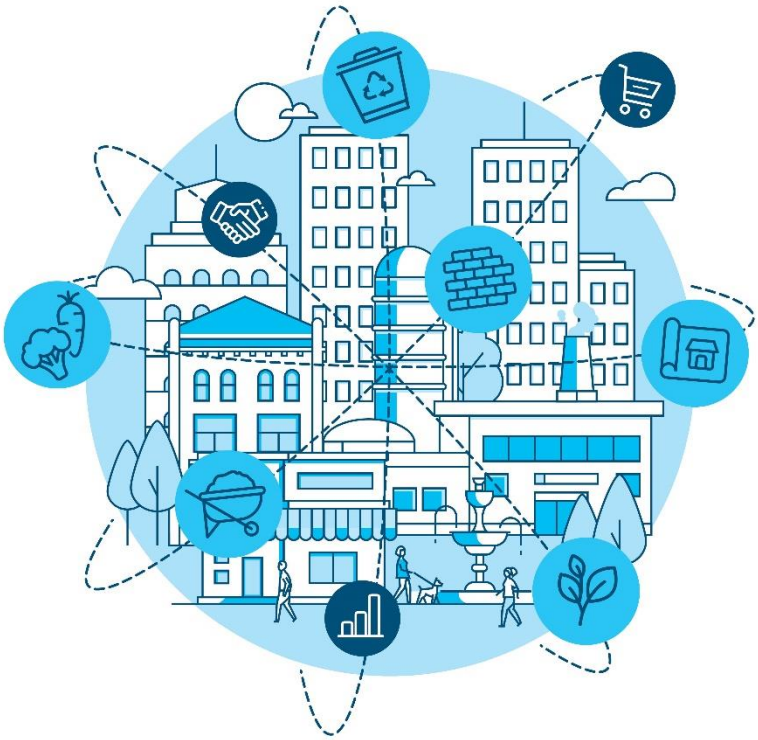
CITYLOOPS

Bio-waste circular toolkit for local and regional governments

Deliverable 3.10

ICLEI Europe



Version	1.0
WP	3
Deliverable	D3.10 Bio-waste circular toolkit for local and regional governments
Date	31.07.2023
Dissemination level	Public
Deliverable lead	ICLEI
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Abstract	This toolkit includes 10 instruments developed by CityLoops cities and their partners to prevent waste, and to close and shorten organic loops. Those instruments are of different nature, including tools, guidance documents as well as blueprints, which cover different types of bio-waste, primarily food and green spaces waste. This toolkit will prove extremely valuable for cities and towns across Europe looking for ready-to-use solutions to embed circularity within their daily activities thus reducing their environmental footprint.
Keywords	Toolkit, bio-waste valorisation, bio-waste collection, waste prevention, circular economy
License	

Contents

1. Introduction

1.1. Background

Cities throughout Europe are increasingly recognising that the transition from a linear to a circular economy is crucial in the fight against climate change and biodiversity loss. 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[1] - 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 Construction & Demolition Waste (CDW) and Bio-waste, identified in the EU's Circular Economy Action Plan as two of the most important waste 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 simulation of impacts 3D visualisation tools and procurement guidelines for bio-waste products. The wide variety of these solutions reflect 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, where no resource goes to waste. 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. They contributed to the further integration of circular principals within municipal policy strategies, an increased use of circular public procurement to increase market demand for circular products and services, and a better understanding of the resources that flow through their city.

[1] European Environment Agency (2021), Growth without economic growth, Briefing no. 28/2020, available at: https://www.eea.europa.eu/publications/growth-without-economic-growth

1.2. About this toolkit

This toolkit collects and presents 10 instruments related to bio-waste developed and tested within the demonstration actions, in four cities and towns: Apeldoorn, Mikkeli, Porto and Seville. These instruments have been developed considering local needs, integrating state of the art research, as well as some elements of peer reviewing. Development has in most cases been led by city administrations, with strong support from research partners (Wageningen Research, XAMK) or consultancies (IDENER). Demonstration actions have proven to be testing beds, effectively demonstrating the effectiveness of these instruments and in turn contributing to close and shorten loops of organic matter (i.e. of bio-waste).

These 10 instruments are of different natures; the major difference being how readily useable they are, with some requiring little to no adaptation while others will have to be reproduced. A typology of those instruments can be established as follow:

- **Tools**: they can be used directly by city administrations to prevent waste, close, or shorten material loops. For instance, Porto's *Green Space Certification Scheme* can be used as is to assess and certify the sustainability of green spaces managed by city services. In practice, we acknowledge that this could nevertheless require some marginal adaptation, as cities' and towns' contexts greatly differ across Europe.
- **Guidance documents**: Guidelines give broad advice and recommendations on circular procedures and processes implemented in Demonstration Cities, including steps to follow. For instance, Mikkeli's *Procurement guide for usage of biogas as a motive power in transportation and logistics services* outlines how to procure and use biogas produced locally for local fleets of public buses and waste collection trucks.
- **Blueprints**: they cannot be used as such, as the underlying tool has been developed for a specific city (e.g. Seville's *bio-waste flow optimisation tool*). Nevertheless, the approach and technical decisions have both been carefully documented, constituting a detailed plan that would greatly simplify the work of cities and towns wishing to reproduce the same tool.

Instruments are open access, and we strongly encourage users to adapt them as required. We also encourage you to let us know if you use and/or adapt any of the instruments, and share with your own contacts, as we believe that knowledge transfer and dissemination will greatly support the transition to a circular economy at the local level.

