heavy metals and arsenic legally acceptable for certified compost. Furthermore, incorporating bokashi into the soil of the demo sites showed positive effects in the amount of organic material, water-retaining capacity, soil life (fungi and bacteria), among others.

However, the application of bokashi leads to unpleasant odours in the parks, as brought to the attention of concerned residents. Therefore,

the timing for spreading bokashi is key. When it is dry, the smell is more intense than when it rains. Therefore, spreading it when it rains is recommended.

In France, the municipality of Saint-Omer is the first municipality in France that has chosen the bokashi composting method to manage their bio-waste. These individual composters ensure airtight conditions that are essential for the bokashi fermentation process to take place. The fermentation process converts the waste into the bokashi cake and bokashi liquid. These nutrient-rich by-products serve as a solid foundation for organic gardening and farming practices.

To incentivize the implementation of this solution, the officials of Saint-Omer offered to finance 75% of the price of the bokashi composting bins for every household that was interested. Additionally, they set in place three designated spots where citizens can dispose of their bokashi mass for their use by gardeners and farmers, in case they are not interested in using it themselves.

#### Resources

→ [A Guide to EM Bokashi, Marlborough District Council \(2022\)](#)

#### Example of a Local Authority encouraging bokashi use amongst citizens:

→ [City of Onkaparinga provides 50% subsidy to local citizens purchasing bokashi buckets](#)

## Biochar

Obtained by pyrolysis, biochar can be utilised for various purposes, including soil enhancement, carbon sequestration, water filtration, livestock bedding, compost enrichment, urban green infrastructure, aquaculture improvement, energy generation, crop residue management, bioremediation, horticulture and gardening, and even as a potential livestock feed additive. Therefore, the production of biochar could be particularly suitable for cities:

- Seeking to enhance soil fertility.
- With agricultural regions aiming to improve crop yields, nutrient availability, and water use efficiency.
- With available green spaces where biochar can be applied to enhance soil structure and nutrient retention.
- That aim to improve the environmental impact of constructing urban infrastructure, as biochar can be integrated into asphalt and concrete.

### Examples - Use of Biochar for Rainwater Treatment and Biogas Production Optimization, the Cases of Apeldoorn and Mikkeli



In the city of Apeldoorn, an unconventional biochar-based treatment system has been implemented for rainwater. This system functions as a pre-soil adoption filtration method, effectively purifying the water before it permeates into the soil. Although the demonstration is currently in progress, conclusive results have not yet been attained for dissemination.

In the case of Mikkeli, while the city did not pilot the production of biochar within CityLoops, they

conducted pioneering experiments to assess how biochar could enhance the biogas production process. Biochar proved effective in mitigating the adverse effects of inhibiting materials and enhancing biogas quality. However, it's crucial to carefully optimise the quantity of biochar added, as exceeding 1% in the biogas process can disrupt it. These findings were highly relevant, considering that there is no evidence that this topic had not been researched in Finland previously.

### Biochar Production from Green Waste in Freiburg, Germany and Stockholm, Sweden

The city of **Freiburg** is committed to effectively recycling the annual 12,000 tonnes of green waste generated from both public and private lands within the region, prioritising material and nutrient recovery. While the majority of the green waste undergoes processing to produce high-quality compost, the woody part is transformed into biochar. The resulting product is suitable for its utilisation as a feed additive or as an enhancer for soil quality improvement.



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In **Stockholm**, garden and park waste are collected and stored in various waste management facilities across Stockholm. Once consolidated at these sites, the waste undergoes a carbonisation procedure to transform it into biochar. As a secondary outcome of this biochar creation process, pyrolysis gas is harnessed to generate energy for the district heating system of the city.

Moreover, when depositing garden waste at these management centres, residents have the opportunity to acquire biochar for application in their own gardens. Additionally, the product is marketed to neighbouring municipalities, enabling them to nurture plants and trees in the city's parks and communal spaces.

### Biochar Production from Sewage Sludge in the City of Crete, Greece

As part of the WaysUp! project, the **city of Crete in Greece**, executed a pilot project at the Technical University of Crete. Here, sewage sludge from the Municipal Enterprise for Water and Sewage of Chania served as the feedstock, along with wood chips and pruning as bulking agents. Excess heat was recirculated to the drying unit. The outcomes included biochar and a nutrient-rich concentrate. The resulting biochar improves soil quality and fertilisation in agriculture.



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### Biochar Production from Green Waste in Freiburg, Germany and Stockholm, Sweden

Escalating energy demand and raw material costs (e.g., for timber production), prompted local actors to explore eco-friendly technologies, material reuse, and waste reduction. In 2021, a **Centru Region** family enterprise started producing biochar from wood waste from local and regional forest, processing a total of 12.850 tonnes per year of waste. The output includes biochar and diverse bio-innovative secondary products (e.g., wood vinegar, wood oil, and cellulosic alcohol) with versatile applications, particularly as pesticides and fertilisers in agriculture. This approach not only mitigates CO<sub>2</sub> emissions and conserves energy but also enhances farming productivity for organic and bio-farmers while valorizing agricultural bio-based goods.



Explocom GK Ltd. financed by Innovation Norway with the project of Circular Economy Based Biochar Production in Romania (CEBAR)

#### Resources

- [Bringing Biochar to your City Lessons from the Stockholm Biochar Project, Nordregio \(2018\)](#)
- [European Biochar Certificate – Guidelines for a Sustainable Production of Biochar, EBC \(2012, as amended\)](#)

## Higher value-added products

Although more costly than other solutions discussed in this section, bio-waste recycling offers the potential for producing higher added value products, such as bioplastics, biofibers, enzymes, bio-chemicals, oils, among others. Not only does the production of these products often require advanced technologies and processes, but it might also require the use of specific biomass streams. For instance, coffee grounds can be used for the production of coffee-oil in **beauty and hygiene products**, by-products from sugar cane or corn starch processing that can be used for the production of **bio-fibres** used in textiles, and the whisky production waste can be used in the production of **bio-chemicals**. These valuable products find applications in diverse industries, including cosmetics, pharmaceuticals, biomaterials, and food production.

Biorefineries play a significant role in the production of high-value added products. A biorefinery is a facility that integrates various biological and

chemical processes to convert different bio-waste streams into valuable products, including biofuels, biochemicals, biomaterials, and more. Biorefineries typically consist of several interconnected processing units, each optimised for specific types of biomass and desired products.

Compared to the other valorisation options and their resulting products, producing high-value end production from bio-waste, might be more beneficial for cities:

- Looking to generate revenue and create new economic opportunities that have market demand and can command higher prices
- With a focus on resource recovery, such as the extraction of valuable compounds, nutrients or other high-value materials. That are at the forefront of innovation and equipped with advanced technologies.

### Examples – Transforming Municipal Bio-waste into Valuable Products; Biorefineries in Spain and Italy

As part of the **CIRCULAR BIOCARBON** project, two biorefineries will be piloted in the cities of Zaragoza, in Spain, and Sesto San Giovanni, in Italy, with the aim to valorise municipal bio-waste and sewage sludge into added-value end products, such as biodegradable and compostable waste bags, coating products, biofertilizers, and liquid bio-stimulants, among others.

This transition yields marketable end-products, replacing fossil-based goods and reducing non-renewable resource reliance. The evolution of city waste plants into biorefineries generates fresh income streams from waste collection and management, while catalysing opportunities for bio-based sector stakeholders.



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### Advancing Sustainable Biofuel Production from Waste Streams in L'Alcúdia, Spain

A pilot project is set to take place in **L'Alcúdia**, Spain, at the PERSEO biotechnological demonstration plant. The project aims to utilise cellulosic rejection streams from waste and wastewater treatment plants in the Barcelona Metropolitan Area to produce bioethanol. The PERSEO plant has the capacity to process 25 tonnes of feedstock per day. PERSEO, in collaboration with CIEMAT, has developed a patented bio-technological technology known

as PERSEO Bioethanol®, which enables the production of second-generation bioethanol from the organic fraction of municipal solid waste (MSW). The semi-industrial plant includes various units such as pre-treatment, fermentation, solid-liquid separation, distillation, storage, effluent treatment, and a control system. Additionally, a portion of the produced ethanol will be upgraded to ethyl lactate using reactive distillation by Tbio-waster.

### Innovative Approach in Valencia for Recycling Food

In the context of the WaysTUP!, Agricultores de la Vega (SAV), in the city of Valencia, conducted a pilot to address food recycling. SAV's facilities in Paiporta will be used for this purpose, where meat by-products, fish by-products, and spent coffee grounds provided by SAV will be processed. The team aims to process 52,000 tonnes of waste per year. The project will involve utilising spent coffee grounds for flavour, polyphenol, and oil extraction, as well as fermenting carotenoids. Functional ingredients such as active peptides



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and enzymes will be produced from animal by-products. The pilot will also focus on gelatin and active peptide extraction.

### Japanese Knotweed into 3D Printing Filament

In the CityLoops project, the city of Apeldoorn used bio-waste of the highly invasive plant Japanese Knotweed, mixed with a PLA matrix to produce the filament that is used for 3D printing. In the demonstration action, the municipality of Apeldoorn worked together with interested entrepreneurs to produce final products. The municipality itself will use this material to produce ornamental objects and street furniture.



