




# CIRCULAR Bio-waste in PORTO

## Demonstration Report

PORTO



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Abstract	Within CityLoops, Porto has endeavoured to close and shorten material loops in the bio-waste stream through five Demonstration Actions, respectively by 1) setting up a separate BW collection scheme in densely populated areas and promoting community composting in others, 2) promoting circularity in hotels and social institutions, 3) developing a green space certification scheme, 4) organising a circular innovation contest and mentoring scheme, and lastly 5) supporting a food redistribution network. This report describes the implementation, results and conclusions of these demonstration actions.
Keywords	Bio-waste, circular economy, sorting of waste, food waste prevention, tourism sector, green space management
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# 1. Executive summary

Bio-waste, one of the largest fractions (around 37%) of Porto urban waste, plays a key role in sustainable waste management. Nowadays, and with the new waste legislation, food waste prevention, bio-waste local treatment and centralised treatment are the focus of the European waste management hierarchy.

Located in the north coast of Portugal, along the river Douro, Porto is the second most important city of the country, with around 232,753 inhabitants (INE 2021) and an average population density of 5 619,3 inhabitants/km<sup>2</sup> (INE 2021), 13% of the inhabitants of Porto Metropolitan Area and 7% of the North Region of Portugal. Porto is surrounded by 16 other municipalities (AMP – Porto Metropolitan Area) that combine a unique range of assets, from industries and universities to agricultural land, gives it an innovative and strong profile and a favourable position to improve the food system through a circular economy.

In the context of the CityLoops project and following the environmental strategies of Porto, including the Roadmap for a circular city 2030, several demonstration actions regarding bio-waste were implemented by the Porto Cluster. The cluster, comprised of Porto Municipality, Porto Ambiente (municipal waste collection company), LIPOR (inter-municipal waste management company) and 2GoOut Consulting, tested the following demo actions:

- Bio-waste selective collection and local treatment model;
- Bio-waste circularity in the tourism and social sectors;
- Launch of Green Space Certification System;
- Circular Entrepreneurship Initiatives;
- Reducing food waste by a donation network.

## ***Bio-waste selective collection and local treatment model***

This demonstration action has two axis of action:

- Implementation of a new selective collection route for food waste with smart containers in order to direct the waste to centralised treatment in LIPOR facilities. This was done by Porto Ambiente and integrated on the already existing routes.
- Testing of a new localised treatment model for food waste, with the installation of two composting islands in two different neighbourhoods of the city. This task was headed by LIPOR.

Both tasks had a big component of awareness raising by the population. On the one hand, the selective collection requires a commitment from the population in separating the food waste from the remaining household waste. To support this effort, a specific kit was given with a small 7 litre container and an access card. On the other hand, the community composting required the surrounding population to deposit their food waste on the street containers specifically installed for this objective.

**Results:** A new route was implemented with the installation of 120 street containers for food waste with electronic controlled access, covering 15 000 families. Until now 3 new jobs were created, and more than 330 tonnes of food waste were collected.



Two community composting spaces were created in Paranhos and Amial neighbourhoods, with 15 composting bins and 177 families/households participating. Up to February 2023, 9,16 tonnes of bio-waste were locally treated and 2,75 tonnes of compost were produced and distributed by the community.

### ***Bio-waste circularity in the tourism and social sectors***

Focused on the prevention of bio-waste production and increasing circularity for the HORECA and social sectors, LIPOR developed a circularity model to be adapted and use on the trial institutions:

- Grande Hotel do Porto (historic hotel in Porto downtown);
- Castelo de Santa Catarina Hotel (hotel in Porto downtown);
- Somos Nós Association (social institution for disabled people).

The model focused on all stages of food management, from the moment that food is bought to its disposal, changing acquisition habits, valorising food waste locally and monitoring data to continuously improve the tools developed.

Results: All entities reduce their food waste, improve their knowledge on the organic farm production, food sustainable consumption and selective collection. In general, the level of bio-waste circularity increased.

### ***Launch of Green Space Certification System***

Based on sustainable management practices for green spaces, LIPOR and Porto Municipality developed and are implementing a Green Space Certification System for public and private spaces. Certification criteria covers three big areas of green spaces' management:

- User;
- Water and Nutrients recirculation;
- Biodiversity and Landscape;

The certification system involves diagnosis, training, implementation of improvements and final evaluation.

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.

Results: 350 l of compost were applied on the chosen spaces, reducing water evaporation and closing the loop on urban nutrients, since NUTRIMAIS (LIPOR's compost) is made from Porto bio-waste and organic certified. New species were planted on all of them but adapted to the spaces and taking into consideration the previous plants. On Calçada das Virtudes, the one with a big slope, drainage ditches were dug to reduce water velocity and soil erosion.

### ***Circular Entrepreneurship Initiatives***

To stimulate circularity with fresh ideas and increase the population engagement in the cities challenges, Porto Municipality launched a circular entrepreneurship contest – [FoodLoop](#). The contest had no monetary prize, but instead, a two evaluation stages to evaluate the evolution of applicants' ideas: a bootcamp to transform the 20 best ideas in pilot projects and a six month mentorship to develop the 5 winners' projects in regarding their business models and value proposition.

An active communication campaign was done with several formats: online communication, face-to-face ideation workshops, dedicated 15 min presentations to specific audiences and physical outdoor publicity around the city.

**Results:** 23 applications, 15 of them accepted the challenge to go through the Bootcamp. In the end 5 of them were the FoodLoop winners

- Ground4food - Valorisation of coffee grounds for the production of micro greens;
- PortoType - Local and small bio-digesters using hydrogen fuel cell technology to produce biogas, methane, hydrogen and fertilizer compound;
- Symbiosis Agriculture Industry - Economically viable and local production in a dynamic greenhouse with hydroponics using the wasted resources of industrial labour (heat, CO<sub>2</sub> and water);
- UPCYCLING Porto - transformation of “big data” into “small data”, that is, into indicators related to food waste/perishable foods and make them accessible through the Porto Card, preventing their waste;
- AgriTech4Youngsters – bridging agricultural production with robotics learning through the installation of automated farmers, designed to grab and take grown up vegetables on grow beds.

### ***Reducing food waste by a donation network***

To reduce food waste with a high environmental and social impact, LIPOR and Porto Municipality joined forces to implement a food donation network across Porto territory. This network connects donors of leftovers (still edible) and receivers (social institutions) introducing new practices of food conditioning that follow food safety regulation and are recognised by Health and Regulation national bodies.

**Results:** From May 2021 to December 2022, there were 14 donors and 6 receivers, 207 957 equivalent meals were distributed by 12 083 families, and 104 tonnes of food waste were avoided, resulting in the prevention of 437 tonnes CO<sub>2</sub> eq emissions

### ***Lessons learned***

A summary of the main conclusions is presented:

- New tools and equipment need to take into account the users’ needs, the ease of adoption and the adaptation to the reality of social institutions, households or hotels;
- Planning is key. Bio-waste management needs to be a key factor in urban planning and design, defining specific areas for public spaces to have waste collection and/or local treatment;
- Political commitment is fundamental on key moments to reinforce the importance of circular economy on the team and on the region;
- Circular Procurement allows to create a systemic change through public purchasing. The commitment and the engagement of the board and of the purchase departments is of fundamental importance to succeed on the implementation of these circular procurement practices;
- For local entities, it is very important to recognise the state of art on circularity applied to bio-waste sector, and more broadly to food system, to understand where can be done improvements;
- For behaviour change, awareness campaigns are never enough. Specific needs were identified to increase impact: continuous improvement and diversification of campaigns (visuals, methods of engagement), more powerful communication platforms to really

change behaviours, such as national TV or outdoors (national television does not promote awareness and consciousness, promotes unethical consumption);

- From the experience of making awareness raising campaigns in supermarkets, it was possible to understand that these types of places are not good for territory specific campaigns, like the ones described in chapter 3.1.1. People who go supermarkets are not necessarily inhabitants from that area and don't have the time to listen because they are focused on buying goods and go home.
- The population participation and engagement are the key to the success of the project;
- Give feedback to all the stakeholders is a way to keep the connection and the commitment through the action's implementation. Our experience shows that feedback is the key for involvement motivation and the success of the initiatives. Feedback gives a sense of belonging and reinforce the importance of being present and active on the activities and reinforces the power of networks and groups. On the other side, not giving feedback after inviting entities/persons to participate feels like they were used just to fulfil a specific need, breaking trust and commitment from all sides.

### ***Assessment of scalability and replicability***

CityLoops results, integrated on Porto Municipalities strategies and ambitions, such as the Roadmap for the Circularity of the City or the Climate Pact, are expected to be replicated at a regional level. Moreover, the fact that the municipality of Porto is one of the 8 municipalities that constitute LIPOR, provides a valuable opportunity for demonstrating the effectiveness of these actions and tools, and replicating and adapting them regionally.

The Porto team recommends that a shared investment approach should be taken to replicate new tools, which could be done by the municipalities of LIPOR, for example. Recognising the importance of innovative tools also implies risk sharing due to the need for adaptation to new realities, new territories and new stakeholders.

Some tools developed in Porto need little adjustment to be replicated, such as the **local treatment. community composting spaces** and the **food donation network**. Nevertheless, is always important to reflect on the improvements needed presented on this report.

The **selective collection and circularity models** were developed and implemented in the very specific context of Porto's waste management system and the social and tourism sectors of Portugal. Therefore, the team recommends that a careful assessment of the specific context of each city is undertaken before replicating these tools.

The **green space certification** needs to consider local climate, native species, and place specific needs. Nevertheless, the model developed, and the areas of evaluation can be replicated directly, since sustainable urban green spaces management lives upon the three pillars of this demonstration action: User, Biodiversity and Landscape, and Water and Nutrients recirculation.

Regarding the **circular entrepreneurship initiative**, it is important that municipalities take the risk of testing new proposed ideas. Implementation of ideas, instead of money or technical training, could be used as the contest prize. The face-to-face ideation workshops proved to be a promising way to involve citizens and students, as it provides them with a great opportunity to think outside the box and gain specific knowledge related to the problems that their local community faces.

In general, the replicability of demonstration actions always needs a certain degree of adaptation to the local context. Participatory workshops, as well as the realisation of "on-site"

visits are an appropriate methodology to share and identify potential barriers, problems and also opportunities. The team believes that the lessons learned from demonstration actions are crucial to their replication.

## 2. City context

### Description

Located in the north coast of Portugal, along the river Douro, Porto is the second most important city of the country, with around 232,753 inhabitants (INE 2021) and an average population density of 5 619,3 inhabitants/km<sup>2</sup> (INE 2021), 13% of the inhabitants of Porto Metropolitan Area and 7% of the North Region of Portugal. Porto is surrounded by 16 other municipalities (AMP – Porto Metropolitan Area) that combine a unique range of assets, from industries and universities to agricultural land, gives it an innovative and strong profile and a favourable position to improve the food system through a circular economy (Figure 1).

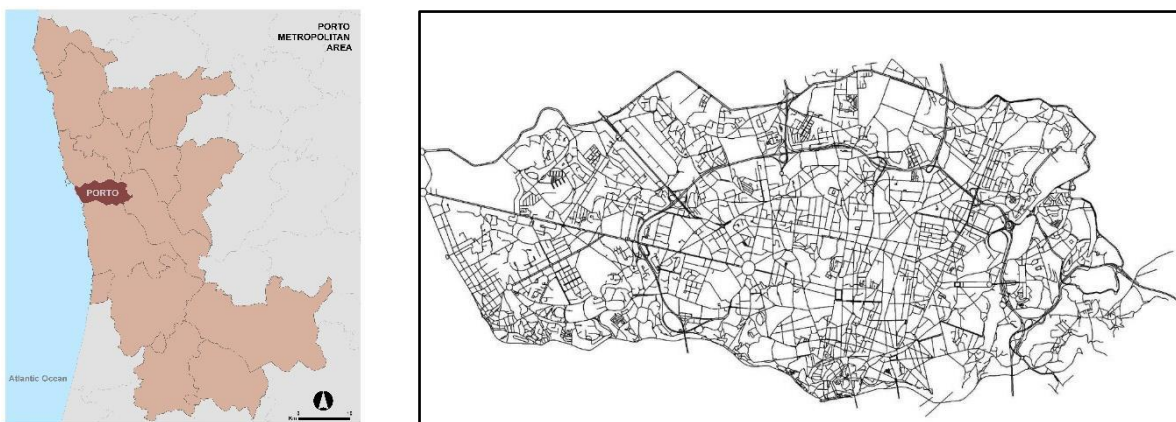


Figure 1 - Porto Metropolitan Area and Porto Municipality map (source: city of Porto)

Porto Municipality has suffered high population decline over the last decades. However, it has seen a small population growth since 2017, partially as a result of the city's rising reputation as a place to live. There is, however, a continuous influx of population for reasons of work or study, which increases the population in 72,3% every day in Porto territory (INE 2011).

Porto is the beacon of Porto Metropolitan Area (PMA) with 2 040 km<sup>2</sup>, 1 736 228 inhabitants and an average density of 851 inhabitants/km<sup>2</sup> (AMP 2023). From 2011 to 2021, there was a small population decline of 23 296 inhabitants (a reduction of 1,3%) ([Pordata](#), 2021).

At the municipal level, in 2022 Porto produced 140 775 tonnes of municipal waste, from which 35 000 are from selective collection (recyclables and bio-waste from households, restaurants and similars) and the remaining are mixed waste, that is transformed to energy by LIPOR. Bio-waste represents 37% of the total amount of selective collection (12 950 tonnes). Overall, each inhabitant produces 1,66 kg/day of municipal waste in Porto Municipality. This value is influenced by the floating population of Porto:

- The number of people who work or study in the city but lives outside;
- The number of tourists.

The estimates from Porto Ambiente are that, daily, 400 000 persons use the territory (residents and non-residents).

LIPOR is a public company managed by the eight municipalities where performs its activity: Espinho, Gondomar, Maia, Matosinhos, Porto, Póvoa de Varzim, Valongo and Vila do Conde.

Located in PMA, LIPOR is responsible for the managing, recovering, and treatment of urban waste. Every year, LIPOR treats around 500 000 tons of urban waste which is produced by about 1 million inhabitants from the eight municipalities. Besides this, LIPOR has developed an integrated management strategy based on four key solutions: multimaterial sorting plant, composting facility, waste to energy plant and landfill. All the system is supported by a waste prevention and a strong communication strategy. It is important to mention some specifications about the LIPOR waste management system.

Regarding the financial aspect, taxes are only charged regarding the mixed waste valorisation on the waste-to-energy plant. Bio-waste and multimaterial flows are free of charge for all eight municipalities.

Regarding the organisational aspect, the board of administration comprises a representative from each of the eight municipalities, which ensures a coherent and committed approach to waste management and decision-making at the regional level.

### ***Food system context***

Porto Metropolitan Area has a great variety of rural, urban and peri-urban territories, which is an important factor to take into account to plan and implement circular and sustainable strategies and plans at a regional scale.

As one of the main economic drivers of the northern region of Portugal, Porto Municipality is driven by a highly developed transport network for products. The economic activities of Porto are mainly focused on the tertiary sector, especially financial activities, real estate, and services. In the last years, there was a rapid growth in the tourism sector, with a significant increase in overnight stays, making it a more economically appealing sector. However, primary sector activity, such as agriculture, is of little economic relevance, employing only 0,27% of the working population. The small local farmers, producing either for their own consumption, for sale to individuals, or for collaboration with agricultural cooperatives.