1.2.1. Target audience

As previously hinted, this toolkit primarily targets cities and towns across Europe and potentially beyond. This includes:

- **City administrations**: Demonstration Cities – and Replication Zones alike - have mostly been involved in CityLoops through their administrations. As such, city administrations and more specifically departments such as the Environmental Services Department (including waste management and green spaces management), the Education Department, the Procurement or to some extent the European Cooperation Departments, are the primary targets of this toolkit. Within them, practitioners (rather than executives) should be the users of those tools.
- **Waste management agencies and public utilities**: municipal waste companies or waste management authorities such as LIPASAM in Seville or LIPOR in Porto have been directly involved in CityLoops, while Circulus and Metsäsairila Oy, respectively in Apeldoorn and Mikkeli, have been indirectly associated with Demonstration Actions. As such, and quite obviously given the topic, this toolkit could be great addition to either waste management authorities' prevention or waste management strategies.
- **Any other actor directly in contact with bio-waste management**: some of the tools can be used to other organisations that either produce or manage waste. For instance, Porto's *Circularity Decision Making Support tool* could well be used by restaurants and hotels – or at least get some inspiration from it.

Beyond these categories of actors, it could well be that other actors would benefit from using these instruments. If this applies to your organisation, please do!

1.2.2. Why use this toolkit?

We believe that local authorities across Europe – and beyond – can greatly benefit from using this toolkit, or simply some of the instruments, as it will undeniably allow them to progress towards the circular transition. More specifically, using this toolkit will allow users to:

- **Save time and money**, as development and testing has already been done by CityLoops Demonstration cities, in a context where local authorities lack time and resources.
- **Benefit from their peers' expertise and experience**, as years of experience and expertise have been "embedded" in these instruments. More, the possibility to contact Demonstration Cities will allow users to gain further insights on the instruments themselves and the challenges they aim to overcome.

1.3. How to use this toolkit?

This toolkit should support you in implementing circularity in specific areas of municipal intervention, and ultimately support the transition to a circular economy in your city.

Instruments are open access and free of charge. It is not mandatory to credit CityLoops Demonstration Cities (developers) for using any of the instruments, however we would appreciate to know who is using the instruments, in which context, and more importantly to get any feedback and know about any change that may has been made. Please let us know by writing at the following email address: info@cityloops.eu.

Likewise, please feel free to approach us if you have any questions or doubt about any of the instruments or about how to use them.

This toolkit should be used as a complement to the CityLoops Bio-waste Practitioner Handbook[2] , which provides an overview and practical recommendations to local authorities willing to make bio-waste management more circular, by preventing waste, closing, and shortening material loops of organic matter.

We also recommend users to have a look at the CityLoops Demonstration Reports[3], which describe and assess the results of the demonstration actions, and more specifically explain how the instruments have been developed and used.

Disclaimer: this toolkit does not include the instruments themselves, it includes descriptions and high-level instructions, **alongside links to the instruments themselves.**

[2] https://cityloops.eu/resources
[3] https://cityloops.eu/resources

1.3.1. How to navigate this toolkit?

All the instruments in this toolkit are freestanding and can be used independently. We would recommend you choose those instruments that are most relevant to you.

For the sake of simplicity, instruments have been organised into the following categories:

Bio-waste prevention

Includes a series of instruments aiming at preventing waste in the HORECA [4]sector, in green spaces and in the social sector.

Click here to go to this section.

Bio-waste collection

Focuses on improving the efficiency of bio-waste collection.

Click here to go to this section.

Bio-waste valorisation

Provides guidance on bio-waste valorisation, especially which valorisation option to choose for different feedstock.

Click here to go to this section.

Enablers

Provides guidance on how to develop enabling conditions for circularity in the bio-waste stream along the entire value chain.

Click here to go to this section.

[4] Hotels, restaurants and catering

1.4. Toolkit overview

INSTRUMENT	DEVELOPER	TYPE	DESCRIPTION	LINK
Food demand management model	Porto	Tool	Tool to prevent food waste in the social and tourism sectors by forecasting food demand based on historical data.	https://drive.google.com/drive/folders/1Nf85HlVGsQU6-UWfhjoTyL47RDk9TNvL
Circularity decision-making support tool	Porto	Tool	Tool based on a multicriteria analysis method to rate hotels, restaurants, and social institutions' circularity and identify where they can progress.	https://cityloops.eu/fileadmin/user_upload/Materials/Tools/Bio-waste_prevention/PORTO_-_Circularity_decision_making_support_tool.xlsx
Circular Procurement Guidelines for the Social Economy and Tourism Sector	Porto	Guidance	Guidance document to embed circularity within tenders for school catering, social institutions, and green space management.	https://cityloops.eu/fileadmin/user_upload/Materials/Tools/Bio-waste_prevention/City_Loops_Porto_circular_procurement_guidelines_EN_final_version.xlsm
Green space certification system	Porto	Tool	Certification scheme to assess green spaces' circularity and promote sustainable gardening practices.	https://cityloops.eu/fileadmin/user_upload/Materials/Tools/Bio-waste_prevention/wetransfer_green_space_certification_methodology_vf-pptx_2023-01-30_1108.zip
BW flow optimisation app	Seville	Blueprint	Technical report on the BW flow optimisation app, including requirements, functionalities, and list of components.	https://ow-app.idener.es/
Bio-waste innovative sorting and treatment methods	Apeldoorn	Tool	List of innovative sorting and treatment methods to identify the best treatment option for different categories of green space waste.	https://cityloops.eu/fileadmin/user_upload/Materials/Tools/bio-waste_valorisation/Sorting_tool_Apeldoorn.pdf
Bio-waste valorisation decision tool	Apeldoorn	Tool	Decision-making tree to identify the best valorisation option for a given type of bio-waste, taking into consideration baseline conditions.	https://cityloops.eu/fileadmin/user_upload/Materials/Tools/bio-waste_valorisation/Bio-waste_valorisation_decision_tool_%E2%80%93_Apeldoorn.pdf .
Business case development canvas	Apeldoorn	Tool	Canvas to support city administrations and entrepreneurs alike to develop circular business models.	https://cityloops.eu/fileadmin/user_upload/Materials/Tools/Enablers/CircularSquare.pdf