### Coffee Ground into Bioplastics

As part of the WaysTUP! project, in the city of London, the sustainable production of coffee oil was demonstrated by revalorizing this

raw material for the production of bio-polymers (PHA) for the creation of new plastics.



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### Resources

- [Materiom](#) - provides a large catalogue of high-value added products from organic residues
- [D1.3 Catalogue of urban biowaste solutions and good practices examples, Horizon 2020 WaysTUP!](#)
- [Global biorefinery status report 2022, IEA Bioenergy \(2022\)](#)
- [Biorefineries Roadmap: as part of the German Federal Government action plans for the material and energetic utilisation of renewable raw materials, The German Federal Government](#)

# Enabling the transition to circular bio-waste management

The shift toward circularity represents a profound systemic change. While implementing circular solutions is essential, it alone is not sufficient. It is made possible by a series of enabling and cross-cutting actions, that are:

1. Strategy development
2. Cross-department collaboration & political support
3. Stakeholder engagement
4. Awareness raising
5. Data and assessment
6. Innovation
7. Capacity building
8. Financing
9. Circular public procurement

Rather than prescribing when each of these actions should take place (as it is often the case in guidance documents), we prefer to highlight the fact that they should all be taken into consideration **before, during and after** any project, and more largely at any moment in time during the circular transition. For each action, we provide general recommendations alongside examples and lessons learnt from CityLoops and other projects.

## 1. Strategy development

More and more cities and towns across Europe are developing strategies and roadmaps to steer the circular transition<sup>47</sup>. A strategy provides a **direction of travel, sets targets at short, medium and long term, and prioritises actions and projects**. It can be crucial in ensuring cross-departmental collaboration across often large and complex public organisations.

In this regard, **policy coherence** is crucial by ensuring that different policies and initiatives work together in a coordinated manner to achieve common goals. When it comes to setting a vision for the bio-waste sector, various sectors are involved, such as waste management, agriculture, energy, among others. Policy coherence helps align these sectors and their respective policies to create a holistic and integrated vision. Indeed, associating vital stakeholders to its development can help set ambitions, identify opportunities and challenges, while also creating a sense of shared ownership<sup>48</sup>. Strategies can be city-wide or sector-specific: bio-waste can either be included within a comprehensive circular economy strategy or have a dedicated roadmap. Mikkeli has for example adopted a City Strategy for the years 2022-2025 with the circular economy as one of its key priorities, with clear targets in relation to bio-waste management. The strategy contributes to the long-term goal of achieving climate neutrality by 2030<sup>49</sup>, while mentioning Mikkeli's international commitments, such as the Circular Cities Declaration. Likewise, the Roadmap for a Circular Porto is strongly connected to the municipality's Climate Pact<sup>50</sup>.

The backcasting method is a valuable approach for **formulating a strategy**. This technique involves imagining a future scenario and then working backward to determine the necessary actions and steps to attain that objective. When applied to the circular transition of the bio-waste sector, backcasting can assist in identifying and preparing for sustainable waste management practices, optimising resources, and promoting circularity throughout the bio-waste industry.

The steps that can be taken to develop a circular city strategy are the following<sup>51</sup>:

- 1) Define the relevant stakeholders that should be involved in the process
- 2) Assess the baseline or starting point of the city
- 3) Define the focus area
- 4) Define a vision around a circular future
- 5) Define the actions that need to be taken to reach the defined goals
- 6) Establish a governance mechanism that will support this transition
- 7) Define a monitoring and evaluation frameworks
- 8) Identify ways to finance the circular economy
- 9) Structure and compile the strategy

<sup>47</sup> Circular Cities Declaration. (2023). Circular Cities Declaration Report 2022. ICLEI – Local Governments for Sustainability, European Secretariat, p. 12.

<sup>48</sup> Ellen MacArthur Foundation. (2019). Circular economy in cities: Policy levers. Retrieved from <https://ellenmacarthurfoundation.org/policy-levers>

<sup>49</sup> Mikkeli. (2021). Strategiset Toimenpideohjelmat 2022-2023. Mikkeli.

<sup>50</sup> Lorena, A., Santos, E., Palha, M. R., & Santos, S. (2017). Roadmap para a cidade do Porto circular em 2030. Departamento Municipal de Planeamento e Gestão Ambiental, Câmara Municipal do Porto.

<sup>51</sup> European Investment Bank. (2022). Towards European Circular Cities: A Guide for Developing a Circular City Strategy.

### Examples – A Strong Status Quo Analysis for Drafting a Circular Strategy in Amsterdam<sup>53</sup>

The strategy produced by the City of Amsterdam exemplifies the use of quantitative and qualitative data to guide the circular economy focus area. The document followed a methodological approach and incorporated feedback loops to validate data-driven analysis results. The steps taken by the city were the following:



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- In October 2015, the Municipality of Amsterdam collaborated with Circle Economy and Fabric TNO to create a circular economy vision based on quantitative insights.
- They introduced the City Circle Scan (CCS), a step-by-step process to identify crucial circular economy stages within value chains and identify areas for transition.
- The CCS involved evaluating circularity across 30 sectors within the Amsterdam Metropolitan Area, using four primary indicators and associated quantitative or qualitative sub-indicators.
- Sectors were evaluated within broader economic value chains, and these chains were ranked qualitatively based on their impact and potential.
- The top 10 value chains were identified, and through consultation with local stakeholders, the construction chain and organic residuals chain were selected for focused development.
- The city initiated two programs – Learning by Doing and Circular Innovation Programme – to practically explore circularity approaches city-wide.
- These programs paved the way for the drafting of the “Amsterdam Circular 2020-2025 Strategy” in 2019.
- The strategy introduced three core focus areas: the construction value chain, the organic value chain, and the consumer goods value chain.

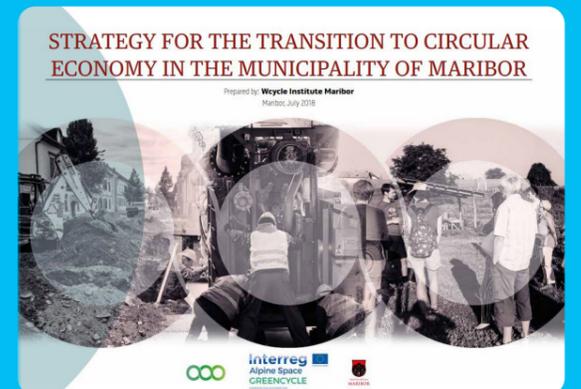
### Collaboration as a Key Element in Defining Maribor’s Circular Strategy<sup>54</sup>

The ‘Strategy for the Transition to Circular Economy in the Municipality of Maribor’ (2018) focuses on municipal utility and service providers as central actors for the city’s circular economy shift, facilitated by established inter-agency collaboration.

Involving key stakeholders and especially municipal and utilities companies has been instrumental in the successful development of the strategy.

Maribor’s strategy outlines seven key “strategic project areas” where public service providers can define interventions:

- Municipal waste services
- Incorporating processed soil and construction waste in urban buildings
- Managing surplus heat and renewable energy
- Promoting sustainable mobility and urban transport
- Reusing recycled water and alternative water resources



- Implementing sustainable land management and regenerating degraded areas
- Establishing a cooperative economy network

Each project area is accompanied by specific activities, primarily managed by public companies. Activities range from administrative changes (unifying fleet requirements for easier repair) to long-term projects like adapting water networks for recycled water.

#### Resources

- [A Guide for Developing a Circular City Strategy](#), Circle Economy (2022)
- [How to Develop a Circular City Strategy: Webinar](#), European Investment Bank (2022)
- [A Practical Approach to Develop a City Roadmap Focusing on Utilities](#), Circular Cities (2019)
- Further examples of circular cities strategies can be found across the world:
  - [Richmond](#), US
  - [Turku](#), Finland
  - [Toronto](#), Canada
  - [Prague](#), Czech Republic
  - [Andalusia](#), Spain

<sup>53</sup> Gemeente Amsterdam. (2020). Amsterdam Circular 2020-2025 Strategy.

<sup>54</sup> JASPERS. (2022). Developing Circular Economy Strategies in Europe — Best Practices.

<sup>55</sup> Wcycle Institute Maribor. (2018). Strategy for the Transition to Circular Economy in the Municipality of Maribor.

## 2. Cross-departmental collaboration & political support

Different departments have a role in making bio-waste management more circular within municipal administrations, as demonstrated in the introduction of this handbook. Moreover, waste management is often carried out by municipal companies which, albeit municipally controlled, remain distinct organisations. In this context, effective coordination across different teams, departments and municipal organisations is vital for addressing shared circular economy challenges, ensuring alignment of objectives, and avoiding information gaps. To facilitate this coordination, local authorities should consider the following:

- A dedicated person should be appointed for managing the transition to circularity in the bio-waste sector.
- Setting up ad hoc coordination bodies, such as committees, agencies, or working groups, to facilitate collaboration and decision-making across teams and departments.
- Ad hoc meetings can be organised to foster coordination between departments and municipal organisations to exchange ideas and coordinate circular economy initiatives.
- Joint projects focused on the circular economy can bring different departments together, enabling collective efforts toward sustainable goals.
- Shared databases and information systems provide a common platform for data exchange, enhancing cooperation and data-driven decision-making.