Porto municipality also has 13 municipal urban vegetable gardens (integrated in the "[Horta a Porta](#)" project in partnership with local entities) spread through the city occupying 4.5 hectares. These allotments are available for families to produce their own organic vegetables and benefit from the contact with natural cycles.

Most of the food distribution in Porto Municipality is done through various retail infrastructures, from supermarkets to hypermarkets or convenience stores, which follow the Portuguese trend of long food supply chains and concentration of products (90% of the food available).

### ***Porto Municipality's environmental and circular strategy***

Porto Municipality's environmental strategy was launched in 2014, followed by the climate change adaptation strategy in 2016 and the circular economy roadmap for 2030 in 2017. These documents reflect the support and the importance of sustainability across the territory. Since 2019, with Porto being one of the focus cities of EMF study "[Cities and circular economy for food](#)", the food system has been an important axis of sustainable action taking a holistic vision of the whole system, bio-waste being part of it.

Looking to support short supply chains with local/regional food, Porto Municipality continues to promote or support local markets with the purpose of supporting the local economy, such as the iconic [Bolhão Market](#), the centenary market where can be found fresh products, from fruit, vegetables, fish and meat, and the several street markets, that are usually held on a

weekly basis, and where a wide variety of products, from clothing, live animals, plants and flowers and food products can be found. Led by the Municipality, there is also the weekly market of organic products, ongoing since 2004 in the West city park, and the “[Good Food Hubs](#)” initiative, since 2022 in faculties promoting the connection between the organic producers and consumers (using a digital platform/app to sales and face-to-face markets and events), both stimulating local/regional production and consumption. These initiatives encourage local and regional production and consumption by bringing producers from the metropolitan area and North region to the city and promoting direct encounter between producers and consumers, thereby reducing the number of players in the food value chain.

Regarding the bio-waste sector in Porto, an estimated 51.145 tonnes of bio-waste were generated in 2022 (Porto Ambiente), of which only 24% was collected separately. All the bio-waste collected separately was sent for organic valorisation at LIPOR composting plant, however there is yet a high potential of bio-waste recovery and recycling from unsorted bio-waste amounting to around 37%, that currently is being sent to LIPOR waste-to-energy plant.

The bio-waste selective collection began in 2007 applied to the HORECA sector (hotels, restaurants, cafes) and supermarkets. Only in 2018, it was possible to expand to households in some areas of the city, covering less than 1% of the population. Subsequently, in 2021, the new project – [Orgânico](#) – also supported by CityLoops, allowed the implementation of street bins in other residential areas of the city, reaching 60%.

Bio-waste management has become one of the major concerns in Porto Municipality and is a priority in its urban agenda, due to increasing touristic activity and large numbers of work and study related commuters and the resulting generation of waste with its adverse impacts on public health and the environment.

Regarding food waste initiatives, there are some that are already in place such as: ‘[Dose Certa](#)’ project; ‘[Embrulha](#).’ project, ‘[Zero Desperdício](#)’ Network and ‘[Solidarity Restaurants](#)’.

In order to successfully implement these projects, some support should be provided to the population. This includes providing incentives, training, inclusion and active involvement, communication campaigns - to improve both the quality and the results of its implementation. In the Municipality of Porto, an active involvement and communication campaigns are already in place but without economics incentives yet.

Beyond these projects, the Municipality also introduced social and sustainability principles in their public procurement processes and promotes education and awareness campaigns to ensure that healthy and sustainable food is recognised and consumed by the public, as well to ensure that citizens understand the importance of preventing food waste. For Porto Municipality it is important to integrate policies related to food and health in an innovative perspective, ensuring food quality and healthy diet (Ellen MacArthur Foundation 2019), while increasing the sustainability of the food system with lower or zero carbon footprint to preserve or improve the local environment, promote social integration and inclusion and support employment.

All the initiatives and actions mentioned above integrate the roadmap to a circular Porto by 2030 launched in 2017 and are aligned with the systemic approach to the food system that Porto Municipality is applying and goes beyond the bio-waste selective collection.

Porto Municipality considers important to create mechanisms to support and scale up initiatives that comprise a) local/regional organic food and city’s possible food autonomy, b) access to

healthy and sustainable food, c) food waste prevention and maximizing the use of food resources, d) increase the selective bio-waste collection and closing nutrients cycles, e) and awareness raising about food system challenges to people and local organizations, contributing to reduce environmental negative impacts, to increase resources efficiency and reduce external dependencies of raw materials. These main ambitions also are great opportunities to decrease social inequalities, promote healthier food, generate new business opportunities, and close the biomass cycle.

The roadmap for a circular city is an ongoing process in constant update and all the actions, such as the Cityloops' demonstration actions, contribute to implementing circularity in Porto Municipality applied to the food system.

It is worth noting that Porto's city dynamics and vibrant community, which include residents, workers, visitors, and organizations, rely on an interdependent relationship with the peri-urban area and surrounding municipalities. Porto Municipality recognizes the value of collaboration and partnership with neighbouring municipalities, organizations, and people from the region. By participating in multi-sectoral and multi-actor projects, the city creates opportunities for meeting and sharing experience and knowledge, mobilizing diverse actors to adopt circular best practices and transition to a circular economy applied to food system in a transversal way at the regional level.

Projects such as CityLoops, which counts with LIPOR's partnership (with an inter-municipal action in 7 more municipalities, beyond Porto), and the Circular Economy Network of collaboration launched by Porto Municipality, in 2017, reinforced by the implementation of the CityLoops Collaborative Learning Network (CLN) at local level, are concrete examples of these practices. To participate in the CLN, all the municipalities from Porto Metropolitan Area were invited with intention to join efforts to transit to a circular economy.

### 3. Demonstration Activities

The demonstration action of CityLoops conducted in Porto Municipality aims to find innovative ways to decrease the food and other bio-waste generation, to improve separate collection, and to boost the sustainability of the local food system, in a social inclusive and just way. These actions focus on the social economy sector, the tourism sector (restaurants and hotels) and residential neighbourhoods with high-rise buildings – primarily via improving bio-waste collection systems and facilitating both reuse and composting. These are complemented by circular procurement recommendations for organisations in these three sectors.

In this context, the demonstration activities can be summarised as follows in next sub-chapters:

- Bio-waste selective collection and local treatment model
- Bio-waste circularity in the tourism and social sectors
- Launch of Green Space Certification System
- Circular Entrepreneurship Initiatives
- Reducing food waste by a donation network

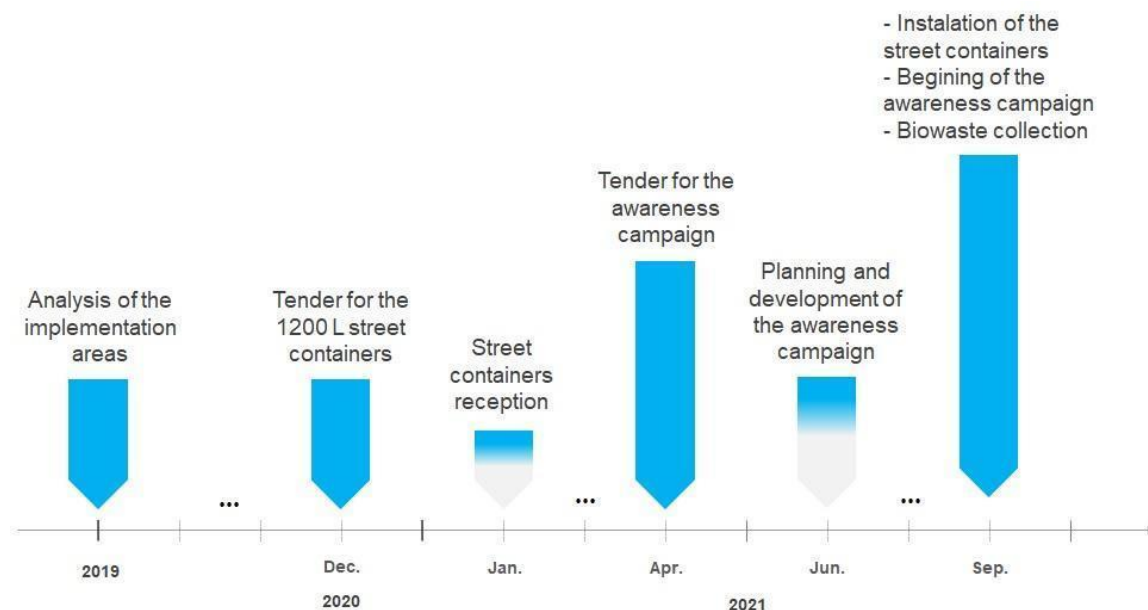


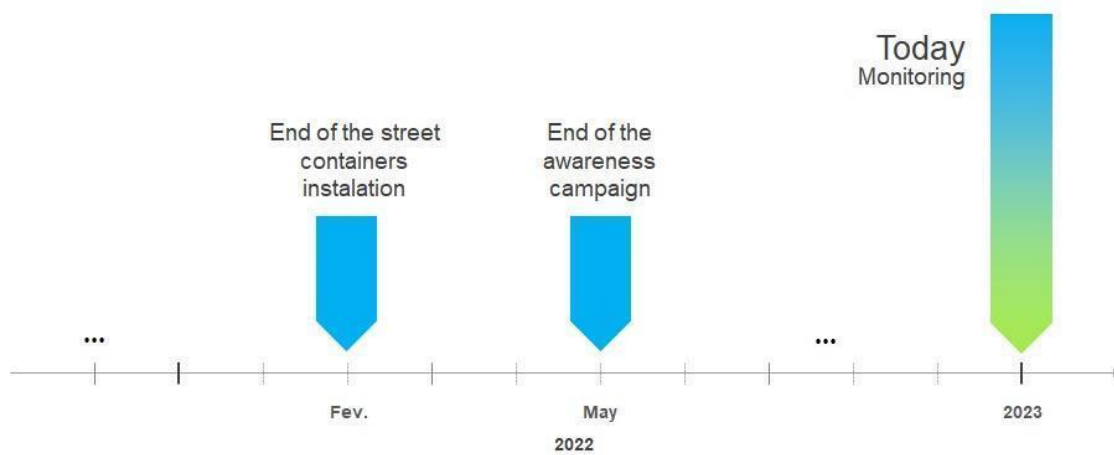
## a. Bio-waste selective collection and local treatment model

### 3.1.1. Bio-Waste Selective Collection

Porto Municipality aims to promote its bio-waste circularity by improving bio-waste selective collection with street containers and by implementing community composting islands in some neighbourhoods.

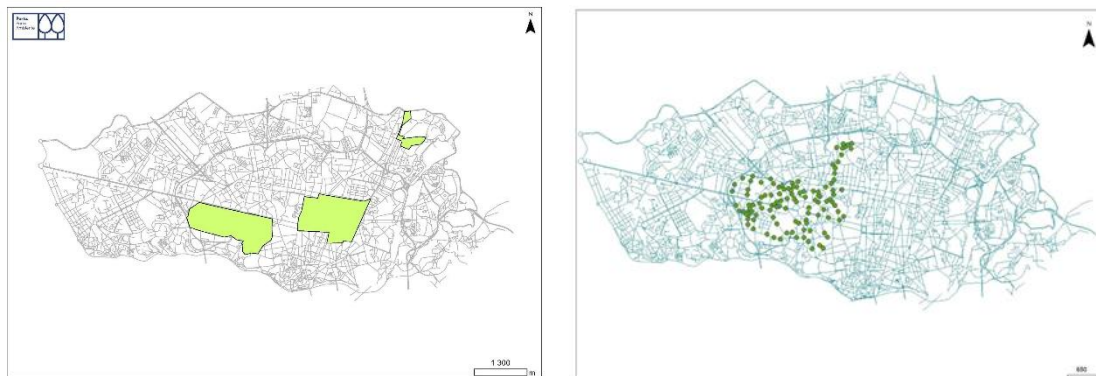
Regarding the food waste selective collection, the implementation of this action comes in line with the food waste selective collection with street containers already implemented in Porto Municipality early in 2021. With this implementation it seeks to achieve about 15.000 households, which represents an addition of 10% of population in Porto Municipality. To carry this out, it is necessary to acquire more than 120 street containers of 1200 litres with electronic controlled access. Besides this, it is also necessary to develop an awareness raising campaign and communication materials for population's engagement focused on the city inhabitants (HORECA and similar producers have selective collection since 2007 – see [chapter 2](#)). Figure 2 shows a chronological timeline with all the steps that were taken to implement this demonstration action.





*Figure 2 - Chronological timeline of the implementation of the bio-waste selective collection*

Therefore, back in 2019, the implementation areas were chosen by using geographic information tools, considering areas with high population density. Besides this, high food waste potential areas were considered, as well as areas with the best operational conditions, such as space conditions next to the existing street bins and accessibility to the waste collection truck. The area chosen for the implementation of this action was in Boavista and Bonfim, as shown in Figure 3.



*Figure 3 - Areas chosen for the implementation of selective collection (on the left) and final location of street containers implemented (on the right)*

Following the selection of the area, the procurement process for the 1200 litres street containers was initiated. After this in 2021, the procedure to hire the awareness campaign was started. However, due to challenges in finding a supplier that could guarantee the correct performance and maintenance of the electronic lockers, and the pandemic caused by COVID-19, delayed these acquisition procedures.

Although the pandemic has slightly delayed the take-off of this action, it began in September 2021 with the installation of the 120 street containers for food waste with electronic controlled access. The installation lasted approximately 6 months.

However, it was necessary to slightly modify the initial chosen areas of implementation due to some operational issues, such as territorial integrity to ensure the articulation between other projects on going, as well as some delays on the procedures to acquire the equipment needed.

The new area chosen is shown in Figure 3. Simultaneously with the installation of the street containers, the awareness raising door-to-door campaign began in the chosen areas. This campaign followed the “Projeto Orgânico” (Figure 4) graphic line, which implementation started early in April 2021 in Porto Municipality.



*Figure 4 - Awareness campaign image and street action with the banana mascot*

During the door-to-door awareness campaign, “kits” were handed out to each household containing a 7-litre bin, 2 electronic cards to open the street container, informative brochures and project related promotional gifts. Moreover, during this campaign people were advised on how to correctly separate food waste, including the disallowance of using any type of bag, whether plastic, paper or biodegradable ones.

Beside these door-to-door campaigns, street activities were also promoted near the highest population density areas, as well as the ones with high buildings. During these street activities, a banana mascot was used to attract the younger audience (Figure 4) and the awareness technicians remained close to buildings and households’ entrances. Additionally, awareness campaigns in the nearby supermarkets and commercial surfaces were also promoted to try to attract more people to the project, especially those who were not able to get their “kit” during the door-to-door campaign. These types of actions were a requirement in the awareness campaign public tender. One of the award criteria for the tender was the presentation of a protocol with some of the commercial surfaces to allow the campaigns to be held in their spaces. To carry out these actions, face-to-face itinerant structures were created, with informative counters. The awareness campaign lasted approximately 8 months and ended in May 2022.

As expected, the selective collection of food waste in the street containers was also initiated in September 2021, simultaneously with the container’s installation and its respective awareness raising campaigns.

With the installation of more than 120 street containers, it was necessary to create a new collection route with these new collection points and hiring 3 employees. The way in which different technical solutions and different tools were developed and tested improve the knowledge, allowing to expand of the circularity network with propriety and foundation. The truck used for the collection has specific features for the food waste collection, including a washing system that allows the collection and the maintenance of the containers, at same time.