General procurement guide for organic waste management	Mikkeli	Guidance	General guidance document to prevent bio-waste and improve its valorisation in tenders.	https://cityloops.eu/fileadmin/user_upload/Materials/Tools/Enablers/CityLoops_WP3_organic_waste_in_procurement_in_the_city_of_Mikkeli.pdf
Procurement guide for usage of biogas as a motive power in transportation and logistics services	Mikkeli	Guidance	Procurement guidance for (locally produced) procuring biogas for municipal transportation and logistics services.	https://cityloops.eu/fileadmin/user_upload/Materials/Tools/Enablers/WP3_tool_procurement__biogas_procurement_guide_in_Mikkeli.pdf

2. Bio-waste prevention

Waste prevention is at the top of the waste hierarchy, and as such should always be the most preferred option. 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. 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, repair or refurbish are simply not possible here. With 59 million tons produced across the EU in 2020 only, tackling food waste is the most pressing issue, as it accounts for about 16% of the total GHG emissions from the EU food system. Aside from climate change, conventional agricultural practices in Europe are also responsible for substantial biodiversity loss, chemical pollution, nutrient flows alteration and water scarcity. Tackling food waste would therefore mechanically reduce the impacts of food that ends up being lost or wasted. This 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.

This section includes four different instruments, all developed by Porto: the food demand management model, the circularity decision-making support tool, the circular procurement guidelines, and the sustainable green space certification system. These instruments cover two main categories of bio-waste: food waste and green spaces waste. For food waste specifically, this will allow local authorities to prevent waste generated in the HORECA sector (including social institutions) as well as from catering activities.

2.1. Food demand management model

The *food demand management model* aims to prevent food waste in the social and tourism sectors by forecasting food demand based on historical data.

2.1.1. Background

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.

2.1.2. Description

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 data sources used to develop this tool are those provided by the food services, namely historical data on the number of menus served. The information on the menus offered is also used in this project. Besides these, external data, such as data on the weather, has been used. The number of students with classes each day is also used in the case of university canteens and this data is provided by the academic institutions.

Statistical techniques allowed a descriptive analysis of the data to be developed and relationships between the variables considered to be identified. Machine learning techniques such as neural networks, support vector machines, and regression trees support the prediction model's construction. The prediction performance of the models introduced has been compared with the performance of classical forecasting models based on univariate time series and with the estimated demand based on managers' judgment. Machine learning techniques also support determining each variable's importance in estimating each menu item's demand.

Target groups

- Local Governments (Catering)
- Social Economy Sector
- Tourism Sector: hotels, restaurants

Format

- Spreadsheet

2.1.3. Using the food demand management model

The model is available to any city/stakeholder interested in adopting this for forecasting food demand. Its flexibility allows any stakeholder to generate their forecasts given a set of explanatory variables.

The tool can be transposed to any context. However, for it to be used, it is necessary to **gather and structure the historical information that is input to the model**. The model developed is data-driven, and consequently it implies first the definition of the explanatory variables of demand, as well as their collection. Once this collection and corresponding data structuring and pre-processing completed, the tool can be used.

For those interested in using the tool, the most relevant aspect is to store demand historical data, as well as data regarding the characteristics of the menus used in each unit.

Another issue has to do with stakeholder's acceptance of the models. To promote this, we believe that sharing the project results in other cities/units may be very relevant.

ATTENTION POINTS
During the development of the mathematical model and demonstration of the tool some challenges were faced: • Most entities (i.e. restaurants) lack the data needed to implement this tool, or they have different data (financial records) that cannot be used (low quality data). This is a barrier but is also a great opportunity for these entities to improve their food acquisition, since they will be able to forecast their needs based on historical records, hence reducing the bio-waste produced. • Managers (of restaurants) shared the need to have a more user-friendly tool. This is important when developing a tool to be used by someone who is not an expert on bio-waste.

DOWNLOAD
The food demand management model can be found here: https://drive.google.com/drive/folders/1Nf85HlVGsQU6-UWfhjoTyL47RDk9TNvL
Content: the folder includes the spreadsheet as well as user instructions: - *1. First setup.pdf* - *2. How to use the tool.pdf* The file "demand.xlsm" contains historical data collected in Porto, as an example to run the model.

2.2. Circularity decision making support tool

The *Circularity decision making support tool* is based on a multicriteria analysis method; it can be used to rate hotels, restaurants, and social institutions' circularity and identify where they can progress.

2.2.1. Background

In Portugal, while both tourism (hotels and restaurants) and the social sector are big local producers of food waste, they are at the same time a source of under-explored opportunity for waste reduction and prevention. The circularity decision making support tool has been used with restaurants or social institutions managers to move towards a circular vision, working with them from farm to fork.

2.2.2. Description

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:

1. Product acquisition;
2. Storage;
3. Cooking;
4. Customer contact;
5. Surpluses elimination

This organisation helps users identify measures to be taken at different stages. Each measure is subsequently evaluated / scored on its environmental performance according to the Lansink ladder, but also on its technical and economic feasibility. As a result, the user receives a list of measures hierarchised according to the global score of each one. In addition to the environmental hierarchy, the result also allows the organisation to be measured according to their feasibility, facilitating the implementation of a realistic action plan.

The tool was developed based on the multicriteria analysis method. This method is particularly useful for the development of decision-making tools that require not only quantitative, but also qualitative analysis, when problems have aspects that go beyond tangibility. In this way it is possible to define priorities and facilitate the decision-making process in a more rational and reliable way, as it allows the incorporation of important qualitative information.

The defined criteria were:

- Environmental performance, assessed on the impact of the measures in 2 sub-criteria:
- Compliance with the waste management strategy;
- Maintenance of the material value that enters the economy
- Economic evaluation:
- Need for investment;
- Cost / benefit ratio
- Technical evaluation;
- Technological complexity;
- Procedural complexity;
- Complexity of know-how
- Legal framework, within the HACCP standard.