In addition to cross-departmental collaboration, **political support** is crucial for the implementation of circular projects. Strong political backing enhances the likelihood of securing necessary funding and resources, bolsters the legitimacy and credibility of the project, and is vital for overcoming resistance from stakeholders and addressing obstacles – such as regulations or legislation – that might impede adoption.

Finally, coordination with other levels of government and other public entities (i.e. vertical governance) would also enable the transition to a circular economy.

### Example – In Porto, High Political Support Makes the Difference

Implementation of Demonstration Actions in Porto benefited from a strong support from the council, with direct involvement of Porto's Vice Mayor who significantly facilitated the coordination between local entities involved: the municipality itself, Porto Ambiente (the agency in charge of environmental services) and LIPOR (the metropolitan waste management authority). Furthermore, the Vice Mayor's physical presence and active engagement in specific events demonstrated tangible support for the implemented activities, effectively underscoring the city's commitment to these initiatives. Among these activities were:

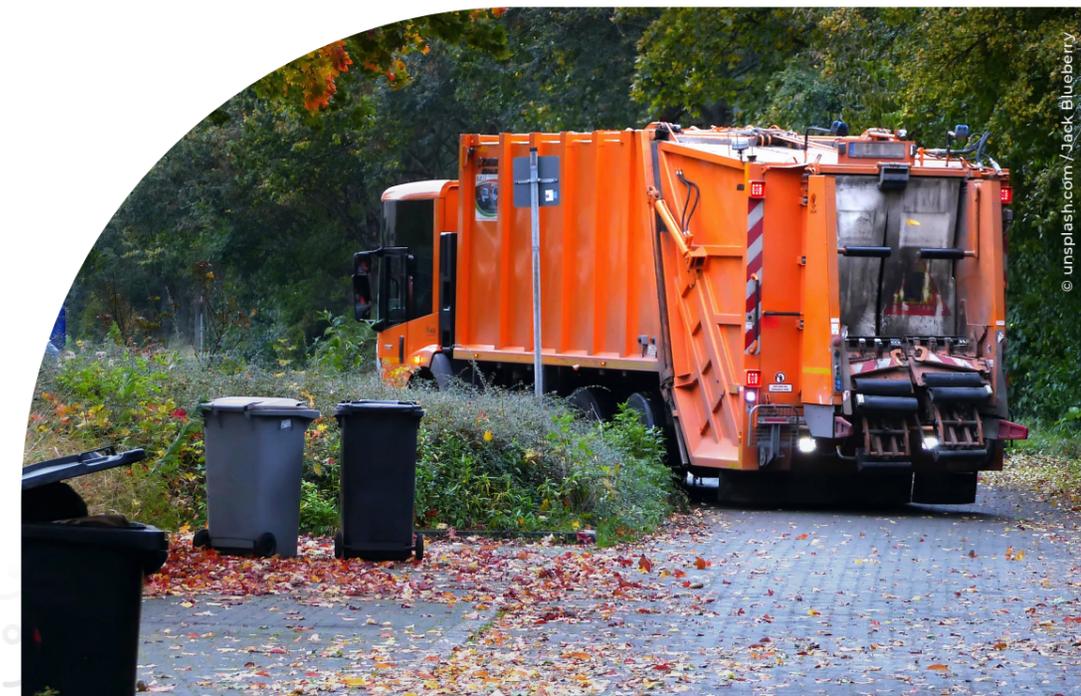


- An event where local residents were invited to participate in sharing the initial compost produced through the two community composting sites established as a component of the CityLoops project.
- The launch of a mentorship program within the context of the Circular Entrepreneurship Initiative, symbolising Porto's dedication to fostering circular business practices.

By actively participating in these events, the Vice Mayor reinforced the city's involvement and enthusiasm for the project's goals, fostering community engagement and showcasing Porto's dedication to sustainable initiatives. Nevertheless, the effective collaboration among the municipality, Porto Ambiente, and LIPOR was what was crucial in the execution of Porto's CityLoops actions.

### Resources

- [Working Together: A toolkit for campaigns collaboration across the public sector](#), UK Government Communication Service (2016)
- [Circular City Governance A first guide for policy makers](#), Vlaanderen-Circulair (2020)



### 3. Stakeholder engagement

System change can only be achieved when all actors work hand-in-hand<sup>56</sup>, and this applies to bio-waste, as plenty of stakeholders are involved in the bio-waste lifecycle (e.g. generating food waste) and could potentially play a role in preventing bio-waste and valorising it. To harness this potential, effective stakeholder engagement is crucial.

It involves identifying relevant stakeholders, building relationships, fostering trust, and working together to co-create solutions and address challenges. In the bio-waste sector, these stakeholders can include governments entities at different levels, waste management companies, waste producers (including citizens), as well as academia, NGOs and environmental groups promoting circular economy principles, among others.

Local and regional governments can facilitate collaboration among public, private, and non-profit actors to combine resources and expertise to address a shared project or challenge. Some consideration for successful stakeholder engagement for municipalities are the following:

- Starting by **defining clear objectives** for stakeholder engagement effort is crucial. It is important that municipalities understand what they aim to achieve and how involving stakeholders will contribute to that. Additionally, **relationships** with stakeholders should be **built over time**, and not just during specific projects. It fosters trust and encourages ongoing collaboration.
- Ensuring stakeholder viewpoints are integrated into the planning and decision-making stages of a project necessitates **early engagement** in its lifecycle. This will consequently foster a sense of ownership and shared responsibility. Crucial to this process is the **identification and prioritisation of stakeholders** who are directly affected by or have a vested interest in the project or issue at hand.
- **Tailored communication** strategies for different stakeholder groups are crucial. Their interests, needs, and preferred channels of communication should be considered. Examples of this are provided in the Awareness raising sub-section.

#### Examples – Plan together, achieve together in Seville and Ljubljana<sup>57</sup>:

The following steps were taken by the city of Seville for mapping and engaging with different actor groups:

- 1) Value chain approach was adopted to identify the most relevant activities within the value chain, where stakeholder involvement was necessary.
- 2) Stakeholders were identified that carry out the identified activities of the value chain.
- 3) A list of relevant organisations was prepared and contacted by phone. During these phone interviews, several additional stakeholders were identified through snowball sampling.
- 4) An in-person meeting was organised to get everyone's input for the elaboration of a Preliminary Diagnosis Report.
- 5) Additional information on the legal framework, available resources and waste streams was gathered and used to draft the report.
- 6) The Preliminary Diagnosis report concluded with a proposal of general lines of action, outlining the demonstrations, actions, activities and instruments that were going to be carried out by the city of Seville.



On the other hand, the city of Ljubljana prepared its Circular Economy Strategy including over 80 different stakeholders from all city-departments, public institutions and public companies. The strategy has four main priorities, one of them being on food loss and waste.

The circular transition taking place in Ljubljana is distinguished by its ability to embrace a wide range of proposals put forth by various stakeholders, and then effectively integrate them into its strategic development projects. This inclusive approach ensures that these proposals are translated into tangible action plans, bringing about real-world results.

<sup>56</sup> Ellen MacArthur Foundation. (2019). Circular economy in cities: Policy levers.

<sup>57</sup> Circular Cities Declaration. (2023). Circular Cities Declaration Report 2022. ICLEI - Local Governments for Sustainability, European Secretariat.

### Mikkeli: Teamwork Makes the Dreamwork

For the planning and implementation of each demonstration action, a stakeholder group was established in Mikkeli. For demonstration action 1, the Bio-waste and the Collection and Sorting stakeholder groups were established:

→ The Bio-waste stakeholder group consists of waste management companies and municipal bodies, and the citizens of the demonstration area. Meetings took place regularly among the actors. In these meetings, the progress of the demonstration activities were examined, results presented, and optimization adjustment were discussed.

→ Collection and Sorting stakeholder group consists of organisations directly involved in the respective operations, namely Mikalo Ltd (municipal housing company) and Metsäsairila (municipal waste management company). This group analysed different collection and sorting models, as they were ultimately responsible for operationalising future activities across the city. A workshop was carried out to find out the barriers that influence poor bio-waste collection.

The main conclusions were considered in the activities carried out for the implementation of the demonstration actions. For example, in the workshop a lack of information and motivation



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was identified as one of the main obstacles of separate bio-waste collection as well as the low impact of conventional information campaigns. As a result, bio-waste collection was promoted through fun games for the families at a local festival.

For demonstration action 2, the New Treatment and Final Product stakeholder group was established consisting of Metsäsairila Ltd, Biosairila (biogas plant) and Etelä-Savon Energia (energy company). Given that this stakeholder group has an operative role in managing and treating the bio-waste in Mikkeli region, the group helped and gave practical guidance to coordinate and facilitate the demonstration actions.