The initial purpose was to complement these containers with a **Smart Collection System tool** based on a mathematical model that will integrate data from the newly installed set of smart sensor containers with the transportation trucks. The tool was not developed due to the inexistence of conditions to share information with the Academy and other sector's companies. The data protection laws really conditioned this information sharing. (see Table 1 - Smart collection system tool description)

Furthermore, with the project development and analysing the results obtained, the creation of a dynamic collection route proved to be not necessary, since the collection frequency is determined by the typology of waste itself and not by the container's filling level. Considering the high container's capacity, the collection frequency of 2 times per week (to avoid unpleasant odours and the spreading of insects) and the estimated production of bio-waste, there's no need to change the execution of the established collection route.

*Table 1 - Smart collection system tool description*

<b>SMART COLLECTION SYSTEM TOOL</b>
<p>The idea of this tool was to monitor not only the participation rate of each household but also the use rate of the street containers. These are important pieces of information to help in the decision of enhancing awareness raising campaigns or eventually in the reallocation of the street containers. Due to constrains the mentioned below the tool was not developed and the collection route will be supported by the tool developed by Seville Municipality.</p>
<p><b>Lessons learned</b></p> <ul style="list-style-type: none"> <li>● Through the development of this tool, there were some issues that hamper its implementation. Take into consideration the lessons below prior to the implementation of this type of solutions.</li> <li>● The national market for the supply of the electronic lockers proved to be inefficient, regarding specifically the support to fix the damaged ones. This is a critical point for the success of this type of tools and DemoActions, since broken lockers do not retrieve the needed data and are permanently open or closed, leaving the containers vulnerable to contamination of other waste flows.</li> <li>● Besides this, also the integration of the tool data into the Porto Ambiente data system was quite difficult. The suppliers' market has very closed solutions and do not promote the open-source ones, which is the strategy followed by Porto Ambiente for the development of the information system.</li> <li>● Even though the initial tool was not developed, this presented an opportunity for synergies with other cities in the project, such as Seville. In the design phase of the project, some solutions seemed possible, however during the implementation phase, contextual factors and barriers emerged or changed. It is very important to have this in mind when developing and implementing circular economy projects.</li> </ul>

### 3.1.2. Bio-waste Local Treatment

At the same time, Porto Municipality started to test a local treatment model as a complement to the other envisaged solutions for bio-waste (home composting and door-to-door selective collection) (Figure 5). Below it is possible to see the implementation scheme, highlighting the most important steps.

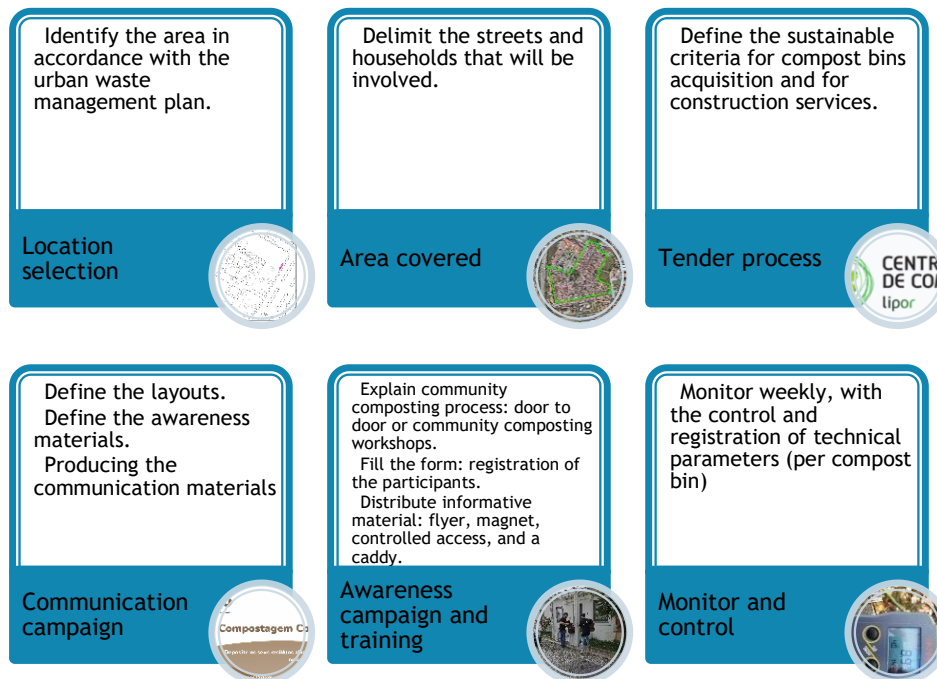


Figure 5 - Local treatment process

During 2020, two areas for community composting sites were identified. The criteria to select *Bairro do Amial* and *Bairro de Paranhos* was the typology of buildings (without private gardens or with small areas, and therefore not suitable for home composting), public areas available and waste services already planned by Porto Ambiente (for example, these areas were not part of bio-waste selective collection) (Figure 6).

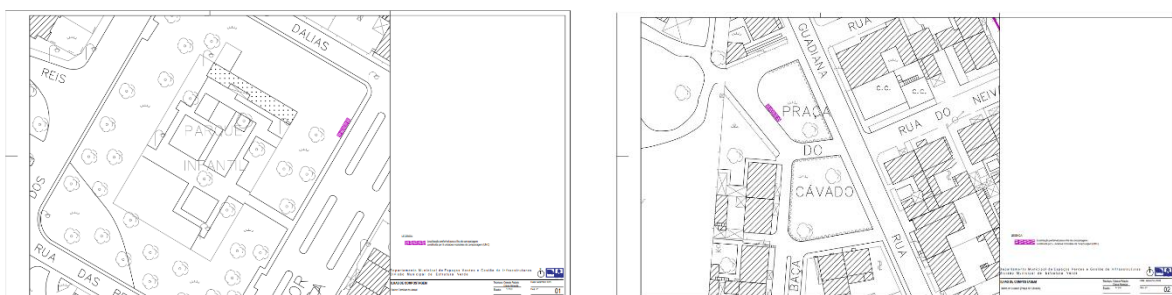


Figure 6 - Location of the two community composting areas: Amial neighbourhood (on the left) and Paranhos neighbourhood (on the right)

By locally promoting workshops and/or door to door explanation on composting, the residents are encouraged to start the process in their own neighbourhood. After the workshop, each household received a flyer, a magnet, and a caddy, plus the possibility of receiving *in loco* or remote support, if any doubt may occur.

Between December 2020 and July 2021, the tender process, acquisition, construction, and installation of the community composting sites was the priority. Circular procurement guidelines were applied in this stage (see link for the tool below). For the success of this solution, a local awareness campaign to engage citizens of the surrounding areas was needed. The idea was that this campaign could be extended to associations and other entities with head offices located close to the composting islands, assuring the integration of composting into the community social dynamics, and increasing user's number. Communication materials were defined, developed, and produced: flyers, information boards, magnet, digital communication and a caddy (Figure 7 and Figure 8). These materials contain information related to composting process, such as what is possible to throw into the compost bin, how to use compost and a contact information.



Figure 7 - Communication materials for the families: flyer, magnet and the caddy



Figure 8 - Communication materials on the community composting spaces.

In August 2021, the door-to-door information campaigns started in the two selected neighbourhoods by gathering participants' registration. At the time of registration, participant received composting workshops and the communication materials (Figure 7 and Figure 8). To support promotion and increase the community engagement, two local associations were invited to be partners: *Transformers* (youth association) and *Associação de Moradores do Bairro do Amial* (neighbourhood residents association). *Transformers* helped in dissemination of communication campaigns and *Associação de Moradores do Bairro do Amial* hosted a composting workshop for the residents. This was the beginning of the composting island!

At this stage the "Compost Master" was introduced, a person that will be the face of these community composting areas. The key responsibilities of the "Compost Master" are the weekly

monitoring of the compost bins, including the control and registration of technical parameters, logistical and administrative activities and ensure communication and awareness with residents. It is important to emphasize the role of the compost master, a paid role created to answer some previous identified challenges. The compost master is the face of the composting islands and is the main link between the participants and the equipment, the main contact for doubts and the proximity person that inhabitants relate to.

In May 2022, an event was organized to celebrate the first production of compost in the two community composting sites “Sharing the first compost produced” (see Figure 9). This event was hosted by Porto’s Vice Mayor Filipe Araújo and all the participants were invited.



Figure 9 - Compost delivery event from the community composting sites.

## 3.2. Bio-waste circularity in the tourism and social sectors

### 3.2.1. Bio-waste Circularity Models

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. Bio-waste (BW) circularity models will be implemented at a local level, directly with these sectors helping them to improve their sustainability, moving towards a circular vision, working with them from farm to fork.

The models outline a set of actions to be implemented along the bio-waste life cycle and in accordance with the reality of each pilot. In parallel **a series of tools and support actions** are also presented, which will allow supporting the implementation of the Circularity Models. (see [chapter 3.2.2.](#))

#### Methodology

The implementation of the BW circularity models will follow a 5-steps methodology, from a diagnosis phase until the recognition (Figure 10). The action plan phase will be done prioritising

the actions to be implemented in accordance with each entity needs, which in turn will define different timelines for each step.

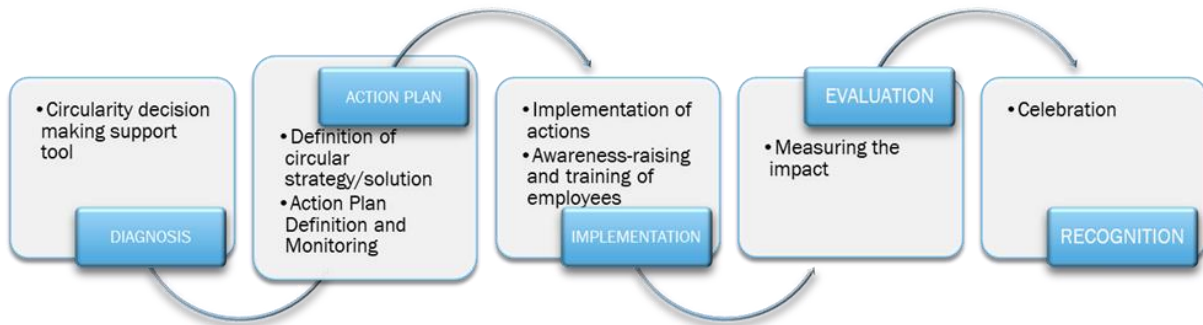


Figure 10 - Bio-waste circularity models methodology

In success of the Tourism and Social Sectors (Hotels, restaurants, and Social Entities) relies on the willingness and commitment of the administration. All the staff should be involved in the whole process and the most important step is the diagnosis phase that will determine the success of the entire model. In addition, staff rotativity should be taken into account since it is a sector with high turnover rates.

**DIAGNOSIS PHASE:** In this phase the **Circularity decision making support tool** is applied (see Table 3 - Circularity decision making support tool description). With this tool the circular management organic materials flows are analysed, and the level of circularity is measured, identifying the good practices and the improvements needed, allowing to select the measures that may increase the circular performance.

The **circularity decision making support tool** is applied, identifying the good practices which already exists and the ones that may improve the circular performance of the entity (hotel or social institution). The tool analysis the waste flows from waste prevention to waste recycling, and for this reason it is important to focus on solutions that cover the first waste hierarchy levels (prevention/reduction, re-use, recycling) like food production availability (rooftop, green area); food waste reduction (Dose Certa Project; Embrulha. project); bio-waste valorisation (local treatment; selective bio-waste collection), and training and awareness campaigns).

**ACTION PLAN PHASE:** With the results of the diagnosis phase, the circular strategy/solution for the entity (hotel or social institution) and the development of the action plan are developed. This action plan includes the definition of the monitoring process and the results expected from each entity. The idea is to implement local solutions that offer the best circular performance for the entity.

**IMPLEMENTATION PHASE:** In this phase the measures/actions that will provide the best circular performance are implemented in the entity (for example, local vegetables production, food waste reduction strategies, BW selective collection):

- a) *Local Vegetables Production:* To complement the food purchasing, the hotel or social institution can be encouraged to create its own space for food production, involving staff, clients, or beneficiaries, depending on the area available for food production:



- Rooftop or land space used for in-house vegetables production: vegetables and aromatic herbs, medicinal and culinary plants were planted. These gardens not only provide fresh ingredients for the menus but also serve as a potential leisure and relaxation spots for people (Figure 11).

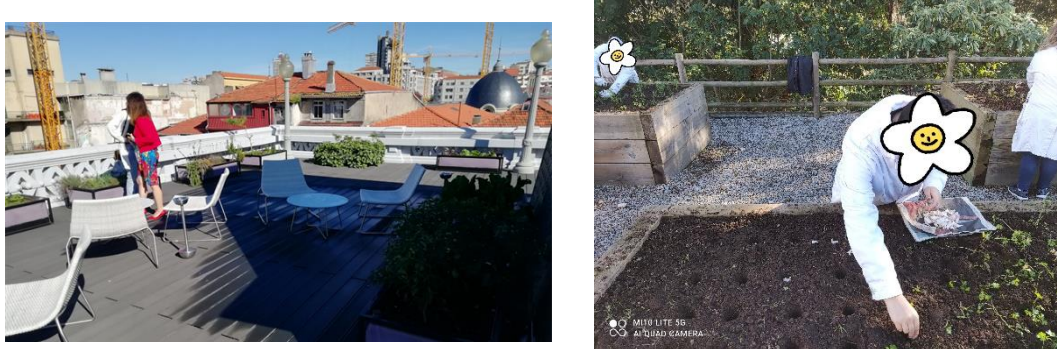


Figure 11 - Local vegetables production: rooftop (on the left) or allotments (on the right)

- b) *Food Waste Reduction*: "Dose Certa " Project (Right Portion) could be implemented to reduce food waste production and promote sustainable food consumption. By accounting and characterising the food waste (edible food, non-edible food and soup) produced by the restaurant it's possible to point out where the food is wasted. In partnership with Portuguese Association for Nutrition (PAN), it is possible to adjust the quantities that are served to the client thus reducing the food waste (potential reduction estimated around 30%). Combining the two approaches - analysing food and waste produced on the preparation of meals and training chefs, cooks, and staff for a more conscious planning of meals - it is possible to effectively reduce the amount of food waste produced in restaurants, resulting in meal cost reduction (Figure 12).



Figure 12 - Dose Certa analysis for food waste reduction  
Circular Bio-waste in Porto: Demonstration Report

- c) Urban Waste separate collection: with a customised waste intervention service for entities, a specialised, technical support in operating its waste management process was implemented, to improve not only participation but also the quality of the waste collected.
- d) *Training*: Changing adult behaviour is not an easy task, but with the use of workshops and training on topics such as organic farming, waste reduction, waste separation and environment protection can yield positive results. The most innovative aspect of this approach is involving all the staff responsible for providing a dining service around food waste reduction, sustainable diets, and circular procurement, as a way to demonstrate the simple steps that each of us could do to start to become more circular in our work, community and life, such as:
- Buy by season and locally;
  - Recipes by season to cook seasonal fresh foods;
  - In the menu, indicate that the side dish can be changed;
  - In the menu, minimize the variety of ingredients used in dishes to maximize opportunities for cross-use;
  - Make colourful meals that contrasts with the colour of the plate;
  - Use bruised fruit to prepare fruit skewers, smoothies or jams;
  - Communication about this subjects with staff and customers.