For the development of this tool, the PWC development diagram "The Circular Business Model Avoids Value Leakage"[5] and the strategy for the circular economy adopted by Resolution of the Council of Ministers no. 190-A / 2017[6] were used. To assess the impact of the measure on the waste management strategy, a qualitative assessment was chosen, translated into a score from 0 to 10. To assess the maintenance of material value, we opted for the percentage result of the PWC study, despite the fact it was not possible to verify the basic calculations of the study.

Target groups

- Restaurants,
- Social services canteens,
- Hotels

Format

- Excel spreadsheet

2.2.3. Using the Circularity decision making support tool

This tool is used like an external audit, at two moments: the diagnosis phase, and the evaluation phase.

- Detailed instructions can be found in the spreadsheet itself.
- A detailed account of it can also be found in Porto's Demonstration Report (3.2.1, p.22)[7]

[5] PWC (2019), The road to Circularity, Why a circular economy is becoming the new normal, p.8, available at: https://www.pwc.de/de/nachhaltigkeit/pwc-circular-economy-study-2019.pdf

[6] Resolução do Conselho de Ministros n.º 190-A/2017 - Plano de Ação para a Economia Circula, available at: https://files.dre.pt/1s/2017/12/23602/0005400073.pdf

[7] https://cityloops.eu/resources

DOWNLOAD
The Circularity decision making support tool can be found here: https://cityloops.eu/fileadmin/user_upload/Materials/Tools/Bio-waste_prevention/PORTO_-_Circularity_decision_making_support_tool.xlsx
Instructions are included in the spreadsheet.

2.3. Circular Procurement Guidelines for the Social Economy and Tourism Sector

This guidance document aims is to embed circularity within tenders for school catering, social institutions, and green space management.

2.3.1. Background

In Portugal, while both tourism (hotels and restaurants) and the social sector are big local producers of food waste, they are at the same time a source of underexplored opportunity for waste reduction and prevention. Circular procurement guidelines were developed to improve public, tourism and social economy sector procurement. It also addresses green spaces.

2.3.2. Description

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 for other cities.

Other cities can make use of the tool by applying the presented sets of example criteria that promote circularity in the food and public space maintenance sectors.

Target groups

- Local governments
- Social economy sector
- Food and catering sector
- Green spaces sector
- Tourism sector

Format

- Spreadsheet

2.3.3. Using the circular procurement guidelines

Extensive instructions can be found in the spreadsheet itself, while a case study on it has been implemented by Porto can be found in the Demonstration Report, p22: https://3.basecamp.com/4291695/buckets/14002133/uploads/6319659666

ATTENTION POINTS
When using the procurement guidelines, it is very important: • to ensure the commitment of the board and the political alignment and support. Since this is a tool to be used in public tenders, the whole institution needs a clear sign of political commitment. • purchase departments gather experts but also tackle resistance to change and innovate. It is fundamental to involve, from the beginning, all relevant departments and their staff; • training courses need to be developed for different audiences, since questions arising from each of the audiences will differ. For example, a technical training for purchase departments and another one to suppliers or entities.

DOWNLOAD
The Circular Procurement Guidelines can be found here: https://cityloops.eu/fileadmin/user_upload/Materials/Tools/Bio-waste_prevention/City_Loops_Porto_circular_procurement_guidelines_EN_final_version.xlsm
Instructions are included in the spreadsheet.

2.4. Green space certification system

This certification scheme will allow users to assess green spaces' circularity and promote sustainable gardening practices.

2.4.1. Background

In response to rising concerns related to contemporary urbanisation, from poverty to pollution, residents in cities around the world are asking for improved green areas that are safe to use and are sustainable. Porto Municipality is aware of this and intends to keep improving parks and gardens' management standards, not only by addressing environmental concerns, but also in response to current management challenges and demands from the community. This sustainable green space certification system intends to disseminate sustainable gardening

practices to promote the use of the compost produced at LIPOR's[8] composting plant while reducing the use of chemical fertilisers and pesticides through the adoption of smart and sustainable gardening solutions.

2.4.2. Description

The purpose of the **Green Space Certification System** is to stress the importance of sustainable green space management, through the adoption of good practices for the promotion of biodiversity, the maximisation of benefits provided by the ecosystems and the recognition of spaces where these topics are already being addressed, so that citizens can appreciate and benefit from more natural spaces in urban areas. Active communication and information among citizens/users to promote their engagement is paramount to the success of this conversion process!

One of the main gardening practices is the use of organic compost to improve urban soil quality and highlight the importance of returning nutrients to the urban soil. At Porto Municipality, the use of organic compost produced by LIPOR on the management of gardens and parks reinforce the efforts already in place in the city to increase sustainable green public spaces and the decision made in 2015, to adopt sustainable public green areas management practices, which included the substitution of chemical by mechanical weeding to control unwanted weed growth on public gardens and parks. The option of using compost contributes to this management system by reducing the need of chemical fertilisers, improving soil biodiversity and quality while contributing to mitigating the effects of climate change. The certification system also allows for the creation of dynamic and natural green areas, promoting sustainability, biodiversity and good agricultural practices (through home composting and organic farming). Finally, this certification also promotes contact with nature and quality of life of citizens, and it aims to provide information for them to identify and enjoy safe and environmentally well-managed green areas.

In terms of procedure, urban green spaces are first identified and selected to be analysed for their gardening practices. After filling in a check list with the gardening practices already in use, action plans are then developed to improve sustainable urban garden practices.

Target groups

- Local Governments, green spaces management departments
- Any stakeholders wishing to improve gardening practices.

2.4.3. Using the green space certification system

Porto's Demonstration Report provides extensive descriptions on the certification system (p.34), while detailed instructions can be found in the spreadsheet.