### Toolbox – Optimising bio-waste collection (Seville)

Recognizing stakeholders, comprehending their relationships, and seamlessly incorporating them into a development process necessitates the use of methodologies. This need arises because stakeholder engagement processes are often iterative and recurrent, and stakeholders can play various roles at different stages of project development and implementation.

The primary objective of this document is twofold: firstly, to conduct a literature review of existing methodologies for stakeholder identification, and secondly, to provide a practical guide. This guide is intended to aid cities in the planning, facilitation, and analysis of stakeholder-oriented processes within the context of urban development.

The guidance can be found [here](#)

### Resources

- [National Action Manual for local uptake: Italy – Running a Biowaste, SCALIBUR](#)
- [Biowaste Club concept, CSCP](#)
- [Engaging Stakeholders Video Presentation, URBACT \(2020\)](#)
- [How to engage stakeholders for powerful and inclusive climate action planning, C40 \(2023\)](#)

## 4. Awareness-raising

Awareness-raising is crucial to support the transition to a circular economy at the local level<sup>58</sup>, and the bio-waste stream is no exception. Local authorities have a vital role to play in this regard, towards citizens, but also businesses and any other relevant actors. Raising awareness can contribute to breaking down cultural barriers and changing behaviours, while enhancing trust and creating a sense of a shared ownership for the circular transition. Main activities that municipalities can undertake:

→ First, local authorities should **inform about local strategies and initiatives** related to the circular economy. For instance, information about collection dates, where collection points are located, instructions for sorting bio-waste or information on how bio-waste is valorised should all be easily accessible. It can be on the municipality's or on a dedicated website, or even through an application, as in Seville, where residents can locate the closest bio-waste containers<sup>59</sup>. Contact points, whether in-person, via a hotline or a community manager further help to inform end-users.

→ Additionally, **hosting or supporting events** is an excellent way for local authorities to raise awareness, once again to inform but more importantly to answer questions and interact with end-users. Participation in institutional events such as the European Sustainable Development Week and organisations such as schools or companies, enables outreach to specific audiences, while being present during municipal festivities and open-air events makes it possible to connect with the wider public.

→ **Communication campaigns** are another way to raise-awareness, particularly relevant when starting up new initiatives, for instance with the launch of a new collection scheme. Through different communication channels (local journal, flyers, social media...), clear and adequate messaging, and effective timing (e.g. before, during and after the launch), a communication campaign can really foster support for such initiatives and ensure participation over time.

→ **Mapping and sharing information on local initiatives**, for instance on community-led composting points or on food redistribution platforms, allows to create connections between actors, to join forces and to contribute to close material loops, such as the Made In Seine-Saint-Denis platform<sup>60</sup>, which lists a number of initiatives, including urban gardens, community-supported agriculture subscription schemes, food donation associations...

→ **Showcasing and celebrating achievements**, as well as communicating on on-going projects and potential failures – in a word being transparent – enhances trust and ensures a long-term adhesion to the circular transition. Documenting and communicating regularly on municipality-led projects also allows to share knowledge and experience with other local authorities.

Awareness-raising will be the most efficient when carried out in an ongoing manner, before, during and after any project.

<sup>58</sup> Ellen MacArthur Foundation. (2019). *Circular economy in cities: Policy levers*, pp. 16-17.

<sup>59</sup> CityLoops. (2023). *City Simulation Platform*.

<sup>60</sup> Seine-Saint-Denis. (2020). *Made In Seine-Saint-Denis*.

### Examples – Targeted Communication to Foster Citizen Engagement and Collaboration in Porto

The city of Porto conducted awareness-raising campaigns through door-to-door and street outreach in order to engage citizens to take part in community composting and selective collection of food waste. This approach provided a valuable opportunity for campaign promoters to gather specific knowledge from potential users while also bringing citizens closer to the entities responsible for improving the waste management system.

More largely, providing regular updates via email and close interaction with on-ground activities can help all stakeholders feel valued and invested in the process, a key factor in achieving success. For instance, if no communication occurs with any contributing entity after its attendance to an event, people may feel used and not valued, breaking trust and commitment from all sides.



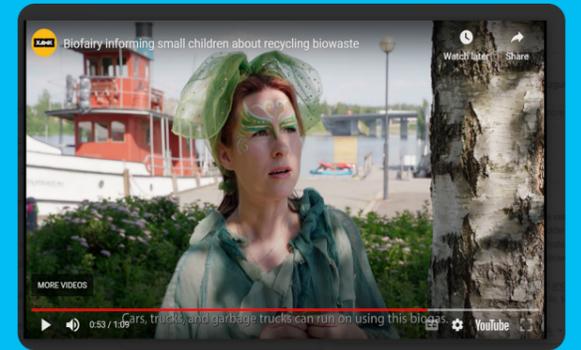
### Celebrating Achievements: the Case of Porto

As part of the CityLoops project, the city of Porto expressed gratitude to its residents for their collaboration, commitment, and contributions to the community composting project. Porto did this by organising events and actively involving them in the composting process. For instance, the city shared the first compost produced with the residents of the neighbourhood where the composting facility was located, fostering a sense of community engagement and ownership.



### Mikkeli & Seville: Inclusive communication strategies

To raise awareness among citizens, the city of Mikkeli planned events tailored to different age groups, such as children, adults, and the elderly. For example, to engage with children, games and **a bio-fairy mascot** were used to simplify the communication on separate bio-waste collection and the production of biogas. Moreover, children were given the opportunity to visit a waste truck and learn about the waste collection system during a large children's carnival event, which was well received by both children and parents.



To reach out to young adults, a presentation was held by the city of Mikkeli together with Metsäsairila Ltd. in Aalto University on the recycling of materials in Finland. Also, the participation in a yearly recycling event for the youth helped to reach out more widely to this audience.

To engage with adults, events were organised at malls in the format of a pop-up event, in the context of the "Circular economy days". Here, the bio-waste topic was presented by Mikkeli's CityLoops representatives.

Similarly, in the city of Seville, an awareness raising campaign has also been expanded to children with the aim of educating the younger

members of the community about how the separate collection system works, its benefits and positive environmental impact. To do so, information points were set up with monitors where relevant information was presented. Moreover, waste kits were distributed to the students. A total of 20 schools in Sevilla participated in the campaign, called "Ecochef". In addition, other communication strategies that the city carried out to reach out to residents were: mailing informative brochures to households, placing informative posters in residential areas (e.g., bus stops, entrances of buildings, commercial establishments), and additional information points in different locations including public areas, food markets and supermarkets, as well as digital marketing campaigns and door-to-door communication.

### Resources

- [Food Waste Prevention Animated Video aimed at Children, Wexford County Council \(2019\)](#)
- [Your Food = Your Money, Food Waste Prevention Video, Monaghan County Council \(2012\)](#)
- [Home Composting Leaflet for Citizens, Galway County Council \(2016\)](#)

## 5. Data and assessment

Data collection, monitoring and evaluation all support policy improvement and implementation of circularity. Monitoring assesses the effectiveness of circular initiatives and policies by tracking indicators like bio-waste diversion, recycling rates, and greenhouse gas emissions reduction. It enables benchmarking and comparison among different entities, offers insights into policy efficacy, and promotes transparency and stakeholder engagement. The main activities that local authorities can undertake to collect or produce data and assess performance are:

- Firstly, it is important for local authorities to **set the baseline**, to assess where they stand in relation to bio-waste management (cf. Understand your territory).
- Local authorities should **define Key Performance Indicators (KPIs)** based on targets included in the strategy (cf. Strategy Development). These KPIs should be subject to regular tracking and analysis for the purpose of evaluating performance and identifying trends.

→ It is essential to **establish data collection systems** capable of gathering pertinent information from diverse sources, serving distinct objectives. For instance, an examination of waste generation and treatment methods can provide insights into a city's waste management situation, existing challenges that require addressing, and priorities for enhancing the circularity of the bio-waste sector. Additionally, data collection processes should be standardised to maintain consistency and comparability over time.

→ **Surveys** can be executed to gather feedback from residents, businesses, and stakeholders regarding service quality, community contentment, and areas in need of improvement. For instance, this approach can be employed to assess the reception of a newly implemented collection system within a neighbourhood and to gauge the necessity for potential incentives or informational campaigns to enhance performance.

### Example – Conducting Surveys to Gather Data and Improve Performance

As part of the CityLoops project, the city of Porto runs a yearly survey for citizens to measure their level of satisfaction related to the municipal waste management services provided. The purpose of this survey is to improve the quality of the services provided and implement new information campaigns.



Moreover, within the VALUEWASTE project, a survey was conducted with the aim of assessing social acceptance and awareness levels regarding the use of urban bio-waste as a valuable local resource. Understanding citizen's perception enabled the development of targeted communication campaigns and the implementation of the citizen's feedback into the development of the project.

A significant finding of this survey was the lack of information available to the public regarding waste management, new policies, and emerging trends, including at the EU level. Citizens expressed a clear need for more information on these aspects, as well as on the properties and functionality of the produced bioproducts.