**EVALUATION PHASE:** In this stage, the **Circularity decision making support tool** will be used once again, this time to demonstrate to the entity the achievements and the impact of each measure/action implemented. The idea is to show the before and after in terms of circularity, as well as the impacts achieved:

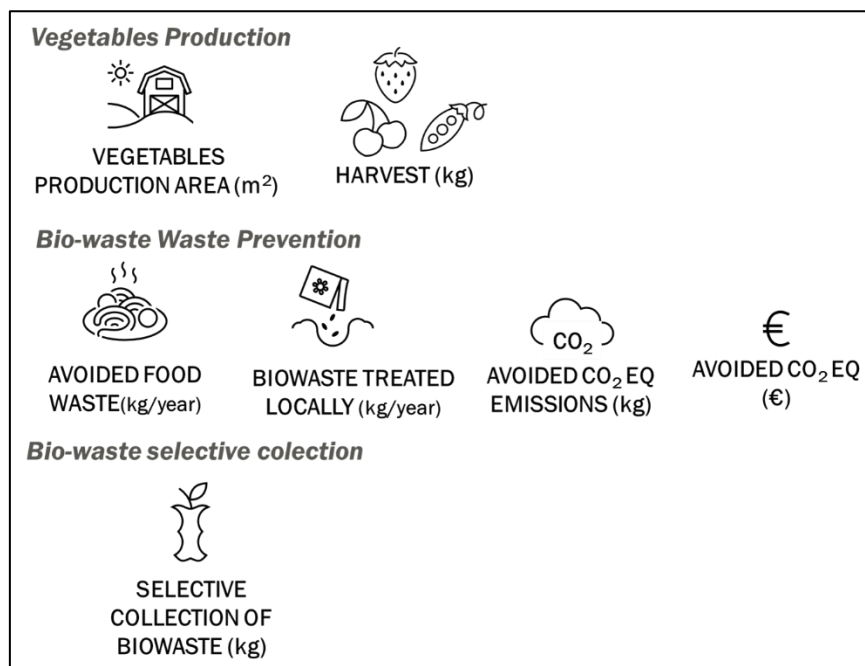


Figure 13 - Impact indicators to be presented after the circularity decision making support tool application.

**RECOGNITION PHASE:** celebrate the achievements with the entity giving them a “Coração Verde” (Green Heart) certification or “Aqui dizemos não ao desperdício” (Here we say “no” to food

waste) stamp (specific for restaurants). This is the moment where all the team receives the certification “Coração Verde”. This recognition could be presented in a moment where all the entities involved are present. Some of these entities are the Hotel (Administration and Staff), the Municipality, the Waste management company, and the Portuguese Association of Nutritionists, among the ones that have contributed to the model in one way or another (Figure 14).

In Porto Municipality this Bio-waste Circular Models has been implemented, first in the Grande Hotel do Porto (Tourism Sector) and then in Joaquim Urbano Hospital where the Joaquim Urbano Temporary Reception Center (JUH) (Social Institution) is installed.

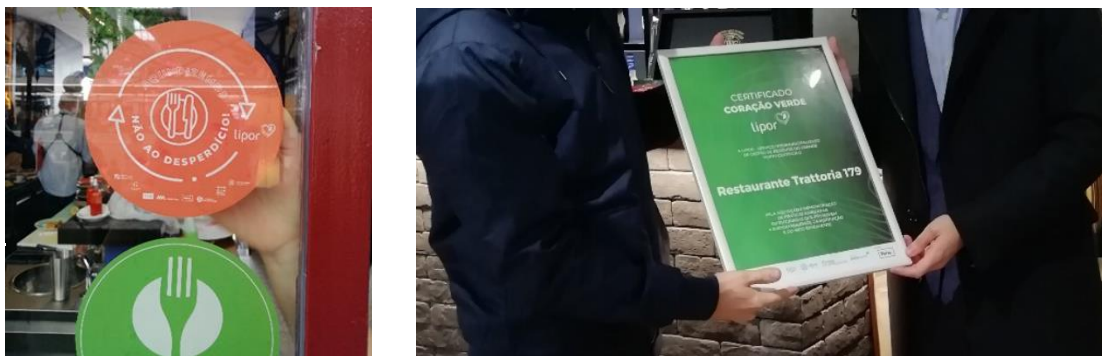


Figure 14 - recognition stamp for restaurants (on the left) and "Coração Verde" certification (on the right)

### IMPLEMENTATION IN THE TOURISM SECTOR – HOTELS

Grande Hotel do Porto (GHP) opened its doors on 27 March 1880. Playground for the nobility and aristocracy from all around the world, a haven for spies, politicians and exiles, a privileged setting for artists, bohemians and intellectuals, many elected Grande Hotel do Porto as their home in town. To attend guest’s needs and give them the best possible experience, the hotel has been modernized, adapting to today’s demands, with the objective of offering comfort to those who seek charm in central Porto (Figure 15).



Figure 15 - Hotel: Grande Hotel do Porto

At GHP the sustainability practices are not mandatory, but a natural way of being. For this reason, GHP accepted the challenge to implement the BW circularity model, with the safeguard that the pandemic situation could compromise all the work. The **circularity decision making support tool** was applied, identifying the good practices which already exist and the actions that will improve the circular performance of the GHP. With this results the action plan for a circular solution for the GHP was made, with the definition of the main actions: in-house vegetables production on the rooftop; food waste deduction by Dose Certa project; urban waste separate collection; Technical Training (Figure 16).



Figure 16 - Local vegetables production on hotel's rooftop (on the left), food waste reduction with "Dose Certa" (on the center) and urban waste separate collection (on the right).

The implementation and evaluation phases were concluded and the **circularity decision making support tool** was applied. The main results for the GHP are shown in Figure 17:

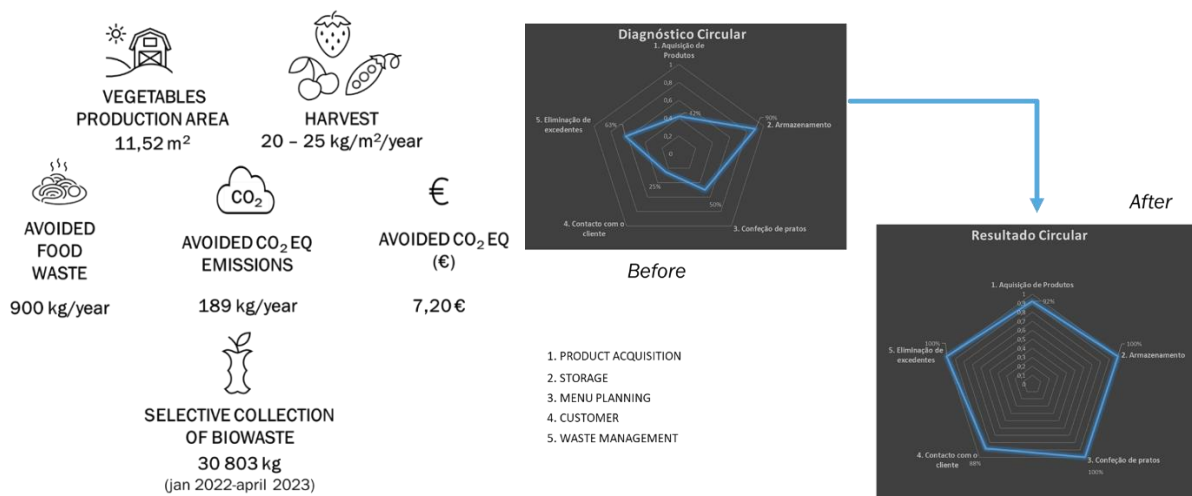


Figure 17 - Results from the implementation of circular models in Grande Hotel do Porto

Castelo de Santa Catarina Hotel (CSCH) is located in central Porto, and it is considered one of the most romantic hotels in the city. It is an emblematic Heritage building steeped in history, where tradition meets modernity (Figure 18).



Figure 18 - Castelo de Santa Catarina Hotel (Source: Booking)

The **circularity decision making support tool** was applied, identifying the actions that would improve the circular performance of the CSCH. From the results, the action plan for a circular solution was developed, with the definition of the main measures: food waste reduction by Dose Certa project; urban waste separate collection; and technical training. CSCH concluded with success all the measures and the circularity decision making support tool was applied. All the phases are concluded and the **circularity decision making support tool was applied**. The main results, in terms of bio-waste circularity, for the CSCH are presented in Figure 19:

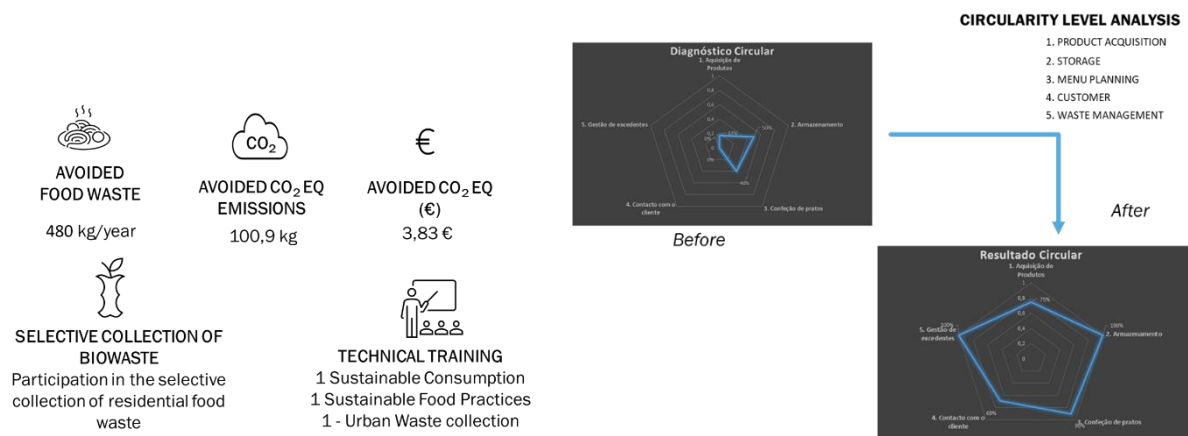


Figure 19 - Results from the implementation of circular models on Castelo de Santa Catarina Hotel

## IMPLEMENTATION IN THE TOURISM SECTOR – RESTAURANTS

In Portugal, both locals and the increasing number of tourists have lunch or dinner in restaurants. In Porto, the second largest city of this country, restaurants are numerous and

invariably waste from leftovers is produced (Figure 20 - Traditional amount of food for 1 person. The picture shows one of the 300 different codfish dishes in Portuguese cuisine. Figure 20).



Figure 20 - Traditional amount of food for 1 person. The picture shows one of the 300 different codfish dishes in Portuguese cuisine. Figure 20).

To reduce the food waste in Porto restaurants, the biodegradable foodie bag, Embrulha, was extended to take home leftovers. This foodie bag was distributed free of charge for leftovers among restaurants in Porto. The initiative was successful and extended, with updated branding and impact measurement, leading to recognition in the form of a stamp given to participating restaurants (Figure 21). This initiative supported the bio-waste circularity model for restaurants, which could respond efficiently to the food waste problem. The Embrulha is more suitable for a specific type of restaurant, usually the restaurants with traditional services/menus.



Figure 21 - Embrulha package with the new image

The involvement of the owner and staff is crucial for the success of this solution, but also communicating it to target clients, as well as promoting the use of this biodegradable packages (in a fancy way). This was important to shift how people perceived food waste. Instead of being a “poor man’s” thing, the fancy Embrulha package is something people are not embarrassed with. Each restaurant, owner, and staff received information and an explanation about the project, their role and the monitoring requirements (Figure 22).



Figure 22 - Explanation and materials for the restaurant

All the data has been collected and represented in a digital dashboard: restaurants involved, number of Embrulha packages distributed and quantity of food waste and CO<sub>2</sub>eq emissions avoided (Figure 23). In Porto Municipality, 56 restaurants received the stamp recognition “Aqui dizemos não ao desperdício” with the food waste reduction of 3,1 tonnes in 2021 and 6,7 tonnes in 2022 (see Figure 23).



Figure 23 - Power BI with all data. (source on the following [hyperlink](#))

## IMPLEMENTATION ON THE SOCIAL SECTOR – SOCIAL INSTITUTIONS

The Joaquim Urbano Temporary Reception Center (JUH) (Figure 24) is a social response destined to homeless people, where during temporary accommodation, a multidisciplinary team ensures psychosocial support, personal hygiene, and clothing, five meals a day (breakfast, lunch, snack, dinner and supper), laundry, nursing, psycho pedagogical and ludic-recreational activities. In JUH the diagnosis phase **Circularity decision making support tool** was applied with the development and implementation of the related action plan. JUH is working on Food Waste Reduction, with Dose Certa project.



Figure 24 - Joaquim Urbano Temporary Reception Center

During the implementation phase in JUH, some operational difficulties and constraints were identified, for example lack of human resources, operational issues or change in the staff, which jeopardised the successful implementation of the model. Therefore, an alternative entity was selected: Somos Nós Association (Social Institution).

Somos Nós Association is a Private Institution of Social Solidarity, created by parents and friends of young adults with disabilities, who have reached the end of their school life and need alternatives for their personal and professional fulfilment. Their personal fulfilment goes through the interaction with the community, not only enjoying the training, culture, and leisure spaces that it provides, but also through the execution of useful tasks for that same community, which stimulate their abilities and self-esteem (Figure 25)



Figure 25 - Somos Nós Association (source <https://somosnos.pt/>).

In September 2022 the **Circularity decision making support tool** (see Table 3 - Circularity decision making support tool description) was applied and the main actions were: in-house vegetables production on land space; food waste reduction by Kaizen in the kitchen and Dose Certa project; Urban Waste separate collection; technical training. Somos Nós Association concluded all the phases of the implementation phase (Figure 26).

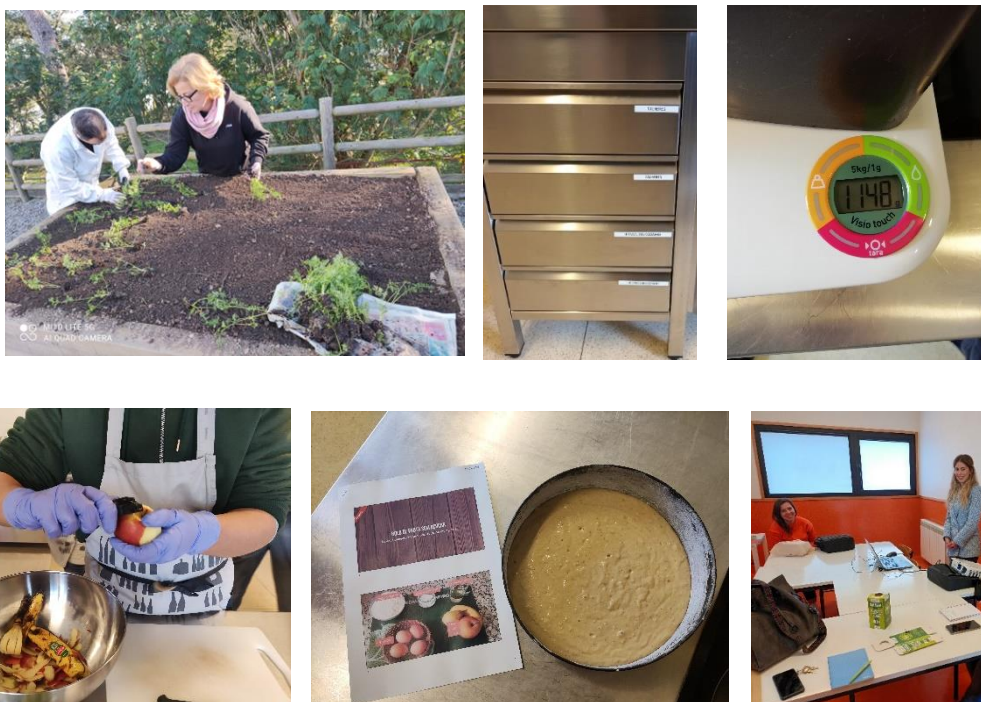


Figure 26 - Actions implemented in Somos Nós Association

In Figure 25 results related to the circularity models are presented:



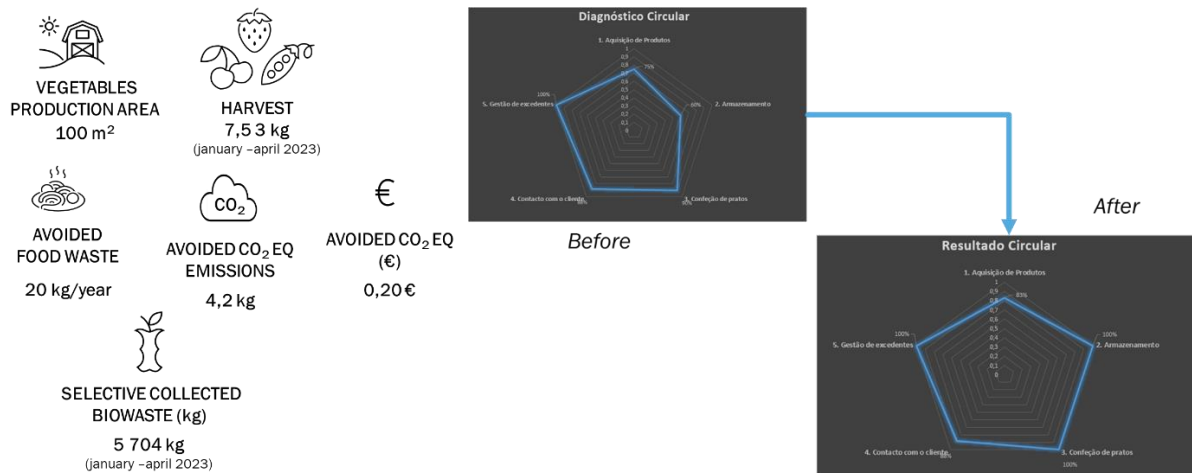


Figure 27 - Results from the implementation of circular models in Somos Nós Association.