ATTENTION POINTS

[8] Waste management agency for the Porto region, and CityLoops project partner

- It is crucial to involve all the main stakeholders in the process, mainly the coordinating team and the technical team, such as the head of the green spaces' office, the green spaces' manager, and the gardeners' team manager, as well as the gardeners themselves. By doing so, there is a higher chance of achieving greater success with the certification system implementation;
- The improvement plan is always dependent on the financial and operational capacity, and therefore the team should be involved in its definition, they can even suggest alternative possible solutions that meet similar specific objectives/criteria;
- The green space certification system was developed to be applied to diverse green spaces with different dimensions and may respect its specific characteristic (historical, urban, peri-urban, high, or low use intensity);
- It is important that this tool, designed to be applied to different spaces, to remain open to receive improvements from the first pilots. Therefore, it is essential to consider the tool's adaptability to specific spaces. For example, criteria such as water use may be irrelevant in a dry garden or require customisation.

DOWNLOAD
The green space certification system can be found here: https://cityloops.eu/fileadmin/user_upload/Materials/Tools/Bio-waste_prevention/wetransfer_green_space_certification_methodology_vf-pptx_2023-01-30_1108.zip
Instructions are included in the spreadsheet.

3. Bio-waste collection

Separate collection of bio-waste is an absolute precondition for closing the loop of organic matter and diverting it from either landfilling or waste-to-energy valorisation. If in many instances decentralised treatment, such as home or community composting, appears as the most sustainable option, it is usually not suitable for densely urbanised areas. That is why most cities and towns across Europe must set up separate collection schemes by 2023, as required by the revised Waste Framework Directive[9], and engage with different categories of waste producers to make sure that bio-waste is effectively sorted.

Setting up a separate collection system includes a number of technological, organisational, regulatory as well as financial choices, depending on the local context. If in decentralised valorisation, transportation is unnecessary as treatment occurs at the source, centralised options require transportation to the treatment facility. As such, the most common types of collection systems are:

- **Door-to-door or kerbside collection** (e.g, bags or containers): Differentiated waste collection occurs at the user's home, with various waste types collected on different days using different containers and frequencies. Waste is manually collected by municipal workers and loaded into collection trucks. This method lacks end-user control. In some urban areas, conventional door-to-door collection faces challenges due to topography, climate, and limited space, leading to frequent occupational accidents. 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 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, and there is no form of control over the end-users in this collection method[10].

In all cases, separate collection of bio-waste comes with numerous challenges, most of them captured in Mikkeli, Porto and Seville's Demonstration reports. One of the biggest challenges is the additional cost of separate collection that is incurred by waste management authorities. This is why Seville has developed a *Flow Optimisation App*, aiming to identify the optimal collection route for garbage trucks, reducing costs and associated GHG emissions.

[9] European Commission (2020), Guidance for separate collection of municipal waste, available at: https://op.europa.eu/en/publication-detail/-/publication/bb444830-94bf-11ea-aac4-01aa75ed71a1/language-en/format-PDF/source-129395707

[10] ICLEI (2023), Bio-waste Practitioner Handbook, CityLoops, Deliverable 3.11 - not published yet

3.1. Bio-waste Flow Optimisation App

This technical report on Seville's *bio-waste flow optimisation app* includes requirements, functionalities, and list of components, allowing for replication and implementation in other cities.

3.1.1. Background

To comply with the current European objectives in the field of the municipal waste management, the municipality of Seville is seeking to implement various tools and actions in the city to advance the deployment of separate collection systems for bio-waste, its treatment and valorisation as well as the optimisation of its logistics, and raise awareness of households and large bio-waste generators. Seville implemented a bio-waste selective route in an area of the city, looking at optimising every dimension of collection, such as containers or communication campaigns. It also developed a Flow Optimisation App, aiming to identify the optimal collection route.

3.1.2. Description

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. Factors such as type, origin, and volume of the material, CO_2 emissions and loading of the waste trucks, and distance travelled are optimised in a way that minimises negative environmental impact and maximises logistic efficiency of the collection.

Data-driven planning decisions can support the proper scale-up of separate collection to the whole city and help determine the optimal location for new treatment plants and optimal valorisation technologies.

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.

For the back-end part of the application, the data analysis and machine learning were powered by Python libraries. Communication between data sources was managed with Python when

needed. The use of Django as a framework helps to improve the performance of the applications developed with other popular web frameworks. The initial developments were provided to the managers for testing in containers or virtual machines to facilitate direct deployment in any computer. A GitHub repository has been created with a clean Django project to serve as template to implement the initial features of the software tool.

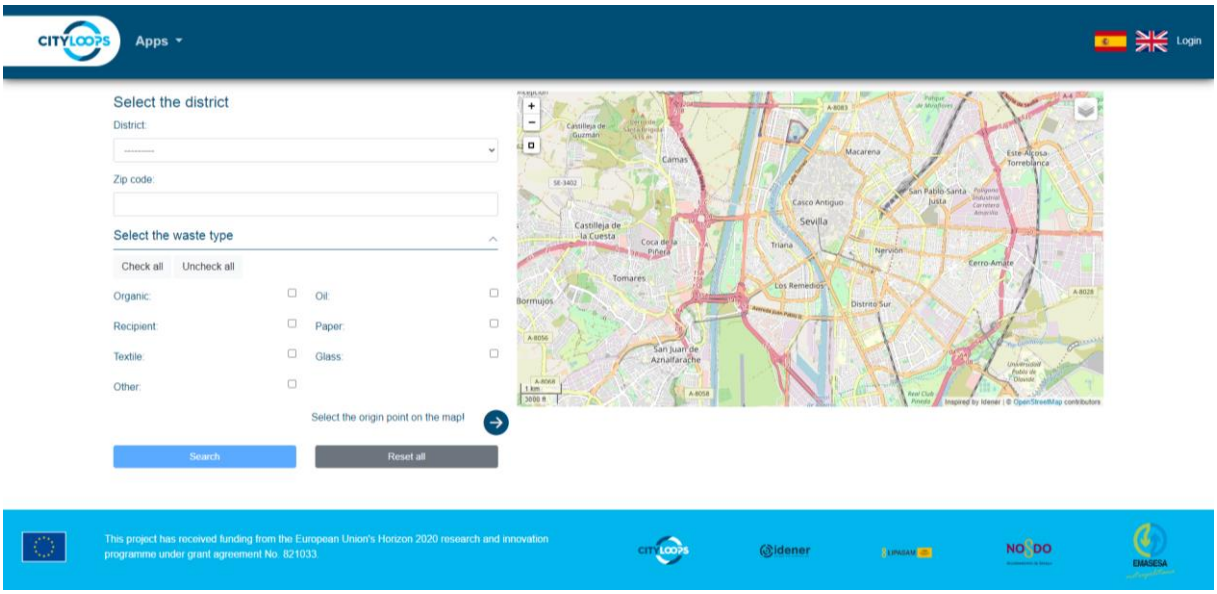
Socio-economic data from available statistical reports on the website of the municipality, municipal waste collection data from Lipasam and open access geospatial data have been used. The main challenges were the availability of data in the required format, and the lack of historic socio-economic data. This made it necessary to proceed to some data formatting, while the lack of data being not possible to solve, the tool and the data analysis methodology had to be adapted to the available data.