### Toolbox – Circular City Indicator Set (NRI)

In the CityLoops project, a comprehensive evaluation framework was developed to assess cities' progress in implementing circular economy actions. Inspired by existing literature and the EU monitoring framework, this CityLoops framework covers all project aspects and offers detailed guidance for local-level circular economy practices. The framework includes an indicator

system with **94 indicators**, categorised by strategic objectives, spatial scale, and scope. The project's pilot cities selected specific indicators based on their actions, baselines, and intermediate and final results as outlined in their Evaluation Plans.

**The indicator set can be found [here](#)**

### Resources

Some of the frameworks and indicator sets that are applicable to this level are the following:

- OECD. [The OECD Inventory of Circular Economy indicators. \(2020\)](#)
- [Urban Agenda for the EU – Indicators for circular economy \(CE\) transition in cities \(2016\)](#)
- [Toward a Circular Economy Regional Monitoring Framework for European Regions](#), Anna Avdiushchenko (2018)
- [Moving Towards the Circular Economy/City Model: Which Tools for Operationalizing This Model](#), Girard, LF & Nocca, F (2019)
- [EU Monitoring Framework at Country-level \(2018, as amended\)](#)



## 6. Innovation

Innovation is at the core of the circular transition and local authorities are in a unique position to boost innovation within their communities. Innovation can contribute to the transformation of the bio-waste sector by finding new uses for bio-waste, promoting technological advancements, creating new economic opportunities, and driving policy innovation, among others. Local governments have the power to create an economy that nurtures and supports innovation through a variety of activities:

- Municipalities should create an **innovation-friendly ecosystem**, for example, by streamlining permitting processes, offering incentives to innovation-driven businesses, and establishing sandbox frameworks that allow for controlled experimentation.
- They should also **invest in infrastructure** such as innovation hubs, co-working spaces, and research centres focused on bio-waste management to encourage collaboration and idea exchange.

→ **Foster partnerships and establish networks** to encourage collaboration, facilitate knowledge exchange, and promote cross-sectoral innovation. Cross-sectoral innovation is relevant in the bio-waste sector because it leverages the strengths of various industries to develop comprehensive, innovative, and sustainable solutions.

→ Additionally, local authorities should provide **financial support and incentives** to startups, businesses, and researchers engaged in bio-waste innovation projects. This can include allocating resources to research institutions and universities to foster the development of new technologies and solutions, as well as **hosting innovation challenges and competitions** to encourage entrepreneurs to create creative solutions to local waste management challenges.

→ Lastly, they can stimulate demand by being the initial customers of circular design products and technological solutions through **public procurement**.

### Urban Living Lab & Innovation Hub in the Cities of Maribor and Almere

Living labs are vital for testing and enhancing urban solutions. They offer a controlled space for cities, businesses, and residents to showcase circular principles in practice. Through experimentation, they grasp system dynamics, yielding tangible results that inform wider urban strategies.

As part of an EU-funded project, Urban Soil 4 Food<sup>61</sup> aims to convert waste into safe and certified soil, promoting increased food self-sufficiency and reducing negative environmental impacts in Maribor. In order to do so, the city will establish an agri-living lab for testing and piloting innovative concepts like micro urban gardening and urban soil rehabilitation. Additionally, it aims to support start-ups with a focus on circular economy principles.

Innovation hubs, on the other side, is a physical or virtual space designed to foster innovation,

entrepreneurship, and collaboration. The primary focus of an innovation hub is to provide resources, support, and a conducive environment for creativity and entrepreneurship. As an example of this, the public-private partnership between the Municipality of Almere, Province of Flevoland and VodafoneZiggo has opened a Green Innovation Hub<sup>62</sup> early this year (2023), which focuses on developing digital innovations in the field of food, but also construction, energy, mobility and digital inclusion.



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### Examples – Entrepreneurship Contest FoodLoop in the city of Porto

The Entrepreneurship Contest for Circular Ideas - FoodLoop- was launched in Porto to promote the circular transition of the bio-waste and the broader food system, in alignment with the city's environmental strategy and Roadmap for Circular Economy 2030. The contest aimed to empower entrepreneurs to turn environmental and social challenges into circular business opportunities while fostering collaboration among stakeholders.

The contest's focus on the food system made it inclusive for various sectors and stakeholders, attracting citizens, social institutions, and local entrepreneurs. Winning ideas encompassed creating synergies between sectors, promoting innovative food waste management, preventing food waste through donation and recovery schemes, addressing the nutritional needs of vulnerable communities, and enhancing local/regional agri-food circuits.

Instead of monetary prizes, the contest offered training and mentoring. This approach has shown positive outcomes, as it attracts raw and diverse ideas that can be refined and adapted during the process.

**FOOD  
LOOP**  
Uma ideia alimenta a outra.

The contest's implementation has revealed some valuable lessons:

- The absence of monetary rewards encourages participants to be open-minded and receptive to feedback, leading to potential idea transformations.
- Providing a monetary prize could attract more mature ideas that require financial support for implementation.
- Effective and diverse communication campaigns are essential for the success of such initiatives, encompassing various channels to reach a wider audience.
- Face-to-face activities and ideation workshops have been effective in overcoming challenges and fostering creativity and problem-solving skills among participants.

### Resources

- [City Accelerator Guide for Embedding Innovation in Local Government, OECD \(2015\)](#)
- [Regional Innovation Scheme \(RIS\), EIT](#)

<sup>61</sup> Urban Soil 4 Food. (n.d.). Eutropian.

<sup>62</sup> Green Innovation Hub. (2023).

## 7. Capacity building

Within the circular transition, the successful adoption of circular practices and technologies relies on new skill sets. Notably in cities, circular economy projects are often based on experimentation and pilots. This is both an opportunity for creating new knowledge and information, but also a challenge in terms of the human and technical capital needed to design and execute these projects.

Upskilling and reskilling initiatives can empower individuals with the knowledge and capabilities needed to engage in circular bio-waste processes effectively. The main activities that local authorities can undertake in this regard are:

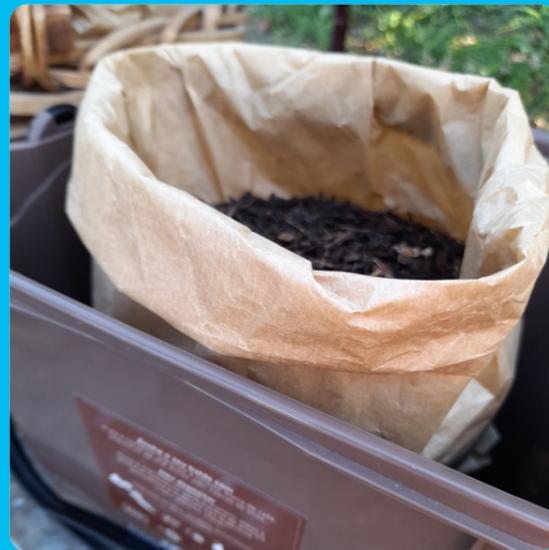
→ Identifying **skill gaps and knowledge gaps** within the local workforce that pertain to circular bio-waste processes. This means understanding the specific competencies required for the circular transformation of the sector.

→ Moreover, local authorities should **raise awareness** about the importance of upskilling and reskilling in the context of the circular bio-waste sector and the new opportunities that such transition creates. This can be achieved through communication campaigns and events.

→ **Training programs** should be offered/promoted by local authorities, which for instance can be training waste management personnel in advanced recycling techniques, educating farmers on sustainable agricultural practices that utilise bio-waste as a valuable resource, and educating individuals in community composting activities. Moreover, training for public administrations is also required, which can be done through city-to-city learning, offered by dedicated networks.

### Examples – Training on Community Composting in Porto

In both neighbourhoods where the composting spaces were implemented in Porto, composting training was provided to its inhabitants. Moreover, in the city of Porto, a “compost master” role was introduced in the community composting areas. The responsibilities of this role include monitoring, recording technical parameters, handling logistics and administration, and facilitating communication with families. The Compost Master serves as a bridge between the population, the composting areas, and LIPOR, ensuring proper operation and addressing any concerns. Similarly, in the city of Pontevedra, the Revitaliza team is composed of 39 compost masters, who in addition to monitoring the composter, teach individuals or entities (e.g., restaurants or hotels) how to compost<sup>63</sup>.



<sup>63</sup> Zero Waste Europe. (2019). The Story of Pontevedra.

### Training on Food Waste Prevention in Porto

As part of the implementation of circularity models within the CityLoops project, the city of Porto has conducted training in hotels and social institutions for the prevention of food waste through a more conscious planning of meals, as well as training on organic farming. Additionally, in collaboration with Zero Desperdício, the city also offered training on food recovery, according to the hygiene and safety of products and beneficiaries.



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### Resources

Platform that offer resources related to the circular skills are:

→ [SIRCLES \(Bio-waste management\)](#)

→ [CIRCULAR SKILLS](#)

→ [CYCLE](#)

→ The Circular Jobs Initiative. Some relevant resources for public authorities include:

→ [The role of municipal policy in the circular economy, investment, jobs and social capital in circular cities.](#)

→ [Closing the skills gap: Vocational education and training for the circular economy](#)

→ [Jobs & skills in the circular economy: State of plan and future pathways](#)

## 8. Financing

It goes without saying that financing is essential to the circular transition. In a context of budgetary pressures, it is advised for local authorities to identify and leverage funding programs at EU and national level.