### 3.2.2. Tools to support the Bio-waste Circularity models

Table 2 - Food demand management tool description

FOOD DEMAND MANAGEMENT TOOL
<p>A mathematical model for predicting food waste flows in the social and tourism sectors. Using machine learning algorithms, the tool was fed with data from partners from previous projects that have the historical records needed for the algorithm.</p> <p>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 Hotel and Social Institutions working on the Bio-waste Circularity models didn't have the data needed fully use this tool, since they are not used to keep record and register this type of data.</p>
<p><b>Lessons learned</b></p> <p><i>During the development of the mathematical model and demonstration of the tool some challenges were faced:</i></p> <ul style="list-style-type: none"> <li>- Most entities 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 institutions to improved their food acquisition, since they will be able to forecast their needs based on historical records, hence reducing the bio-waste produced;</li> </ul>

## FOOD DEMAND MANAGEMENT TOOL

- Managers 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.

<https://cityloops.eu/biowaste/prevention-and-collection>

Table 3 - Circularity decision making support tool description

## CIRCULARITY DECISION MAKING SUPPORT TOOL

Tool to support social institutions, hotels, restaurants and its crew to assess the circularity impacts of their decisions or behaviours. This tool uses a multicriteria analysis method which encompasses environmental, technical and economic criteria. It will show users the 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.

This tool is used similar to an external audit, in two moments: the diagnosis phase, and the evaluation phase (see [chapter 3.2.1](#)).

### Lessons learned

- The tool works better when used by an external personal (similar to an audit) who is impartial and critic about the information given by the managers.
- Entities are interested in reducing waste at all levels. If this tool would be complemented by other tools/analysis for different flows (textiles or reusable materials for example), definitely would attract the entities attention.

<https://cityloops.eu/biowaste/valorisation>

Table 4 - Circular procurement guidelines description

## CIRCULAR PROCUREMENT GUIDELINES

The Porto Circular Procurement Guidelines is based on an integrated vision for Circular Economy for school meals & catering services and green spaces maintenance (macro vision). At the meso level, the guidelines helps on 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. On the micro level, the tool includes information on how to define and develop criteria along the stages of the procurement procedure guidelines which constitutes 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.

## CIRCULAR PROCUREMENT GUIDELINES

### Lessons learned

*In this process 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 willness.*
- *purchase departments gather experts but also resistance to change and innovate. It is fundamental to involve, since the beginning, the departments and their staff;*
- *training courses need to be developed to 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.*

<https://cityloops.eu/biowaste/valorisation>

## 3.3 Launch of Green Space Certification System

Urban green spaces support sustainable development of cities, providing natural and semi-natural spaces, which gives additional interconnection and enhanced resilience benefits (Chiesura, 2004)<sup>1</sup> Sustainable Garden design and management practices can contribute to a better knowledge related to green waste production and soil preservation.

Based on case studies, it has been observed that to create a successful sustainable urban green space through low-budget strategies, it is important to prioritize an accessible location by identifying connections to the urban fabric); reuse, fix and upcycle (materials, equipment, tools, etc.); build on social potential (plan participatory processes); plan for low-cost maintenance (use natural solutions to save water, etc.) (Herman *et al*, 2018)<sup>2</sup>.

Porto Municipality soon understood not only the importance of urban parks and open green spaces as strategic to increase the quality of life of its citizens, but also the importance of managing these spaces sustainably. In addition, the focus has been also on communicating these practices to the citizens, which are often confused with the application of sustainable green spaces management, that might be misunderstood with abandonment or with little desire to maintain them (p.e.: meadows growing excessively to promote biodiversity).

Precisely for this reason, over the years, projects and awareness campaigns are being developed to help citizens change their perception related to sustainable green practices but also to help them manage their own gardens in a sustainable way.

<sup>1</sup> Chiesura, Anna (2004). The role of urban parks for the sustainable city. *Landsc. Urb. Plan.* 68, 129–138.

<sup>2</sup> Herman, Krzysztof; Sbarcea, Madalina; Panagopoulos, Thomas (2018). Creating Green Space Sustainability through Low-Budget and Upcycling Strategies. *Sustainability* 10(6).

The experience with awareness projects and good management practices in green spaces recognition scheme (private and public) already implemented, such as *Jardim ao Natural* (Natural Gardens) project, *Horta-à-Porta* (Biological kitchen gardens) project and *Green Flag Award® Guidelines*, opened the door to the idea of creating a **Green Space Certification System** (see Table 5). This system aims to increase the sustainable management of any kind of urban green spaces, promoting biodiversity and recognising the spaces already working on these issues, so that citizens can identify and enjoy safe and environmentally well-managed green areas. The **Green Space Certification System**, together with other sustainable practices, will specifically encourage dedicated gardening practices to promote and reuse the compost produced at LIPOR's composting plant – in order to highlight the importance of returning bio-waste to urban soil in the form of compost and the sustainable management of green spaces.

Sustainable gardening is a method that contribute to the creation and maintenance of more efficient green spaces, by reducing human, material and natural resources, while considering the intended uses of these spaces. The adoption of sustainable gardening practices allows us to support, recover and improve the environmental services provided by these man-made ecosystems, such as gardens, while reducing maintenance efforts, as well as water and material consumption. Drawing inspiration from practices used in gardening and farming systems like organic farming, permaculture, syntropic farming and natural gardening, a collection of good practices might be implemented depending on the specificity of the selected sites (historical, urban, peri-urban, high, or low use intensity). These practices may include using appropriate irrigation techniques and designing vary from the type of irrigation used to the way we design new green spaces.

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!

The adoption of good practices for green space management and maintenance aims to:

- Reduce the production of bio-waste (from park and garden management and maintenance);
- Reduce water consumption and the use of environmentally-harmful products;
- Reduce maintenance needs and resources used;
- Promote biodiversity;
- Improve urban living conditions by restoring natural spaces;
- Raise awareness of the need for sustainable green spaces.

For the development of the **Green Space Certification System** four main actions were defined:

- Certification System Design
- Identification of Green Spaces for implementation
- Implementation of the Certification system on Porto Green Spaces
- Evaluation of the Demo action.

The first step was to design the certification system based on the information collected in previous projects (Jardim ao Natural) and inspired by the Green Flag Award® Guidelines. A step-by-step diagram of each phase of the implementation was also created to facilitate the implementation of the system on different Porto municipality Green Spaces and in other institutions (Figure 28).

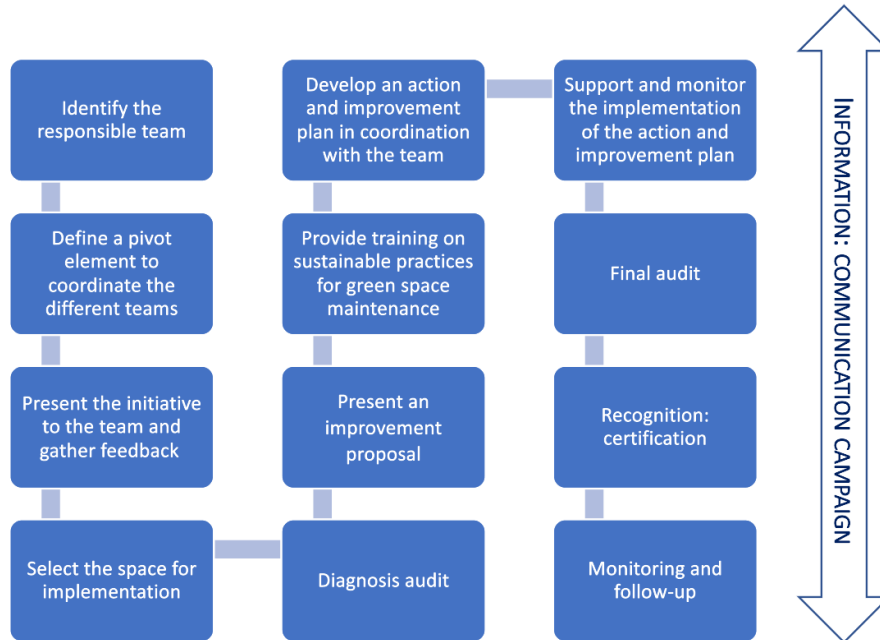


Figure 28 - Step by step diagram for the Certification System implementation

The **Green Space Certification System** was drafted, presented, and discussed with Porto Municipality, namely environmental and green spaces services, and redefined in order to enhance the acceptance of all the stakeholders (citizens and municipality gardeners). After this discussion the system considered 3 important categories that sustainable green spaces must pay attention to: 1) the User, 2) Water and Nutrients recirculation and 3) Biodiversity and Landscape. Each category was divided into different evaluation criteria to which a score is attributed and allows the assessment of the feasibility of certification of the space, as well as improvement suggestions. The evaluation carried out on the spaces takes into account the contribution of each category to the Certification as a sustainable green space. Since this is a first pilot certification, the audit team was comprised by members of LIPOR. Nevertheless, the certification team need to be comprised of:

- Top Management;
- Managers;
- Technicians;
- Green Space Specialists;
- Gardeners.

For the attribution of certification, each space must obtain a minimum weight in each category of:

- **User:** Minimum 15 points (máx. 25 points)
- **Water and Nutrients recirculation:** Minimum 15 points (máx. 25 points)
- **Biodiversity and Landscape:** Minimum 15 points (máx. 30 points)

The minimum number of points for classifying a space as a sustainable green space is 45 points if a minimum of 15 points are attributed to each category (Figure 29).

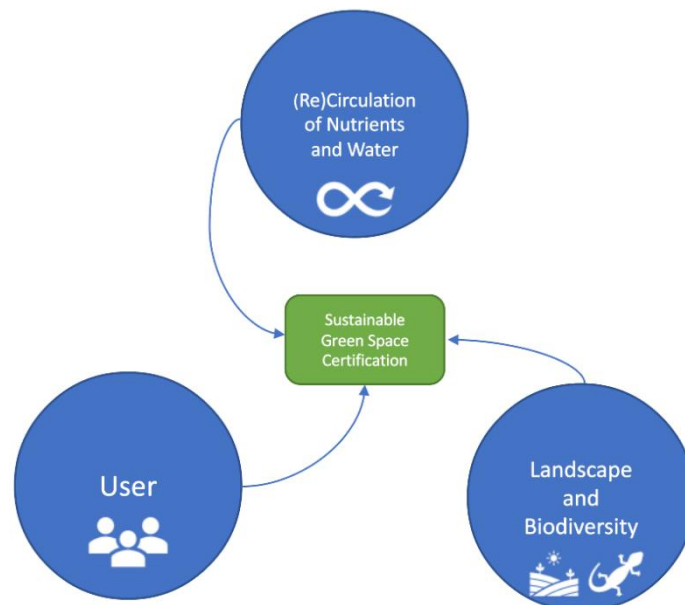


Figure 29 - Categories of the Green Space Certification system

At the same time, the locations for the system implementation were also presented by the municipality and are shown below (Figure 30). These were areas that the municipality indicated as challenging for different reasons namely small green spaces in the historical zone (all), spaces of difficult access for maintenance (Largo do monte dos Judeus and Cidral) and other because of the volume of people that uses that space (Calçada das Virtudes). The spaces considered are:

- Largo Monte dos Judeus – 201 m<sup>2</sup> (160 m<sup>2</sup> 1st level + 41 m<sup>2</sup> 2nd level)
- Canteiro Cidral – 24 m<sup>2</sup>
- Calçada das Virtudes – 675 m<sup>2</sup>

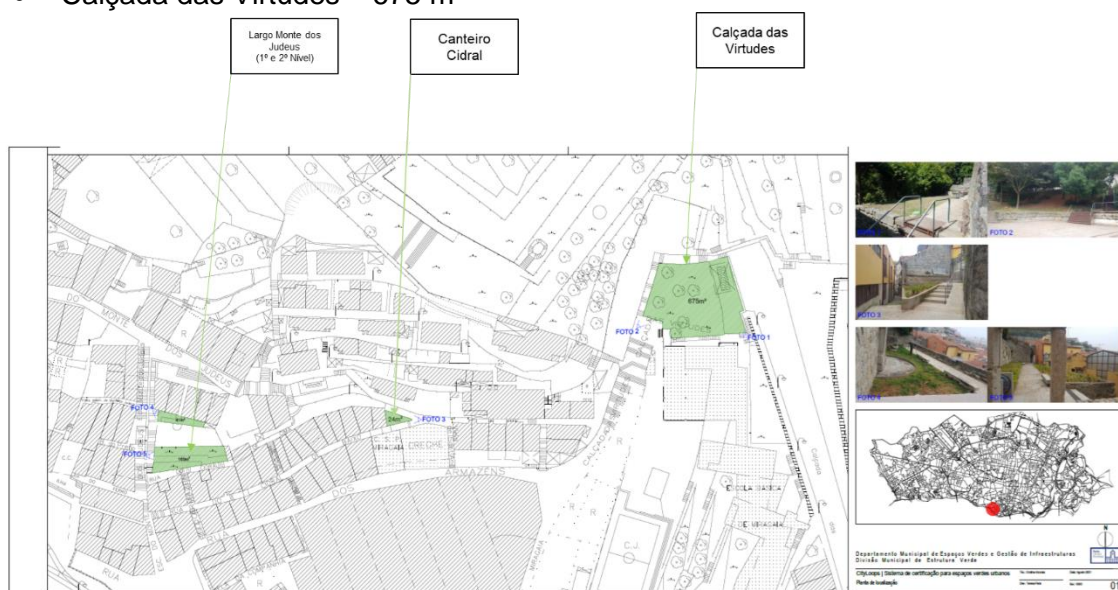


Figure 30 - Green spaces selected to apply the methodology

This identification allowed developers to visit the green spaces and do the first audit to collect information and data about general characteristics and management practices. This visit was accompanied by a green space manager from Porto municipality that gave us some information about the different spaces. The audit resulted in a collection of photographs and a diagnostic/evaluation sheet for each green space.