Target groups

- Local Governments (waste management)
- Citizens and other stakeholders

Format

- Web-based software



Front-end OMSW optimisation tool.

3.1.3. Using the Flow Optimisation App

The app is unique to Seville since the data analysis and backend use local data.Each city would therefore need to develop their own version. The methodology used has been described in an annex to the Seville Demonstration report[11] so that another city could replicate the tool

[11] https://cityloops.eu/resources

based on the local context and data availability/format, and develop different functionalities as required.

To see in more detail the technology used for the development of the platform and a detailed description of its functionalities, please see Seville's Demonstration Report, Annex I.

ATTENTION POINTS
• Having historic socio-economic data as well as environmental data is important in order to achieve accurate results. • The collaboration of partners is crucial for data collection, since there is not always relevant data at the necessary scale in open data platforms. • The tool and the data analysis methodology need to be adapted to the available data, which should help to cover any data gaps.

DOWNLOAD
The Flow Optimisation App can be found here: https://ow-app.idener.es/
A technical report on the development of the tool, including requirements, functionalities and list of components can be found annexed to Seville's Demonstration Report: https://cityloops.eu/resources/key-publications

4. Bio-waste valorisation

The benefits of separate collection can only be harnessed with effective valorisation (or treatment) of collected bio-waste. The most common treatment options are composting and anaerobic digestion. In line with the waste hierarchy, the bio-waste treatment technology that allows the greatest recovery of both material and energy is generally the environmentally preferable option. However, the nature of waste collected as well as context (collection system in place, state of soil, importance of primary sector…) also greatly influence both the sustainability and the feasibility of valorisation option[12]. In this section, an instrument developed in Apeldoorn provides users with an overview of sorting and treatment methods for different types of green spaces waste, to support decision making.

4.1. List of innovative sorting and treatment options for bio-waste from Green Spaces

This *list of innovative sorting and treatment methods* can be used to identify the best treatment option for different categories of green space waste.

4.1.1. Background

Bio-waste that is collected from households, industry or in this case green spaces contains impurities: components that are undesired or hamper the use of bio-waste in the circular economy. Removing these impurities is crucial to enable the correct processing of this material stream. One of the options envisaged to create value from bio-waste rather than having to pay to discard bio-waste is the cleaning of bio-waste by the city.

Whether a component is considered an impurity depends on the requirements of the envisaged valorisation strategy. Impurities can be divided into two groups.

1. The first group consists of materials that are biologically not considered to be part of biomass: e.g. Sand, Plastic, Metal, Glass, Paper packaging (boxes, cups, bags, drinking cartons). These impurities are undesired in almost all recycling processes.
2. The second group consists of components that are biological, but not the desired material for a selected circular process. Examples are bark, when wood is desired, twigs when leaves are desired, moss when grass is desired, or leaves when the stalks of Japanese Knotweed are desired.

[12] European Environment Agency (2020), Bio-waste in Europe — turning challenges into opportunities, p.21, available at: https://www.eea.europa.eu/publications/bio-waste-in-europe

4.1.2. Description

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 Biobased 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:

- Washing (active)
- Washing (passive)
- Filtration
- Sink-float separation
- Hydrocyclone
- Wind sifting
- Fluidised moving bed separation
- Inclined vibration screening
- Electrostatic separation
- IR cleaning
- Cutting
- Grinding
- Drying (active)
- Drying (passive)
- Pressing
- Municipal cleaning

Several experts in the field of sorting and treating techniques within Wageningen Research and the City of Apeldoorn were contacted to compose a list of existing (existing for 1 field of application may be new for another field) and innovative approaches. Several sorting techniques were tested at the lab scale, focussing on bio-waste from the public spaces of the City of Apeldoorn: leaves, grass and pruning. In addition, public websites of providers of sorting and treating techniques were reviewed to collect information. Based on the public information sources and our own expertise, key descriptions of the sorting and treatment approaches were prepared, completed by a short indication of input and output bio-waste qualities. Finally, the description of the treatment approaches was reviewed by experts from Wageningen Research.

Target groups

- Local Governments (public space maintenance, waste management, circularity management)
- Businesses

Format

- Report

4.1.3. Using the list of bio-waste innovative sorting and treatment methods

The knowledge described in this tool has been used in the demonstration actions from Apeldoorn, with a comparison of initial bio-waste feedstock characteristics and requirements of feedstock for specific business cases, and by finding suitable sorting and treatment approaches.

Basically any owner of bio-waste can follow the following approach: 1) Review the basic quality of the bio-waste, 2) Scan the (report) tool for sorting and treatment techniques and approaches which allow upgrading specific aspects of biowaste quality, 3) Get in touch with the potential buyer of the bio-waste feedstock to verify required feedstock qualities, and 4) Select the required treatment(s) and arrange actual sorting and/or treatment, either by the bio-waste owner themselves, or by hiring a third party.

As long as respective sorting and treatment approaches are new to a city, involving an independent adviser (e.g. R&D institute, university) may reduce the reliance on the well-meant but potentially biased advice of customers of the bio-waste.