Local authorities can also play a role in funding the circular transition of the bio-waste sector by providing direct financial support, resources, and incentives to initiatives and projects that promote circularity in waste management. Funding is particularly important to support research and innovation, the development of infrastructure and the adoption of technology.

Below are some of the main activities that municipalities can undertake:

- Local authorities should provide **direct financial support** for circular bio-waste projects, research, and infrastructure. They can offer **grants and subsidies** to businesses and startups involved in circular initiatives, covering costs for research and innovation. For instance, funding research to optimise biogas production, upgrading waste management infrastructure like composting facilities, or subsidising energy production from biogas – due to potential non-competitiveness with fossil fuel energy prices – is crucial for facilitating the transition towards sustainable energy sources.
- They should also establish **incentive programs** rewarding circular practices, such as waste reduction and recycling. Examples include Pay-As-You-Throw pricing based on waste generation and offering discounts on waste collection fees or taxes for residents achieving waste reduction targets, like through home composting.

### Examples – Subsidies for Biogas Production and Use: Mikkeli's approach

In Finland, the production and utilisation of biogas receives support through various energy and investment subsidies. Specifically, to encourage the utilisation of biogas for transportation, the parliament amended the Distribution Obligation Act. This legislation expands the national distribution obligation for transport fuels to encompass biogas and non-biological renewable liquid and gaseous fuels.

To promote this initiative, Mikkeli has introduced incentives and subsidies for the acquisition or leasing of biofuel-powered vehicles. Additionally, economic assistance is extended to businesses adopting vehicles powered by biofuels. In order to communicate these incentives effectively, Mikkeli provides information and comparisons between biofuels and fossil fuels, emphasising their respective climate impacts. This effort aims to raise awareness regarding the environmental advantages associated with biofuel utilisation.



### Promoting Home Composting through Financial Incentives in Casalgrande, Italy

The City Council of Casalgrande offers a 20% reduction in waste tariff for citizens who compost their organic waste in their gardens using a domestic composter. This initiative has resulted in a reduction of bio-waste, improved waste collection, and reduced treatment and disposal costs. Good communication and an Environmental Education Center for household training are essential for the success of the program. Approximately 200 households have participated in the scheme, composting around 26.8 tonnes of waste per year. The investment in the program is proportional to the number of participants, with an average family of four people receiving a reduction of about €40. In total, the expenditure for the program was €8,000.



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#### Resources

- [Circular City Funding Guide](#)
- [The Role of Municipal Policy in the Circular Economy: Investment, Jobs and Social Capital in Circular Cities, Circular Economy \(2019\)](#)
- [Economic Instruments to Improve Waste Management in Greece, I. Frantzis & Associates LTD: and BlackForest Solutions GmbH \(2020\)](#)

<sup>64</sup> Municipality of Casalgrande. (2021). Home composting and economic incentives. Interreg Europe.

## 9. Circular public procurement (CPP)

The purchase of works, goods and services by the public sector represents no less than 14% of European GDP every year<sup>65</sup> and is a strategic tool that local authorities should leverage to further prevent bio-waste and improve valorisation across their activities. On the one hand, procurement allows local authorities to operate more sustainability and to reduce their environmental footprint. On the other hand, it can stimulate the design, provision and management of more circular goods and services<sup>66</sup>.

The procurement process is divided into several phases<sup>67</sup>, in which different actions can be undertaken to prevent and valorise bio-waste. Key actions are:

→ **Rethink needs:** local authorities should rethink their needs, i.e. assess whether the purchase is necessary, and if so try to identify whether the products can be substituted by another product<sup>68</sup>. It is recommended to closely associate end-users during the definition of needs. Once needs have been identified, **market dialogue** and networking between procurers and different actors allows one to better understand the market, and get a sense of what is feasible. Benchmarking other local authorities' tenders plays a similar role.

→ **Integrate circular criteria:** within tenders, local authorities can set different types of circular criteria. With technical specifications they can define mandatory requirements that products or services should fulfil. With selection criteria, they can make sure that tenderers have the capacity and experience to deliver the product or service in question. With award criteria, local authorities evaluate the cost and the performance of the different bids. This is where they can request or invite tenderers to use labels or certifications<sup>69</sup>. For a tender on school meals, technical specification can for instance make it mandatory for tenderers to develop a waste management plan, while selection criteria could be a track record of effective waste prevention and award criteria to redistribute surplus food to charities.

→ **Contract management:** local authorities can set up contract performance clauses in contract to better manage the provision of goods and services and maintain performance over time. The contractor can for instance be required to collect and share data on bio-waste that is presented, following targets set in the contract.

### Examples – Procuring Sustainability: Advancing Circular Economy in CityLoops initiatives

In the CityLoops project, cities have undertaken procurement activities to support the implementation of various demonstration actions. Each city has procured specific products and services aligned with their respective goals and objectives.

- Apeldoorn procured services for mowing grass, tree cutting, and bush pruning, to create bio-based products.
- Seville purchased containers for bio-waste collection with an emphasis on recyclable materials, along with electronic locks and access cards.
- Mikkeli procured biogas-powered buses, waste trucks, and soil products for the construction of green areas.
- Porto procured community composter and street smart containers for food waste collection.

Mikkeli developed two procurement guidelines to enhance circular economy practices: one for transportation and logistics, and the other for reducing organic waste. Moreover, Porto produced Circular Procurement Guidelines specifically for food services and green spaces.



Two workshops were conducted to promote their adoption by the municipality but also by the tourism, catering and social sectors.

More information on the mentioned actions and more can be found in Circular Procurement in Europe: handbook for local and regional governments.

These documents are referenced in the ToolBoxes below.

<sup>65</sup> European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs. (2022). Public procurement. European Commission.

<sup>66</sup> Circular Cities Declaration. (2023). Circular Cities Declaration Report 2022. ICLEI - Local Governments for Sustainability, European Secretariat, p. 14.

<sup>67</sup> Clement, S., & Watt, J. (2016). The Procura+ Manual. ICLEI - Local Governments for Sustainability, European Secretariat.

<sup>68</sup> ICLEI - Local Governments for Sustainability. (2017). Public Procurement for a Circular Economy — Good practice and guidance. Publications Office of the European Union, p. 8.

<sup>69</sup> Defranceschi, P., Rut, M., Novello, F., D'Addario, F., & Semple, A. (2023). Report on Innovative Criteria and Models for Procurement of Sustainable and Healthy School Food. SchoolFood4Change, pp. 13-14.

### Procurement Frontrunners in the Transportation Sector: An example from the city of Vaasa in Finland

In 2014, Vaasa, Finland, initiated a pioneering project to procure 12 buses fueled by biogas from organic waste and waste-water sludge. This initiative aimed to enhance environmental sustainability and establish a circular economy. The procurement contracts featured innovative clauses that rewarded suppliers for surpassing efficiency estimates, fostering continual improvement. This effort resulted in remarkable outcomes: displacing 280,000 litres of diesel fuel annually, reducing greenhouse gas emissions, and enhancing air quality. The project's closed-loop system transformed waste into valuable biogas resources and contributed to local biogas infrastructure development, benefiting both transportation and sustainable mobility.



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### Transforming Food Procurement: Utrecht's Award-Winning Approach and Turku's Carbon-Neutral Objectives

The city of Utrecht, in the Netherlands, won **an Award** in the category Sustainable Procurement of the Year, for applying far-reaching social and sustainable criteria in its food procurement, including the minimisation of food waste. Additionally, it applied a very strong social angle to its tender, aiming for the most inclusive food choice and introducing a fixed minimum percentage of social return, thereby providing the possibility for even the most vulnerable people to be trained and employed.

Similarly, in order to contribute to the city's 2029 carbon neutrality target and reduce emissions associated with local food services, the strategic procurement department of the city of Turku set the following objectives: (1) reducing food loss from 12% to 6% and (2) doubling the proportion of vegetarian meals from 24% to 48%. To date greenhouse gas (GHG) calculators have been applied to service contracts for the City and additionally the proportion of vegetarian meals



in the educational division has increased from one vegetarian meal per week to eight vegetarian meals in a six-week period.

### Toolbox – Circular procurement handbook (RWS and Alba Concepts)

This other handbook draws upon the CityLoops demonstration actions to outline key takeaways. It aims to inspire and guide local and regional European public authorities of all sizes, policymakers, procurement professionals, as well as private entities that want to know more about the current procurement practices, to use their purchasing power in their transition towards a circular economy. Furthermore, it offers practical guidance for project implementation. It includes examples from the

CityLoops demonstration cities and the tools they developed for incorporating circular procurement practices during the pre-tender, tender, and post-tender activities. Finally, it outlines methods to ensure the scalability and integration of these activities as the new norm within any city organisation.

**The Circular Procurement handbook is available [here](#).**

### Toolbox – General guide for bio-waste management in public procurement (Mikkeli)

This tool can be used as a general guide for managing organic waste creation and handling in public procurement and public procurement related processes and functions. It aims to enhance the collection and sorting of organic waste and reduce carbon dioxide emissions in services and functions based on public procurement in the City of Mikkeli. It also aims to enhance the utilisation of organic waste. It is designed to support the city of Mikkeli in reaching the green deal ambitions and goals.