After the evaluation of each space, a plan to improve the green spaces was proposed in order to achieve recognition as a sustainable green space. This plan included photographs of each space combined with a set of suggested activities and physical changes to the space/plants that can be implemented (Figure 31).

In order to guarantee the improvement of the green spaces, the proposed improvement plan was also discussed with the green spaces services to understand the changing limitations of the green spaces and also the potential and capacity for improvement them.

The green spaces improvement sustainable practices plan included the following solutions:

- Providing information to the user (e.g. identification of the place, responsibility for maintenance, reference to the connection framework, toponymy, historical framework)
- Improving soil quality to enhance water retention
- Using organic compost in soil maintenance;
- Using green soil cover material (e.g. dry leaves or chippings)
- Introducing of native or cultural shrubs with reduced water requirements, with flowering at different seasonal periods, promoting the appearance of pollinating insects, and with berries to provide food for birds;
- Implementing wood structures, as ex. lying logs, to provide shelter structures for sheltering micro or macro animals.



*Figure 31 - Green spaces selected by Porto Municipality*

After the redefinition of the methodology, an improvement proposal and an action plan were delivered to the Municipality green spaces department. Two gardeners and one operational manager had technical training at LIPOR facilities on the subject of sustainable space green management and practices. Next steps were: use of compost (NUTRIMAS from LIPOR) and mulch to increase water absorption, reduce water evaporation from soil, protect soil from sunlight, increase soil biodiversity and recirculate nutrients; new and diverse species were planted to increase biodiversity of the spaces; in the high slope space, drainage ditches were created to reduce water speed and reduce erosion of the soil (see Figure 30).



*Figure 32 - Improvements made after action plan presented by the certification team in selected green spaces.*

Finally, the identification signs were installed to raise awareness and inform users about the practices and enhancements made on these three spaces.





Figure 33 - Identification signs on the certified green spaces.

In the end, 350 l of NUTRIMAIS were used in all three selected spaces, together with mulch. The outcomes of these practices are yet to be evaluated, it is too soon to understand the impacts of mulch, compost and new species on biodiversity and soil fertility. In the biggest space, Calçada das Virtudes, the planting of a shadow meadow is still growing, for example.

Table 5 - Green space certification system description

## GREEN SPACE CERTIFICATION SYSTEM

A certification system has been developed to promote sustainable management of green spaces and biodiversity, as well as to recognise the spaces that are already implementing good sustainable practices.

One of the main gardening practices is the use of organic compost (from composting plant) to improve urban soil quality and highlight the importance of returning nutrients to the urban soil. The certification system also aims to provide information to citizens, so that they can identify and enjoy safe and environmentally well-managed green areas.

### Lessons learned

- *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 requires customization

<https://cityloops.eu/biowaste/valorisation>

## 3.4 Circular Entrepreneurship Initiative

The **Contest for Circular Ideas - FoodLoop** (Table 6) - was launched in the city in order to mobilise citizens and organisations to the circular transition in bio-waste and more broadly in the food system. This follows Porto's environmental strategy and Porto's Roadmap for Circular Economy to become circular by 2030, which aims to encourage, support and empower entrepreneurs to turn environmental and social challenges into circular business opportunities and to bring key players together to co-create responses to the challenges and raise awareness of best practices.

With this purpose, Porto Municipality joined forces with experienced people in entrepreneurship, social economy and circular economy to develop a contest model that could:

- focus on the food as a whole and not be restricted to a specific sector of the value chain;
- be interesting for citizens and social institutions and also challenging to local entrepreneurs or companies;
- create synergies between new ideas and established practices with the purpose of upscaling environmental, social and economic positive impacts at the city;
- contribute to a more healthy and sustainable food system, applying the principles of circular economy.



It was decided that the contest would award ideas that:

- encourage the creation of synergies between several sectors and actors, mainly the social and tourism sectors;
- promote and support innovative food waste management ideas;
- prevent food waste with donation and/or recovery schemes;
- satisfy the nutritional needs of vulnerable communities and at the same time reduce food waste;
- promote local/regional agri-food value-chains;
- strengthen multi-sector and multi-actor collaboration to raise awareness and reduce food waste.

The contest was designed with a focus on providing training and mentoring to the winners rather than offering prize money. This approach aimed to add value to the participants by helping them to develop their ideas into projects with potential for successful implementation

and resilience. The focus was on promoting economic, social and environmental sustainability in the projects developed by the winners. The steps that were taken for the contest were the following:



For this purpose, we considered two step awards:

- The first step is a fast training program called Bootcamp, which is available to 20 ideas/teams. The purpose of this step is to explore the idea and develop business plans with positive impact. The Bootcamp also provides an opportunity to network with relevant contacts, which can help solidify the project and open doors to possible collaborations.
- The second steps is a Mentorship program that last for 6 months and is available to the 5 winners. The purpose of this steps is to develop a sustainable business model, consolidate the project and establish key partnerships. The mentorship program also involves creating an implementation plan, searching for public and private, national or international investments, preparing applications. This includes defining the mission,



vision, impacts, budgets, support, and partnerships to secure funding.

In the organization of the contest, partnerships were established with different organizations with the aim of disseminating and supporting the contest, such as:

- APHORT - Portuguese Association of Hospitality, Restaurants and Tourism
- BCSD - Business Council for Sustainable Development Portugal
- Impact House of Santa Casa da Misericórdia - community of impact start-ups, entrepreneurs, artists and activists working in various sectors to create a better world
- Circular Economy Portugal - environmental NGO that strives to create a circular economy and society without waste
- CIS Porto - Social Innovation Center of Porto (municipal initiative)
- INESC TEC - private non-profit research association, with Public Interest
- UPTEC - Science and Technology Park of University of Porto

- Rede Alimentar Cidades Sustentáveis - national network of Food Sustainable Cities
- Smart Waste Portugal - Portuguese Waste Cluster Association

With these partnerships other opportunities had emerged for the participant teams:

- UPTEC offered 6 months of incubation in its entrepreneurship ecosystem and a direct entry to the UPTEC Startup School for one of the 5 winners of the contest;
- CIS Porto offered dedicated guidance and support for the development of non-winning ideas and support in the application to the Mentorship Program, Consultant Scholarship and future initiatives launched by CIS Porto.

For the realisation of the contest, a multidisciplinary jury was constituted with expertise in different areas of the food sector, entrepreneurship, economy, environment and social areas, and with internal and external stakeholders of the municipality of Porto:

- Director of the Environmental Planning and Management Department of Porto Municipality;
- Director of the Social Cohesion Department of Porto Municipality;
- Coordinator of the Master's and PhD in Human Ecology at Universidade Nova de Lisboa and researcher on food waste in Portugal at the Interdisciplinary Center for Social Sciences;
- Head of the Faculty of Nutrition and Food Sciences and Chairman of the Specialized Technical Commission of the Authority for Food and Economic Security;
- Member of the Gulbenkian Program for Sustainable Development team from Calouste Gulbenkian Foundation;
- Innovation Director at 2GO OUT Consulting company and expert in the field of the environment, circular economy, energy efficiency;
- Executive Director of IES-Social Business School and expert in the field social economy and economy with impact.

A participant regulation was created, presenting the participant conditions and the eligible topics:

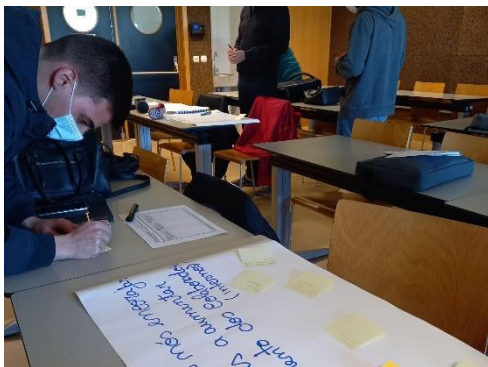
		
Local and ecological production	Food distribution	Consumption habits
		
Food and/or garden waste	Lifespan of food	Industrial and natural ecosystems

Due to the pandemic situation, the contest was only launched in September of 2021 with an open call period until January 2022. To reinforce the launch of the **Contest for Circular Ideas**

(Table 6), a communication campaign and the corresponding communication supports (30 mupis placed strategically in the city, the website - <https://foodloop.pt/> - and a publicity teaser - <https://youtu.be/mahY-5VINUI?t=77>), were simultaneously disseminated in the communication channels of the Municipality of Porto, of the municipal environment channel, and by the partners of the contest.

The goal was to have more than 20 applications, so 20 would be selected to participate in the Bootcamp. In January, mainly in the 3 days before the submission deadline, 13 applications were submitted. In order to encourage wider participation, it was decided to extend the call until April 2022.

To mobilize students to participate, Porto Municipality team implemented ideation workshops in the Faculty of Nutrition and Food Sciences from Porto University (FCNAUP) and in the School of Hospitality and Tourism of the Polytechnic Institute of Porto.



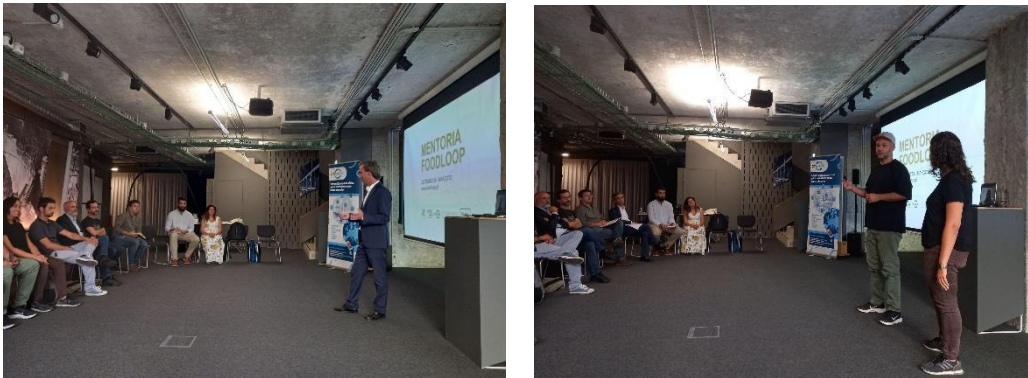
As a result of all this effort, in April 2022 there were 23 applications, that went through the evaluation process by the jury members. As a results, 19 teams were selected to participate in the Bootcamp, of which 15 accepted the challenge. In June, during the 3 days of Bootcamp, the participants developed their ideas and turned them into pilot projects, updated their pitch with the new knowledge learned and updated their application for a second evaluation. Two teams that were not available to go through the Bootcamp process were also given the opportunity to update their information and pitch following the same requirements.



With the new information submitted, the jury chose the 5 FoodLoop winners and they were published on the website. In the last minute, Zero Waste HUB shared that they were unable to go through the mentorship due to the lack of availability from their team members.

In the end, Porto Municipality team called the team classified sixth, which accepted the prize, and the final winners were announced. (<https://foodloop.pt/assets/pdfs/vencedores2022.pdf>).

The mentorship program was launched with the presence of Vice-Mayor and the winners had the opportunity to make a pitch to the municipal team and to the mentorship team.



The mentorship finished on april 2023. It started with the elaboration of an in-depth *Diagnosis* by each team to the mentor identify in which project life cycle stage it is, followed by the elaboration and discussion of the *Development Plan of the Initiative* by the mentor and the team together.

Over the mentorship of 6 months, regular meetings took place between the teams and their respective mentor to monitor the *Development Plan*. When relevant, meetings were carried out with experts from specific municipal services, such as the municipal waste management company, or specialists in circular economy. Additionally, the teams attend four masterclasses:

- European funds – social sector;
- European funds – environmental sector;
- Practical tips on how to apply for funds;
- Communications, Partnerships and Negotiations

The program concluded with a presentation at UPTEC, University of Porto Startup Incubator, of the winners to an audience invited for the effect and the attribution of the extra contest prize. Only three teams were present and the prize was attributed to Simbiose Agricultura Industria. This project was the only one to install a pilot project during the mentorship and was chosen as the one with the highest potential, since it was based on a completely new business model where excessive heat and CO2 were not emissions but inputs to the system.



Table 6 - Contest for circular ideas - FoodLoop - description

CONTEST FOR CIRCULAR IDEAS - FOODLOOP
<p>This contest was launched in the city to potentiate and support innovative ideas that promote the circular transition in bio-waste and more broadly in the food system. The contest aimed to encourage, support and empower entrepreneurs, citizens and social institutions to turn environmental and social challenges into circular business opportunities and to bring together key players to co-create responses to the challenges and raise awareness of best practices. Partnerships with organisations and specialists under this program were also important to bring awareness about the challenges of the food system and bring them to explore solutions and business models with positive social and environmental impacts that can bring more resilience to the sector and to the city.</p>
<p><b>Lessons learned</b></p> <ul style="list-style-type: none"> <li>- <i>It is essential to include in the implementation schedule a timeline with all the steps that are taken in the contest from start to the end</i></li> <li>- <i>The pandemic situation reduced people's face-to-face meetings and we believe that a contest of this nature could be affected by this factor. Therefore, it is important to define a contest that contemplates the absence of moments of meeting between people and organisations. This aspect should be also clearly communicated to ensure they are aware and minimize uncertainty.</i></li> <li>- <i>Closer partnerships and in loco ideation workshops are a good strategic and practical options for the success of the contest;</i></li> <li>- <i>Political presence and follow-up is important for the participants and the involved organisations to recognize the Municipality's commitments;</i></li> <li>- <i>The lack of a prize money can push more advanced projects away from the contest;</i></li> <li>- <i>The creation of a network of partners, specialists and potential investors to support the maturation of projects and enhance their implementation is fundamental to make the contest more interesting.</i></li> </ul>
<p><a href="https://foodloop.pt/">https://foodloop.pt/</a></p>

## 3.5 Reducing food waste by a donation network

**Food Donation Network** provides an alternative to discarding food surplus from supermarkets, restaurants, hotels, companies and municipal services or events, by linking them with local hunger relief agencies or social institutions. The main idea is to create and

maintain an efficient communication and reporting network that links available sources of food to those in need through the existing social organisations.

[Zero Desperdício](#) is a donation network that emerged from a citizenship movement. It was created in response to the economic and social crisis, and when enormous amounts of meals and end-of-life food went to mixed waste containers, animal feed or compost. Facing this, Zero Desperdício started to link food surplus donators (supermarkets, restaurants, hotels, companies and municipal services or events) to social entities on a local scale. This network is carried out using the resources that already exist in the various municipalities of the country (in donors and receivers entities), to reduce food waste where it exists. By using a platform equipped with Business Intelligence tools, all the data has been collected: entities involved (donators and receivers entities), quantity of food surplus donate (tonnes); food waste and CO<sub>2</sub>eq emissions avoided.

Zero Desperdício model is very straightforward when it comes to the roles each organisation plays and how it operates:

- Donors and receivers have to take part on the same specific training in order to be aware and follow the Health and Safety legislation on conditioning of cooked food;
- Donors are responsible for organise and condition the leftovers and communicate what type of food is available (soup, fresh vegetables or fruit, cold or hot plates) and it's quantities;
- Receivers are responsible for collecting the conditioned food, transport it and distribute them according to each receiver model (social canteen, street food, etc...).
- Receivers are also the main responsible for data communication, since they register on Zero Desperdício platform the amount of food received from which donor. Donors can also report the donated food, but it is not mandatory.
- Donors are advised to identify a person responsible for food conditioning.