This *list of innovative sorting and treatment methods* can be used as a complement to decision-making support tools developed by Apeldoorn, i.e. the *bio-waste valorisation tool* and the *business case development tool*.

ATTENTION POINT
• Current use of bio-waste is mostly limited to composting and biogas production, pre-treating biowaste to be suitable in other applications is a new step. The strengths and challenges in using bio-waste in industrial applications are mostly unknown to industries that are currently using wood or fibre crops as raw material. The effect of new sorting and treating methods on the applicability of the bio-waste in industry will therefore need to be demonstrated in larger scale trials.

DOWNLOAD
The list can be found here: https://cityloops.eu/fileadmin/user_upload/Materials/Tools/bio-waste_valorisation/Sorting_tool_Apeldoorn.pdf

5. Enablers

This final section gathers instruments that are not restricted to any specific stage of the value chain or of the organic matter lifecycle. Rather, they cut across those various stages and act as enablers of the closing and shortening of material loops.

A first series of instruments has been developed by the municipality of Apeldoorn and Wageningen research. They aim to inform decision-making of local public actors, respectively with a *bio-waste valorisation tool* and a *business case development tool*.

The other two instruments are related to public procurement (i.e. the purchase of works, goods and services by public sector organisations), with a *General guide for organic waste management in public procurement* and a *Procurement guide for usage of biogas as a motive power in transportation and logistics services*, both developed by Mikkeli. Circular procurement is a powerful lever for cities and towns in the transition to a circular economy. By including circular criteria in tenders, local authorities can operate more sustainably, reducing for example their GHG emissions. By procuring circular work, goods, or services they can also support the development of innovative business models.[13]

5.1. Decision-making support

5.1.1. Bio-waste valorisation decision tool

This decision-making tree will allow to identify the best valorisation option for a given type of bio-waste, taking into consideration baseline conditions.

Background

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. To identify the most sustainable options, but also assess their feasibility and more strategically determine which one should be pursued by the municipality own service and which one should be outsourced to the private sector, this bio-waste valorisation decision tool was developed and used.

Description

This tool aims to help cities to choose between all kind of possible valorisation options for bio-waste prior to deep diving into all the details of a circular valorisation option.

[13] Ellen McArthur Foundation (2019), Circular economy in Cities: An overview of urban policy levers, p.23, available at: https://ellenmacarthurfoundation.org/policy-levers

During the preparation phase of CityLoops a selection of four different valorisation options was made to demonstrate in Apeldoorn. The selection process was based on a set of parameters, ideas, and dreams of a future circular city regarding bio-waste and public spaces.

The input for the tool consists of four distinct factors:

- Factor I: Policy goals of the city
- Factor II: Circular economy principles (butterfly, waste hierarchy)
- Factor III: Parameters of the bio-waste (amount, type, availability, composition, quality…)
- Factor IV: Parameters of possible converting processes (TRL, economic viability…)

The tool built on interviews with several experts in collection and treating of biowaste and in industrial applications of biowaste within Wageningen Research and the City of Apeldoorn. Lab scale tests were performed to obtain the composition and technical properties of biowaste from public spaces in Apeldoorn. During the demonstration activities the decision tree will be further refined using the results from the production trials on larger scale.

While the *list of innovative sorting and treatment methods* details every valorisation option for different types of green spaces waste, the bio-waste valorisation decision tool considers a plurality of criteria, some related to bio-waste but also considering political and environmental factors, to inform decision making. Once the best valorisation option has been identified, ideas can be turn into viable projects, organisations, or businesses using the *Circular Square Canvas*.

Target groups

- Local Governments (public space maintenance, waste management, circularity management)
- Businesses using bio-waste as raw material

Format

- Decision tree with report

How to use the bio-waste valorisation decision tool?

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, 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 can also be used by industries that want to use biomass. This decision tree enables interested industries to discuss with Apeldoorn the optimal steps to obtain bio-waste fit for their application (e.g. bio-waste without impurities, with higher fibre strength). Currently the use of bio-waste in industry is mostly limited to composting or biogas production. Understanding the

relation between handling of bio-waste and desired properties may result in opening up new opportunities for upcycling.

The transition towards a circular, biobased economy requires a large input of biomass. Besides wood and non-food crops other sources of biomass will be needed to replace fossil oil-based materials. Without proper care in collection, storing and pre-treatment alternative biomass sources as bio-waste are not suited for most industrial applications. This decision tree will connect the knowledge of owners of bio-waste with the knowledge of bio-based industries. Any city that would like to increase the value of the bio-waste could use this decision tree to start the discussion with industry.

DOWNLOAD

Link to instrument:

- https://cityloops.eu/fileadmin/user_upload/Materials/Tools/bio-waste_valorisation/Bio-waste_valorisation_decision_tool_%E2%80%93_Apeldoorn.pdf

5.1.2. The Circular Square canvas

This canvas will support city administrations and entrepreneurs alike in developing circular business models.

Background

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. To identify the most sustainable options, but also assess their feasibility and more strategically determine which one should be pursued by the municipality own service and which one should be outsourced to the private sector, this Circular Square canvas was developed and used.

Description

The canvas is designed to provide insight into the costs and benefits of a circular bio-waste project. This canvas is referred to as Circular Square and can be used to develop a business plan. Apeldoorn tested the Circular Square canvas to select promising valorisation options, and assess their robustness, from a triple techno-economic, social and environmental perspective, and based on several co-dependent activities:

- Description of a business model from a city's viewpoint
- Description of a business model from an entrepreneur's viewpoint
- Overview of technical possibilities starting from bio-waste
- Overview of bio-based industries and initiatives interested in using bio-waste
- Stakeholder engagement between cities, citizens and entrepreneurs

- Description of circular city selection criteria

Circular Square offers a complete overview of how to establish a business plan for a circular economic based cost-benefit analysis for any project. The business case in this plan is a supply chain description, including People, Planet, Profit and will help to set up the total business plan for the idea in bio-waste.