**The tool helps the experts within Mikkeli city's organisation to identify the links to the reduction, handling or reuse of organic waste in a single tender within the wide scope of procurement processes.** It will enhance the neutrality and quality of the tenders within different branches. The guide was officially approved by the city in April 2023 for use in the city's procurement processes.

**The guide can be [downloaded here](#)**

### Toolbox – Procurement guide for usage of biogas as a motive power in transportation and logistics services (Mikkeli)

The procurement guide for usage of biogas as a motive power in transportation and logistics services can be used to reduce unprocessed organic waste creation and promote the utilisation of organic waste in biogas production. It aims to support the procurement of public transportation and logistics services in a way that reduces carbon dioxide emissions and promotes demand for biogas as a motive power in tenders. It also supports the goal of a closed cycle for organic waste and its end products.

**The guide helps to underline the demands of sustainability, low carbon dioxide emissions and the usage of biogas as a motive power in public procurement processes,** tenders and documents of traffic, transportation, and logistics contracts in the city of Mikkeli.

The guide can be [downloaded here](#), alongside two case studies – a procurement report of [the local transport procurement process](#) and a [procurement report of the waste transportation procurement process](#).

#### Resources

- [Green Public Procurement Guidelines: Buying Green! - A handbook on green public, European Commission \(2023\)](#)
- [Green Public Procurement Criteria and Requirements \(for various Sectors\)](#)
- [Guidance on Public Procurement for a Circular Economy, European Commission \(2023\)](#)
- [Big Buyers](#)
- [How together we can make the world's most healthy and sustainable public food procurement, WHO \(2022\)](#)
- [Strategic Guide for Public Sector Food Procurement\(PSFP\), Strength2Food \(2021\)](#)
- [Recommendations to national policy-makers on CircularPP, Interreg Baltic Sea Region \(2020\)](#)
- [Innovative Criteria and Models for Procurement of Sustainable and Healthy School Meals, ICLEI - Local Governments for Sustainability, European Secretariat \(2023\)](#)
- [Procura+ Manual, A Guide to Implementing Sustainable Procurement, ICLEI - Local Governments for Sustainability, European Secretariat \(2016\)](#)



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# Annexes

## Resources

Enabling the transition to circular bio-waste management

### 1. Strategy development

- [A Guide for Developing a Circular City Strategy](#), Circle Economy (2022)
- [How to Develop a Circular City Strategy: Webinar](#), European Investment Bank (2022)
- [A Practical Approach to Develop a City Roadmap Focusing on Utilities](#), Circular Cities (2019)

Further examples of circular cities strategies can be found across the world:

- [Richmond](#), US
- [Turku](#), Finland
- [Toronto](#), Canada

### 2. Cross-departmental collaboration & political support

- [Working Together: A toolkit for campaigns collaboration across the public sector](#), UK Government Communication Service (2016)
- [Circular City Governance A first guide for policy makers](#), Vlaanderen-Circulair (2020)

### 3. Stakeholder engagement

- [National Action Manual for local uptake: Italy – Running a Biowaste](#), SCALIBUR
- [Biowaste Club concept](#), CSCP
- [Engaging Stakeholders Video Presentation](#), URBACT (2020)
- [How to engage stakeholders for powerful and inclusive climate action planning](#), C40 (2023)

### 4. Awareness-raising

Examples of Local Authorities raising awareness on bio-waste management amongst citizens include:

- [Food Waste Prevention Animated Video aimed at Children](#), Wexford County Council (2019)
- [Your Food = Your Money, Food Waste Prevention Video](#), Monaghan County Council (2012)
- [Home Composting Leaflet for Citizens](#), Galway County Council (2016)

### 5. Data and assessment

Some of the frameworks and indicator sets that are applicable to this level are the following:

- [The OECD Inventory of Circular Economy indicators](#), OECD (2020)
- [Urban Agenda for the EU - Indicators for circular economy \(CE\) transition in cities](#) (2016)
- [Toward a Circular Economy Regional Monitoring Framework for European Regions](#), Anna Avdiushchenko (2018)
- [Moving Towards the Circular Economy/City Model: Which Tools for Operationalizing This Model](#), Girard, LF & Nocca, F (2019)
- [EU Monitoring Framework at Country-level](#) (2018, as amended)

### 6. Innovation

- [City Accelerator Guide for Embedding Innovation in Local Government](#), OECD (2015)
- [Regional Innovation Scheme \(RIS\)](#), EIT

### 7. Capacity building

Platform that offer resources related to the circular skills are:

- [SIRCLES \(Bio-waste management\)](#)
- [CIRCULAR SKILLS](#)
- [CYCLE](#)
- [The Circular Jobs Initiative](#). Some relevant resources for public authorities include:
  - [The role of municipal policy in the circular economy, investment, jobs and social capital in circular cities](#).
  - [Closing the skills gap: Vocational education and training for the circular economy](#)
  - [Jobs & skills in the circular economy: State of plan and future pathways](#)

## 8. Financing

- [Circular City Funding Guide](#)
- [The Role of Municipal Policy in the Circular Economy: Investment, Jobs and Social Capital in Circular Cities](#), Circular Economy (2019)
- [Economic Instruments to Improve Waste Management in Greece](#), I. Frantzis & Associates LTD: and BlackForest Solutions GmbH (2020)

## 9. Circular public procurement (CPP)

- [Green Public Procurement Guidelines: Buying Green! - A handbook on green public](#), European Commission (2023)
- [Green Public Procurement Criteria and Requirements \(for various Sectors\)](#)
- [Guidance on Public Procurement for a Circular Economy](#), European Commission (2023)
- [Big Buyers](#)
- [How together we can make the world's most healthy and sustainable public food procurement](#), WHO (2022)
- [Strategic Guide for Public Sector Food Procurement \(PSFP\)](#), Strength2Food (2021)
- [Recommendations to national policy-makers on CircularPP](#), Interreg Baltic Sea Region (2020)
- [Innovative Criteria and Models for Procurement of Sustainable and Healthy School Meals](#), ICLEI - Local Governments for Sustainability, European Secretariat (2023)
- [Procura+ Manual, A Guide to Implementing Sustainable Procurement](#), ICLEI - Local Governments for Sustainability, European Secretariat (2016)

### Implementing circularity in bio-waste management

#### Waste prevention

- [European Commission Assessment of Food Waste Prevention Actions](#), Patinha Caldeira, C., De Laurentiis, V. & Sala, S. (2019)
- [Milan Food Policy actions on food losses and waste management](#), Interreg Europe (2019)
- [Urban Food Waste: A Framework to Analyse Policies and Initiatives](#), Daniele Fattibene, Francesca Recanati, Katarzyna Dembska, Marta Antonelli (2020)
- [How to Prevent Food Waste in Health Care Guidance](#), FoodWIN
- [A Policy Brief from the Policy Learning Platform on Environment and resource efficiency](#), Interreg (2018)

#### Example of resources produced by local authorities encouraging waste prevention amongst citizens:

- [A Leftovers CookBook of Recipes for Citizens](#)
- [12 Christmas Leftover Recipes](#)
- [Too good for the bin!](#) app

#### Food redistribution

- DIRECTIVE (EU) 2018/851 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL 2008, as amended (requirement for food waste reduction)
- [EU Platform on Food Losses and Food Waste](#)
- [Voluntary Agreements as a collaborative solution for food waste reduction](#), EU Horizon 2020 REFRESH (2019).
- [Farm to Fork Strategy](#)
- [Sustain Alliance](#)

#### Framework/methodology to measure food waste impact:

- [Food Waste Footprint \(FWF\)](#), FAO (societal cost of environmental impact of food wastage)
- [FUSIONS framework](#) (social, environmental and economic aspects)
- [Key facts on food loss and waste you should know!](#), FAO (2014)
- [Reducing food waste through social innovation](#), EU-Fusions (2016)

#### Decentralised valorisation

- [Decentralised management of organic waste Webinar](#), ZW Live! (2020)
- [Deliverable D 3.7 Scenarios for decentralised bio-waste collection chains with a waste collection database for representative situations](#), EU Horizon 2020 DECISIVE.
- Institute for Local Self-Reliance and Highfields Center for Composting, Growing Local Fertility: A Guide To Community Composting

#### Centralised treatment: Separate collection

- [Guide for Municipalities on How Best to Separately Collect Biowaste](#), Zero Waste Europe (2022)
- [Guidance for separate collection of municipal waste](#), European Commission (2020)
- [Policy Brief on separate waste collection](#), Interreg Europe (2020)

#### Centralised treatment: Sorting and pre-treatment

##### Valorisation options: Biogas production

- [Manual for National Biomethane Strategies in the EU-27](#), Gas for Climate (2022)
- [Biomethane Production and Grid Injection: German Experiences, Policies, Business Models and Standard](#), Energypartnership (2020)
- [Categorisation of European Biogas Technologies](#), Digital Global Biogas Cooperation (2021)