Zero Desperdício has been acting in some Municipalities of Portugal with the objective of preventing and reducing waste, in particular, food waste. On a day-to-day basis, this network operates in the following dimensions:

- Training for food recovery, among other flows, according to the hygiene and safety of products and beneficiaries;
- Coordination and management of networks with potential waste, finding and connecting entities whose surpluses can serve other entities that receive them. This process ensures that the surplus food is diverted from going to waste and instead is used to fulfil the needs of other entities;
- Monitoring of the environmental, economic and social impacts of the project and of each of the entities involved. Data that can be used for internal and external communication of the entities in an informative, educational and motivating way in the change of behaviour.



Zero Desperdício has an operating model with 5 steps ordered chronologically (Figure 34):



Figure 34 - Zero Desperdício operational model (source: <https://dariatcordar.org/modelo-recuperacao-de-excedentes/>).

Porto Municipality identifies the importance to support and contribute to expand this food donation network, already occurring, somehow in an informal way. This is a way to promote the reduction of food waste and, at the same time, the connection between food distribution and social sectors, supporting Porto's families with low income and social needs.

Partnership with Zero Desperdício is expanding the **food donation network** (Table 7), not only with Porto Municipality (involving municipal services related to municipal, social and school canteens and to events promoted by the municipality and other events dependent of municipal licences) but also with small, medium and large companies as food donors that are concerned with their ecological and social responsibility, such as: restaurants and similar, hotels and companies in the wholesale and retail sector; and social organisations as receivers, so that they can redistribute food with quality to citizens in unfavourable living conditions.

Porto Municipality has held meetings with Zero Desperdício to promote this project and its impacts by agreeing a work methodology to mark this partnership. A protocol with Porto Municipality is in sight by the board of Porto Municipality. However, the works are in place to

first test the adhesion of municipal services and municipal support to this network. This will allow to set up an even broader network of stakeholders from the food value chain (donors, redistributors and beneficiaries), by inviting them to commit with this **food donation network** and contribute to reduce food waste. Thinking on the potential of this network and knowing the good results that their work have, LIPOR signed a protocol with Zero Desperdício allowing it to support and improve the application of this project in its Associated Municipalities, that include Porto Municipality.

From January 2021 to May 2023, there were 16 donors and 7 receivers, 287 651 equivalent meals were distributed by 14 917 families, and 144 tonnes of food waste were avoided, resulting in the prevention of 604 tonnes CO<sub>2</sub> eq emissions.

The recovery of food and other surpluses not only minimizes food and other shortages, but also saves the financial investment needed to support people in need. Additionally, it optimizes the natural, human and financial resources used in the production and manufacturing of products, allowing them to remain in the life cycle and fulfil the purpose for which they were produced – human consumption. Furthermore, it helps to reduce GHG emissions, which aligns with national and European targets.

*Table 7 - Food donation network description*

<b>REDUCING FOOD WASTE BY A DONATION NETWORK</b>
<p>Supporting and expanding the informal network already in place is the main goal of this demonstration action.</p> <p>The Zero Desperdício is a local network that link surplus donors to receivers, mainly social entities. With the support of strategic partners, like municipalities, companies, supermarkets, markets and others, it is possible to minimized one of the big problems of today's society, huge amounts of food waste, while at the same time make a difference for social problems.</p>
<p><b>Lessons learned</b></p> <ul style="list-style-type: none"> <li>- <i>Being a network that is dependent of the involvement of local stakeholders, it is crucial to its success the support of local authorities;</i></li> <li>- <i>Due to the need of involvement of different municipal departments, such as environmental, social and economy, it is important to have a articulated action between them, which take into account their availability;</i></li> <li>- <i>Some possible donors continue to believe that the HACCP (Hazard Analysis and Critical Control Point) system continue to be a constraint, limiting the opportunities of food donation and food waste prevention. Therefore, awareness sessions and training workshops to CEO and technical teams are opportunities to mobilize more stakeholders.</i></li> </ul>
<p><a href="https://zerodesperdicio.pt/recuperacao-de-excedentes-alimentares/">https://zerodesperdicio.pt/recuperacao-de-excedentes-alimentares/</a></p>

## 4. Results

### 4.1 Summary

In order to enhance the circularity of bio-waste in Porto Municipality, a series of activities were implemented and assessed. These activities encompassed various aspects of the whole food system, ranging from preventing food waste to effectively treating waste, all with the overarching goal of creating a closed-loop system for organic materials.

To ensure the circularity of bio-waste, and specially the food system in the Porto Municipality, a thorough and targeted analysis of each activity and intervention model is crucial. All demonstration actions are concluded: bio-waste selective collection and local treatment scheme; contest for circular ideas and reducing food waste by a donation network; the implementation of the green spaces certification and bio-waste circularity in the tourism and social sectors.

It is worth noting that the involvement and commitment of different stakeholders, such as private and public entities, as well as the citizens, was crucial for the successful implementation of the demonstration actions.

The different technical solutions and tools developed and tested are shown below. They have not only helped to improve knowledge, and contribute to the municipal circularity network, but also generate results and the lessons learned that are useful for replication.

### 4.2 Impacts

#### 4.2.1. Bio-Waste Selective Collection and Local Treatment model

The collection process and local treatment are the most relevant in the bio-waste management, due to both the cost and the potential impact on the quantity of bio-waste from the urban areas. Thus, some impacts achieved are relevant to be shared (see [Annex 6.1](#) for more details):

##### ***Communication Campaigns***

- **Bio-Waste Selective Collection:** the awareness campaigns developed for the street containers selective collection, door-to-door and also in the streets, supermarkets and commercial surfaces, took place for a duration of 6 months reaching about 15 000 households. It can be concluded that the door-to-door actions developed were more effective to attract people to the project than the ones developed for the streets and/or supermarkets. People proved to be more engaged with the project and becoming aware of the environmental issues during the door-to-door contact.
- **Local Treatment model:** an awareness campaign was developed to support community composting schemes for both areas (around 470 families/households). This awareness campaign was done on a proximity bases, since the community composting schemes

need a higher commitment and knowledge from the households. 177 families/households are now participating in these pilots.

- For both campaigns, the community's adherence to the process was gradual and supported by the exchange of positive experiences among the participants, which motivated the participation of more households.
- For both campaigns, the main challenge of the door-to-door campaign was finding people at home. It is worth mentioning that the number of refusals was minimal.

### **Jobs**

- 3 employees for the new selective collection of food waste route
- 1 employee, the composting master, responsible for both community composting island

### **Bio-waste selective collection results**

- Bio-waste collection – it was considered a baseline value of zero, since this specific collection route did not exist prior to CityLoops.
- The implementation of the new selective collection route allowed to collect more 516,12 tonnes of food waste from September 2021 to December 2022.

### **Local Treatment results:**

- Since this was a pilot action, a zero value baseline was considered. Between August 2021 to April 2023, 9,16 tonnes of bio-waste were locally treated and 2,75 tonnes of compost were produced and distributed by the community.

## **4.2.2. Bio-waste circularity in the tourism and social sectors**

Tourism and social areas were identified not only as big producers of urban waste, but also as having a high potential for change and being more sustainable. The first steps were very difficult because of the COVID pandemic: most of the hotels were closed and the services they have available (hotels and social entities) were adapted to that time. In the end of 2021, the country was "ready to return to normal" (see [Annex 6.2](#) for more details). All entities where the circularity models were tested increased their level of circularity for bio-waste.

- Grande Hotel do Porto introduced changes at the kitchen level, regarding the portions served for staff members, breakfast and brunch for clients. Measurements were made and the chef and his team had a small training to reduce food waste and also raise awareness to consumers to just take the right portion from the buffet. Zero Desperdício network was also implemented in this hotel as a donor entity.
- In the Castelo Santa Catarina Hotel, food waste reduction was implemented for breakfast service using the right portion project. The selective collection of food waste was implemented from scratch. CSCH is now part of selective collection routes.
- The changes introduced by the models and their methodology were not possible to implement at Joaquim Urbano Temporary Reception Centre, due to operational constraints. For this reason, in September 2022 a new social entity, Somos Nós

Association, started the implementation of the BW circularity model. After the implementation of the proposed changes, vegetables are already being harvested at the grow beds, kitchen optimisation was developed for right portion service at lunch and collection of bio-waste was optimised. Finally, local composting was activated again (infrastructures were in place but not in use).

- With the development of the circular procurement guidelines, workshops to introduce the *Circular Procurement practices tool* were conducted and concluded (Municipality purchase departments; Tourism and Social sector). The tool has been finalised and is available to be used by other entities or cities, for any kind of canteens (from social entities, companies, hospitals, catering services) and restaurants (restaurants and hotels).

### 4.2.3 Launch of Green Space Certification System

By implementing a certification system for sustainable green spaces, Porto Municipality achieved a highest level of circularity by using compost from the city bio-waste in the certified green spaces, while ensuring the restoration of soils and soils' biodiversity. The plantation of vegetable species and the reduction of water velocity, all together with the identification signs promote the importance of protecting our planet and its natural resources (see [Annex 6.3](#) for more details).

- The methodology was designed, the green spaces to be transformed were selected and audited and a proposal for space transformation was delivered to Porto Municipality;
- Some of the proposed changes were implemented, such as: introduction of compost and mulch, drainage ditches were created and new species were planted. All this changes were implemented in order to improve the score on the different certification indicators.
- Finally, identification signs were placed on each of the spaces to let users and visitors know about the sustainable practices being implemented there.
- In the process of certification system testing, assessment and certification by the new CityLoops's Certification of Sustainable Green Spaces System, 900 m<sup>2</sup> in total were certified: 4 distinct spaces, the largest with 675 m<sup>2</sup> and the smallest with 24m<sup>2</sup>.
- In total, 192,5kg of compost was used on the 900 m<sup>2</sup>, which reflects 4,4 kg of N, 4,24 kg of P and 2,31 kg of K.

### 4.2.4 Contest for Circular Ideas

In the first phase of applications, from September 2021 to January 2022, COVID pandemic made interactions very difficult with universities and research centres, which resulted in 13 applications in January. Acknowledging this situation made Porto Municipality extend the deadline until April, and the team diversified the communication strategy to face-to-face ideation events with a targeted audience. 2 presentations and ideation workshops were done with Porto Tourism School and Nutrition University, with 26 participants in total. This rose the numbers of applicants to 23.

From the BootCamp, 5 winners were announced and went through a 6-month mentorship on business plan development and pilot implementation.

The Vice-Mayor's presence in the most relevant sessions was important for the participants and the involved organisations to recognize the Municipality's commitment to the purpose of the contest: to contribute to a real transformation towards a circular and regenerative food system.

University of Porto Technology Park (UPTEC) is a startup incubator that offered an extra contest prize consisting of 6 months incubation and direct access to UPTEC Startup School.

See [Annex 6.4](#) for more details.

## 4.2.5 Reducing food waste by a donation network

The food donation network facilitated by ZeroDesperdício is supported by a Power Business Intelligence (PowerBI) which is a great tool for data visualization. Daily, weekly and monthly data can be obtained regarding food donors, food receivers, families supported and volunteer, as well as tonnes of food waste and CO<sub>2</sub> emissions avoided (See [Annex 6.5](#) for details).

- Due to the increase of the food donation network, were avoided 144 tonnes of food waste, transforming the leftovers in edible food and supporting 14 917 families, from January 2021 to May 2023.

## 4.3 Economic Analysis

### 4.3.1 Economic assessment of demonstration

Porto Municipality, within CityLoops Project, aims to promote circularity in the management of organic matter in the social economy sector, in the tourism sector (restaurants and hotels) and in residential neighbourhoods – primarily via reducing bio-waste generation, improving bio-waste collection systems, and facilitating both reuse and composting.

Bio-waste treatment, for selective collection, is free of charge for Porto Municipality. For this, and according to the EU legislation, to improve the bio-waste selective collection or have complementary solutions (community composting) Porto strategy is to divert, as much as possible and with quality, the bio-waste fraction of the mixed urban waste (treatment that is charged). To ensure the quality of this flow it is very important to have a strong communication and awareness campaigns for a better participation of the families.

The management of municipal waste in the city of Porto, considering all synergies of Porto Ambiente, represented, in 2022, an approximate cost of 100€ per tonne. The selective collection of biowaste in high-rise buildings represents a direct transfer of management costs, except for treatment costs, by relieving the costs with incineration estimated in 50€ per tonne. One of the innovations in terms of internal staff resources was the establishment of the person responsible for the community composting sites: "Compost Master". This was a step to recognize the importance of this figure to the success of this type of solution.

Nevertheless, from the experience to date, the addition to the Composting Master is considered very important to ensure in future enlargements a specific human resource to

coordinate the field work and manage the information obtained through the process. This will increase the personnel costs of the selective collection.

After all, the cost of community composting implementation for one location was estimated between €10 000 and €12 500, serving about 100 households. This includes infrastructure and preparation work, composting equipment (5 composters with 1 000 lts capacity), caddy for organic waste transportation and communication materials. It is important to note that in addition to these expenses, other costs should be considered: from acquiring maintenance tools and from hiring the Composting Master. This human resource represents a fixed cost for process maintenance along all the project. According to the experience of international stakeholders, the composting master can monitor around 10 composting islands. At the same time, it is essential to provide life-time costs for repair and preventive maintenance, in order to maintain the space pleasant for use. We estimate these costs are about €1 000 per year. Still at the level of Community composting, an upgraded will be added in the future by investing in automatic monitoring sensors and digital access control systems, with an estimated initial investment of around €5 000. This will help to monitoring the residents access to the compost bins, understand the participate rate and anticipate improvement measures of the project, mainly identify families that are not participating and need extra motivation. It will also allow to optimise human, financial and communication resources.

One of the largest investments made in demonstration actions was in the development of tools promoters of food circularity. In this case, we can highlight the costs with the circular decision tool, with the predictive tool and with the guidelines for circular procurement. These costs were underestimated in the initial phase of the project, concluding that it is very relevant to reserve a significant amount of the budget for this type of tools that require research and data processing. The total investment with these 3 tools was about €72 000. It is equally important to provide costs for improving and optimising tools, in order to ensure data refresh, increase the interactivity of use and, whenever possible, promote their digitization.

Looking at the demonstration actions related to the green space certification system and reducing food waste by a donation network, these are characterised mainly by the development of specific technical work, which translates fundamentally into working hours. Despite the fact that, at the time, these tasks are consuming more hours of work than expected, there is no significant financial impact, since the technical team has been making a balanced distribution between the different actions. Still, and particularly in the case of the green space certification system, it is important to share, for future replications, that for an even more substantial test of the model, it would be an added value to promote the transformation of a pilot green spaces (see the type of improvement measures that can be applied in [chapter 3.3](#)), following all the premises of the proposed model. This investment is estimated around €10 000 and was not foreseen in the project budget.