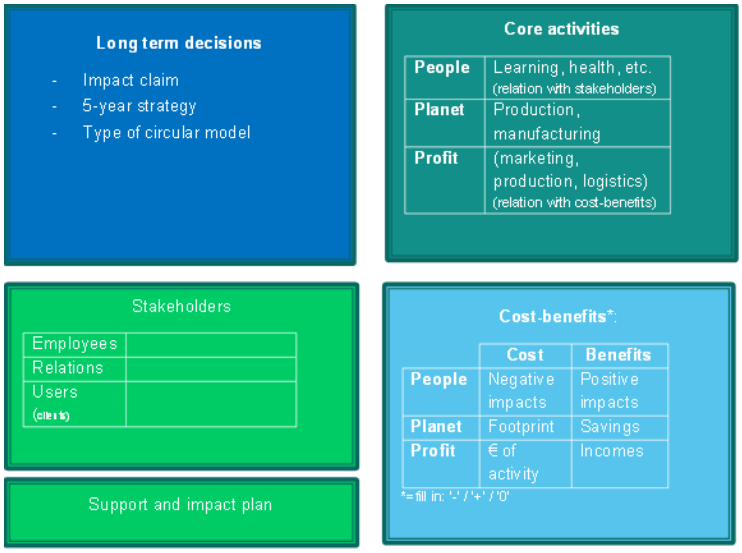


Figure 1: Canvas of the CircularSquare-canvas as developed by Apeldoorn

A business case is part of a business plan. While the plan is the total overview the idea, the business case describes meticulously the most important activity whether the activity is interesting to invest in; Invest in profit, people, or planet. Circular Square can inspire the first steps of circular procurement: In the Circular Square the ambitions of a new project are set. By setting ambitions beforehand and clearly prioritising certain circular strategies a starting point for the interaction with stakeholders is established. The gathered information can be used in the tendering process.

The selection process combined information and knowledge from the City of Apeldoorn and Wageningen Research. Business models were selected from literature and adapted from previous experience in setting up valorisation routes from biomass. Specific attention was given to obtaining information from biomass stakeholders.

Target groups

- Local Governments

Format

- Report

How to use the Business case development tool

The transition towards a circular city regarding bio-waste is enabled by setting up techno-economically, socially, and environmentally sound business cases. The process of selecting

valorisation routes by the City of Apeldoorn could be used as an example for other cities that are looking into opportunities to upcycle bio-waste.

Beyond valorisation decisions, the Circular Square canvas aims to turn ideas into viable projects, organisations, or businesses. As such it complements the *bio-waste valorisation decision tool.*

DOWNLOAD

Link to instrument:

- https://cityloops.eu/fileadmin/user_upload/Materials/Tools/Enablers/CircularSquare.pdf

5.2. Procurement

Practitioners can use this guidance document to prevent bio-waste and improve its valorisation across tenders.

5.2.1. General guide for organic waste management in public procurement

Background

Within CityLoops, Mikkeli has been looking at increasing both quality and quantity of collected bio-waste, while simultaneously reducing the percentage of bio-waste in the collected mixed household waste, and the amount of bio-waste that is incinerated. As part of this effort, the municipality developed a *General guide for organic waste management in public procurement*, aimed at improving the sorting of bio-waste produced by the administration.

Description

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 reducing 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's 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.

It builds on interviews of transportation experts, procurement experts, private consulting experts related to the local transportation development plan and experts of food and cleaning services in the city of Mikkeli.

How to use the general procurement guide?

Replication for other municipalities and cities could be useful especially for the rural cities and municipalities of the same size as well as cities or municipalities that promote the reduction and reuse of organic waste and its handling process end products.

DOWNLOAD

<Link to instrument>

https://cityloops.eu/fileadmin/user_upload/Materials/Tools/Enablers/CityLoops_WP3_organic_waste_in_procurement_in_the_city_of_Mikkeli.pdf

5.2.2. Procurement guide for usage of biogas as a motive power in transportation and logistics services

This instrument will inform tenders aiming at procuring (locally produced) biogas for municipal transportation and logistics services.

Background

Within CityLoops, Mikkeli has also explored new processing and end-product optimisation techniques in both laboratory- and pilot-scale to produce biogas as a fuel for vehicles from bio-waste, and the production of soil amendments from the nutrients present in the digestate, residual streams from the biogas production. As part of this demonstration work, a guide has been written to support the procurement of biogas for transportation needs, with the ambition to contribute to the closing of organic loops at the local level while also securing an outlet to the biogas plant.

Description

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 promotes

demand of 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 process, tenders and documents of traffic, transportation, and logistics contracts in the city of Mikkeli.

Using the biogas procurement guide

The principles of the Biogas procurement guide have already been used in several procurement processes implemented in the City of Mikkeli and good experiences have been gained in the city by adding criteria of sustainability, low carbon dioxide emissions and the usage of biogas as a motive power in public procurement process. Procurement guides and support documents for Mikkeli can give ideas for other cities on how to consider the circular economy in tenders. However, the procurement guides need always to be adjusted to city specificities.

the following accompanying reports showcase successful examples of promoting the use of biogas as motive power in logistics related procurement:

- Procurement report of local transport procurement process
- Procurement report of waste transportation procurement process

DOWNLOAD

Link to instrument:

https://cityloops.eu/fileadmin/user_upload/Materials/Tools/Enablers/WP3_tool_procurement__biogas_procurement_guide_in_Mikkeli.pdf

Link to case studies:

- Procurement report of local transport procurement process
- Procurement report of waste transportation procurement process

6. References

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Resolução do Conselho de Ministros n.º 190-A/2017 - Plano de Ação para a Economia Circula, available at: https://files.dre.pt/1s/2017/12/23602/0005400073.pdf

CITYLOOPS

CityLoops is an EU-funded project focusing on construction and demolition waste (CDW), including soil, and organic waste (OW), 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 OW, 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.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 821033.