##### Valorisation options: Industrial composting

- [European Compost Network](#)
- [Community Composting: A Practical Guide for Local Management of Biowaste](#), Zero Waste Europe (2019)
- [Composting 101 Video](#), An Taisce Biodiversity Week 2022

##### Valorisation options: Bokashi

- [A Guide to EM Bokashi](#), Marlborough District Council (2022)

#### Example of a Local Authority encouraging bokashi use amongst citizens:

- [City of Onkaparinga provides 50% subsidy to local citizens purchasing bokashi buckets](#)

##### Valorisation options: Biochar

- [Bringing Biochar to your City Lessons from the Stockholm Biochar Project](#), Nordregio (2018)
- [European Biochar Certificate - Guidelines for a Sustainable Production of Biochar](#), EBC (2012, as amended)

##### Valorisation options: Higher value-added products

- Materiom - provides a large catalogue of high-value added products from organic residues
- D1.3 Catalogue of urban biowaste solutions and good practices examples, Horizon 2020 WaysTUP!
- [Global biorefinery status report 2022](#), IEA Bioenergy (2022)
- [Biorefineries Roadmap: as part of the German Federal Government action plans for the material and energetic utilisation of renewable raw materials](#), The German Federal Government

## European legislative framework

Current EU legislation and policies related to bio-waste set highly challenging targets for cities to achieve. There are several regulatory frameworks and strategies that impact the circular transition of the bio-waste sector throughout the different stages of the supply chain, namely waste generation, collection, sorting and disposal, alternative valorisation methods, and the utilisation of bio-based products. The main policies and strategies in this field are:

### **DIRECTIVE 2008/98/EC – Waste Framework Directive (WFD):**

- Introduction of a separate collection of bio-waste as of 1 Jan 2024
- Targets regarding recycling and preparation for reuse: by weight, at least 55 % by 2025, 60 % by 2030 and 65 % by 2035. Recycling of bio-waste is key to achieve this target
- Member States are expected to deliver the best overall environmental outcome in line with the waste hierarchy, and to promote the use of materials produced from bio-waste.
- The directive sets out quality standards for compost and digestate produced from bio-waste. These standards are intended to ensure that the resulting products are safe for human health and the environment.
- Member states are required to provide information and raise awareness among the public and stakeholders about the separate collection and treatment of bio-waste, as well as the benefits of recycling and recovering bio-waste, in order to implement the waste management plan.

### **Landfill Directive:**

- Introduces restrictions on landfilling of all waste that is suitable for recycling or other material or energy recovery from 2030
- Limits the share of municipal waste landfilled to 10% by 2035.

### **European Green Deal:**

- Sets some GHG reduction targets for 2020 and has put forward a plan to further cut emissions by at least 55% by 2030 in Europe, with the aim of becoming climate neutral by 2050. It encompasses a package of policy initiatives covering the climate, environment, energy, transport, industry, agriculture and sustainable finance, all of which are strongly interlinked. Relevant initiatives for the bio-waste sector include:

#### **→ Circular Economy Action Plan: Some of the most relevant actions directly or indirectly to the transition of the bio-waste sector are:**

- Halving the amount of residual (non-recycled) municipal waste by 2030, to which sustainable bio-waste management will contribute.
- Mandatory Green Public Procurement (GPP) criteria and targets in sectoral legislation as of 2021
- Policy framework for bio-based plastics and biodegradable or compostable plastics in 2021
- Launch of an industry-led industrial symbiosis reporting and certification system in 2022

#### **→ Farm2Fork Strategy:**

- The Farm2Fork strategy, with a specific focus on food, strives to expedite the shift towards a sustainable food system by addressing various stages of the value chain, including waste prevention and minimising food loss. As a crucial component of this strategy, the European Commission intends to propose legally binding targets by the conclusion of 2023, aiming to significantly decrease food waste throughout the European Union.

#### **→ European Climate Law:**

- The European Climate Law establishes the legal framework to achieve climate neutrality by 2050. It sets binding targets for greenhouse gas emissions reduction and promotes the transition to a sustainable economy. This law indirectly affects the bio-waste sector by driving efforts to reduce methane emissions from organic waste through proper treatment and management.

#### **→ EU Biodiversity Strategy for 2030:**

- The EU Biodiversity Strategy aims to protect and restore biodiversity in Europe. It emphasises the importance of sustainable agriculture and the reduction of chemical pesticide use. These actions indirectly contribute to the management of bio-waste by promoting organic farming practices and reducing the potential for pesticide contamination in waste streams.

### **Renewable Energy Directive and REPowerEU plan:**

- Targets regarding the share of renewables in the energy mix of at least 32% by 2030. However, in May 2022, the Commission published the REPowerEU plan, which sets out a series of measures to rapidly reduce the EU's dependence on Russian fossil fuels well before 2030 by accelerating the clean energy transition. This plan proposes to increase the target in the directive to 45% by 2030.

### **Bioeconomy strategy:**

#### **→ Aims to accelerate the deployment of a sustainable European bioeconomy. The strategy is implemented by means of an action plan. Some of the actions that directly impact the transition of the bio-waste sector are:**

- Promoting investment through the EUR 100 million Circular Bioeconomy Thematic Investment Platform
- Facilitate the development of new sustainable biorefineries
- Analyse enablers and bottlenecks for the deployment of bio-based innovations
- Facilitate the deployment of new sustainable biorefineries
- Develop substitutes to fossil based materials that are bio-based, recyclable and marine biodegradable
- Promote education, training and skills across the bioeconomy
- Support regions and Member States to develop Bioeconomy Strategies

### **EU Fertilising Products Regulation EU (2019/1009):**

- Intends to create a policy framework to encourage the use of organic fertiliser and soil improvers, thereby decreasing the EU's dependency on imports of mineral fertilisers and contributing to a circular economy for nutrients. By fulfilling the requirements of the regulation, compost and digestate-based fertilising products (organic fertiliser, soil improver and growing media) can be placed on the European market.

## Summary of CityLoops Demonstration Actions

A description of the demonstration actions carried out by the CityLoops cities can be found [here](#).

City	Feedstock type	Demonstration action	Output or outcome
Apeldoorn	Pruning waste from public spaces	Biochar production	Soil improver for public spaces was produced
	Grass from public spaces	Fibre-based product production (i.e., paper production)	Paper was produced
	Leaves from public spaces	Bokashi	Soil improver for public spaces was produced
	Japanese Knotweed	3D filament	3D printing of compostable objects was produced
Mikkeli	Household bio-waste	Bio-waste collection and sorting	Collection of bio-waste in quantity and quality was improved
	Household bio-waste	Bio-waste treatment: pilot and laboratory scale experiments	Production of biogas as transport fuel and the production of soil amendment were optimised
Porto	Household bio-waste	Bio-waste selective collection and community composting	120 containers and 2 community composters were installed
	Bio-waste from the tourist and social economy sectors	Promoting bio-waste circularity in the tourism and social economy sectors	Vegetables were harvested on site, food waste was reduced via improving portion size, and the quantity of bio-waste collection increased.
	Green space bio-waste	Launch of Green Space Certification System	Certification methodology was created and 4 public green spaces (or a total of 900m <sup>2</sup> ) were granted the certification
	Bio-waste broadly and more specifically food waste	Circular Entrepreneurship Contest	5 winners went through a 6 month mentorship
	Food waste	Reducing food waste via a donation network	144 tonnes of food waste were avoided, a total of 14 917 families were supported, from January 2021 to May 2023
Seville	Household bio-waste	Separate bio-waste collection route in a neighbourhood of Seville	New separate collection route was created and 30 smart containers were installed.
	Household bio-waste and sludge from WWTP	Biomethane production from bio-waste in co-digestion with sludge	Biomethane was produced

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<b>Abstract</b>	The circular bio-waste management handbook offers recommendations to local governments seeking to promote circularity within bio-waste management. Its objective is to bridge the gap between theory and practice, drawing on relevant literature and a selection of case studies from CityLoops and other projects. This handbook encompasses the entire value chain of the bio-waste lifecycle and addresses not only well-established topics like bio-waste collection and valorisation but also emerging areas such as waste prevention and bio-based materials. Designed for practitioners, and potentially including politicians, it serves as a valuable resource for comprehending the complexities of this waste stream and guiding local decision-making to unlock the circular economy's potential.
<b>Keywords</b>	bio-waste, organic waste, circular economy, local authorities, cities, handbook
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**CityLoops is an EU-funded project focusing on construction and demolition waste (CDW), including soil, and bio-waste, where seven European cities are piloting solutions to be more circular.**

**Høje-Taastrup and Roskilde (Denmark), Mikkeli (Finland), Apeldoorn (the Netherlands), Bodø (Norway), Porto (Portugal) and Seville (Spain) are the seven cities implementing a series of demonstration actions on CDW and soil, and bio-waste, and developing and testing over 30 new tools and processes.**

**Alongside these, a sector-wide circularity assessment and an urban circularity assessment are to be carried out in each of the cities. The former, to optimise the demonstration activities, whereas the latter to enable cities to effectively integrate circularity into planning and decision-making. Another two key aspects of CityLoops are stakeholder engagement and circular procurement.**

**CityLoops started in October 2019 and will run until September 2023.**



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