## 5. Conclusions

### 5.1 Lessons learned from Demo Actions

In general, during all the Cityloops project and its demonstrations actions, the following conclusions were the most remarkable and were shared by all partners:

- New tools and equipment need to take into account the users' needs, the ease of adoption and the adaptation to the reality of social institutions, households or hotels
- Planning is key. Bio-waste management needs to be a key factor in urban planning and design, defining specific areas for public spaces to have waste collection and/or local treatment.
- Political commitment is fundamental on key moments to reinforce the importance of circular economy on the team and on the region;
- Circular Procurement allows to create a systemic change through public purchasing. The commitment and the engagement of the board and of the purchase departments is of fundamental importance to succeed on the implementation of these circular procurement practices;
- For local entities, it is very important to recognise the state of art on circularity applied to bio-waste sector, and more broadly to food system, to understand where improvements can be done;
- For behaviour change, awareness campaigns are never enough. Specific needs were identified to increase impact: continuous improvement and diversification of campaigns (visuals, methods of engagement), more powerful communication platforms to really change behaviours, such as national TV or outdoors (at the moment, national television advertising does not promote awareness and consciousness, promotes unethical consumption);
- From the experience of making awareness raising campaigns in supermarkets, it was possible to understand that these type of places are not good for territory specific campaigns, like the ones described in chapter 3.1.1. People who go to supermarkets are not necessarily inhabitants from that area and don't have the time to listen because they are focused on buying goods and go home.
- The population participation and engagement are the key to the success of the project;
- Frequent communication with all the stakeholders is a way to keep the connection and the commitment through the actions implementation. Our experience shows that feedback on events, discussions and implementation results is the key for involvement motivation and the success of the initiatives. Feedback gives a sense of belonging, reinforce the importance of being present and active on the activities and reinforces the power of networks and groups. On the other side, not giving feedback after inviting entities/persons to participate feels like they were used just to fulfil a specific need, breaking trust and commitment from all sides.



### 5.1.1. Bio-waste selective collection and local treatment model:

Regarding the selective collection:

- The collection truck's washing system revealed to be essential maintaining the containers (avoiding unpleasant odours and the spreading of insects) and increasing the confidence of the population in the system;
- Given that it was not allowed to use any type of bag to deposit the food waste on the street containers, the quality of the waste collected and the compost that results from the composting plant is very good. However, this restriction quite hampers the people's participation on the project;
- Monitoring the usage of the street containers, it was noticed that the food waste deposition with the little bin was not always easy. This issue can be overcome applying a pedal on the street containers in order to ease its disposal
- The market for the supply of the electronic lockers proved to be inefficient, as well as the support to fix the damaged ones;
- Some difficulties and constraints were found in data integration because of the closed system nature of the software

For local treatment:

- It is very important to have an integrated urban waste management plan with differentiated areas for defined objectives: areas for bio-waste selective collection; areas for community composting island or for home composting;
- Community composting schemes should be connected to technology, not only to monitoring the process, but also to control the participation of the families. The Compost Master play a crucial role in the success of these solutions and should be considered as a human resources for scaling up this solution, with a recommended ratio of about 1 Compost Master per 10 community composting spaces;

### 5.1.2. Bio-waste circularity in the tourism and social sectors

For bio-waste circularity models:

- It is fundamental to find the person inside the institution who is sensitive to sustainability and has enough power and motivation to change the practices. It is also important to recognize this specific work of supporting the uptake of new tools.
- The food waste problem and the environmental questions are not relevant to the hotels and institutions, which in turn puts barriers to entities promoting change;
- When the institutions realised the economic value lost with food waste, their attention increased and started to be more open to change and improvements. Circularity models make sense with the economic speech, more than with the environmental or conscious one.
- The technical details of the circularity models and the tools developed demand a level of expertise higher than what exists in social or tourism institutions. The audit model

removes an economic burden from the institutions and opens the possibility for a new service to the institutions of the city.

- The COVID-19 pandemic made some specific parts of this Demo Action not viable. For example, the Embrulha package lost its relevance because there were no people having dinner at the restaurants, so there were no leftovers to take home.

### 5.1.3. Launch of Green Space Certification System:

The involvement of the gardening team is fundamental to deliver this type of certification to green spaces. Green spaces around the city are very diverse in terms of morphology, water needs, sun exposure, which in turn is reflected in different landscapes and different plant species able to be introduced.

- It is important to refine the methodology continuously and adapt it in a joint process to ensure the correct utilization and the correct evaluation of each space, since some criteria may or may not apply.
- The application of Nutrimais (LIPOR compost) was an important measure for the Green Space division to integrate and develop this demo action.
- The involvement of Green Space division since the beginning allowed the effective implementation of the measures. It was important for them to perceive the benefits of introducing the proposed actions.
- 3000 kg of compost were delivered by LIPOR at Porto facilities. At the moment, 350 kg were used on all 900 m<sup>2</sup> integrated in the process of certification.

### 5.1.4. Circular Entrepreneurship Initiatives:

During the development and implementation of the contest, there are important conclusions withdrawn from the whole process:

- The absence of a monetary prize does not give space for mature ideas from laboratories, research institutions or companies that need the financial push to implement their ideas
- On the other hand, it captures the rawer ideas which can then be refined and developed during subsequent phases. For example, during the bootcamp one team changed completely their idea with the inputs from the tutors. Most teams were receptive to questioning their own idea and were willing to rethink them from scratch.
- A diverse communication campaign is key to the success of this type of initiatives. From mupis all over the city to 15 min presentation to university classes, it is important to make a general and also a focused communication campaign.
- Face to face activities and ideation workshops proved to be a great way to break mental barriers and prejudices about creativity, about problems and about their solutions. They also introduced new dynamics into the classroom and the teachers shared the good engagement of their students.

### 5.1.5. Food donation network

The ZeroDesperdício has successfully challenged and dispelled preconceptions surrounding food leftovers and its management, specifically regarding the Health and Safety regulation (HACCP).

Another barrier that was identified in institutional setting, especially for the ones that employ catering services to manage their canteens/restaurants, was the recognition of food surplus as a sign of inefficiency in the system.

Through this demonstration actions, with ZeroDespedício, Porto Municipality was able to address this inefficiency, while workshops and training sessions provided by the organization helped to overcome the HACCP barrier. It is worth noting that ZeroDesperdício model is recognised by the Sanitary Administration (ASAE).

## 5.2 Stakeholder engagement

The Covid Pandemic had a huge impacts in the stakeholder engagement activities due to movement restrictions and the constant modification of national law. This prevented the team from having face-to-face interactions, which are very important for the implementation of new tools and on-site visits. However, the main challenges have been overcome successfully, and all the demonstration actions have been finalised.

In particular with regard to circular model support tools, the anticipated involvement of all stakeholders in order to participate in the construction of the tools, introducing specific improvements and adaptations since their genesis were identified as very relevant. The stakeholder engagement prioritised previous relationships which proved successful on other projects.

Assuming citizens as important stakeholders, awareness raising campaigns were made door-to-door and on the streets. This creates a double-win situation with the city inhabitants: promoters of the campaigns listen and gather specific knowledge from potential users and citizens get closer to the entities that everyday work to improve the waste management system.

Regarding the engagement of entities in all demo actions and in the Collaborative Learning Network, the constant feedback is important, promoting a close interaction with on-ground activities and updates by e-mail. Entities tend to lose their interest if they don't feel they are important to the processes, since they are committing time and resources. This is a key success factor.

Learning from previous experiences is also relevant. Regarding the circular contest, early engagement with **experienced internal and external stakeholders** on ideas contests' management were crucial to understand weaknesses, what works and what doesn't, and how barriers could be turn into opportunities. For example, the team learned that contests with a prize money, often tend to keep the money, because the ideas presented are not structured to know where to use the money wisely. On the other hand, engaging with a stakeholder highly aligned with the contest (**startup incubator**) leveraged the visibility of the contest. This was achieved by inviting the **startup incubator** to host the first event of FoodLoop. In the end, we understood that these type of contests are receiving less and less application, independently if they are promoted by a private entity or company or a municipality.

## 5.3 Procurement

Public procurement represents one of the largest percentages of the Portuguese consumption, for different materials and services. For this reason, public procurement could have a major role in the transition towards a Circular Economy. At a national level it is important to have legislation to support the market and at a local level it is crucial the commitment of the decision makers. For a change in the Portuguese market, it is important that the Circular Procurement (CP) has competitively priced products, services or systems that satisfy the customer needs and lead to extended lifespan, value retention and/or remarkably improved and non-risky cycling of biological or technical materials, compared to other solutions with a similar purpose.

Improving circularity and sustainability criteria into the purchasing processes developed within the scope of the project, represented a really important milestone comparing to the previous processes. In this process some balance decisions and gradual adaptations are needed as a way to give opportunity to suppliers to create or improve their circular solutions. For instance, in some acquisitions it is important to previously consult the market to discuss potential circular solutions and understand their capacity to respond to circular requirements, otherwise it won't be any acquisition. This is also an opportunity to have a close approach to suppliers so that the shift of paradigm on CP can occur contributing to the transition to circular economy in an integrated approach. This was learned the hard way, for example, with the acquisition of the street bins for selective collection of bio-waste. There is an ongoing problem with the lockers that stop working and need maintenance. There is no replacement in the market and this should have been identified in the pre-market engagement process and procurement requirements discussion.

Related with CP practices, some findings can be highlighted: legislation needs to be updated; as mentioned above, the role of public companies in CP is very high due to the opportunity for a change in the market; benchmarking is very important to learn with CP examples that use circular criteria; build internal and external capacity to address the 'people' gap in terms of knowledge and the potential of circular procurement.

## 5.4 Organisational changes

The direct involvement of Porto's Vice-Mayor in Porto Ambiente and LIPOR's board of administration helped the team to define and organize their work without high bureaucratic delays or barriers from people outside the environmental sector.

The development of demonstration actions forced an internal restructuring of human resources allocation, in order to ensure the level of coordination, implementation and monitoring of actions on the ground. Throughout the implementation, the necessary tunings were made in order to maintain the quality of the work. For example, in Porto Municipality another member was added to the team around March 2020. In Porto Ambiente, a project manager was hired specifically for CityLoops. Also, at the level of monitoring methodologies, periodicity of meetings and distribution of tasks it was necessary to maintain all the team active, making greater efforts in periods of peak activity. For example, in the Hotels and Social Institutions, there was the need to clearly identify the intermediary between LIPOR team and the entity in order to ensure fluent communication and good reporting of data. Also inside LIPOR team, instead of 1 person being responsible for all data, several persons were assigned to each task

or type of data. The clear definition of contact pivots between the different entities of the consortium, facilitated an integrated dynamic of the project team.

The importance of Circular Procurement in CityLoops also was reflected in Porto Municipality's organisation, igniting the joint work of different departments to create and develop a Circular Procurement Strategy. At the moment, the procurement requisites have been defined to the develop and implementation of a Circular Procurement Strategy to be hired to external entities in close connection with municipal services.

The local treatment experience introduced an important new factor: the compost master. The creation of this new role in LIPOR proved to be fundamental for the community bins to work correctly and for the population to clarify their doubts. The compost master is the perfect bridge between the population, the community bins and LIPOR.

## 5.5 Data collection and monitoring

In Portugal, there is a challenge to have comparable data or even available data in the tourism and social sectors. In terms of waste collection and treatment it was easier to have it, due to the direct involvement of the key entities in the Cityloops Porto cluster. When other type of data, like number of meals, price of the meals, amount of ingredients, is needed, it is very difficult to obtain this since entities are only familiar with financial data and records. For this reason, for some of the tools the data collection was a very demanding process and the greatest constraint found.

For example, the quality of the data founded in restaurants or canteens, the dispersion and even the lack of data was something that was faced, in the development of the **food demand management tool** (see Table 2).

One way to overcome these difficulties was to obtain the data through alternative methods and sources, such as on-site data processing and raise awareness among different actors about the importance of regularly storing and analysing data. The team realised the little value that is still given to data analysis in Portugal, and identified the need to promote greater literacy in this area, as well as implementing digitization and intuitive analysis of information to meet the challenges of the future.

Another example was with the containers related to the **selective collection**, where the lack of quality of their lockers jeopardised the collection of detailed data, such as number of openings or number of times that containers are used per household.

## 5.6 Future perspectives

The bio-waste reduction and treatment is one of the major challenges of the future and is reflected in municipal and inter-municipal strategies. The first step in scaling demonstration actions in the municipal sphere. The team is aware that there is still a high potential for growth, not only in the application of methods and preventive tools applied to food waste and green waste, but also in local treatment and selective collection of bio-waste.

Selective collection and local treatment is central in Porto Ambiente strategies as a way to improve waste management and increase the circularity of the system. In LIPOR, high quality

bio-waste without contamination from other flows and/or materials produces better compost, which also improves the soil with its use, closing the loop of the urban bio-waste flow.

As previously mentioned, local treatment brings the circular bio-waste management to a more local and human scale, allowing citizens to engage more successfully because they feel they are part of the process. This, along with the urban gardening initiatives, can create high synergies. Additionally, schools, parks and households with green areas can also be areas for new implementations.

The adoption of circularity models by businesses requires a significant shift in their behaviour and mentality regarding food waste. However,, financial incentives have been found to have a great impact on sparking the entities engagement. Nevertheless, to consolidate the data and functionalities of circularity tools, some refinement is needed (see Table 2 and Table 3 for lessons learned).

The circular contest proved to be a good experience in Porto's rising entrepreneurship context. The main challenge was to maintain the engagement of participants, since the ones that applied don't take their ideas as their first job, but more like a hobby. The team believes that a previous commitment of the municipality in implementing the contest ideas can attract more attention and more developed projects. Even though the lack of a monetary prize can be a barrier, the efforts of implementation from the municipalities can show more mature projects the possible results of pilot projects and spark innovation and transformation. Innovative ideas often lack the territorial availability to test and improve, staying on paper for a long time.

## 5.7 Assessment of replicability / recommendations

CityLoops results, integrated on Porto Municipalities strategies and ambitions, such as the Roadmap for the Circularity of the City or the Climate Pact, are expected to be replicated at a territorial level. In addition to this, the fact that the municipality of Porto is one of the 8 municipalities that constitute LIPOR, which in itself allows demonstration actions and their tools to be replicated and adapted at the regional level.

Porto team recommends the shared investment to replicate new tools, which could be done jointly by the municipalities of LIPOR, for example. Recognising the importance of innovative tools also implies risk sharing due to the need for adaptation to new realities, new territories and new stakeholders.

Some tools developed in Porto need little adjustment to be replicated, such as the **local treatment. community composting spaces** and the **food donation network**. Nevertheless is always important to reflect on the improvements needed presented in this report.

The **selective collection and circularity models** were developed and implemented in the very specific context of Porto's waste management system and the Portuguese reality of social and tourism sectors. The team recommends to conduct an assessment of the specific context of each individual city trying to replicate these tools.

The **green space certification** needs to take into account local climate, native species and place specific needs. Nevertheless, the model developed and the areas of evaluation can be replicated directly, since sustainable urban green spaces management lives upon the three

pilars of this DemoAction: User, Biodiversity and Landscape, and Water and Nutrients recirculation.

Regarding the **circular entrepreneurship initiative**, it is important that municipalities assume the risk of testing the new proposed ideas and using this mentality as an incentive for contestants. The face-to-face ideation workshops proved to be a promising way to engage with citizens and students, as they provide an unique and exciting way of working that people that people are not used. These workshops also offer participants specific problem-related to the issues facing their community, which further boosts their involvement.

In general, the replicability of demonstration actions always need a certain degree of adaptation to the local context. Participatory workshops, as well as the realisation of "on-site" visits are an appropriate methodology to share and identify potential barriers, problems and also opportunities. The team believes that the lessons learned from demonstration actions are crucial for their replication.

## 6. Annexes

This section summarizes the impacts achieved by the Porto cluster as measured by the expected outcomes and indicators specified in the city's Evaluation Plan (D6.2). Intermediate-stage results of the demo actions were previously presented in the CityLoops Interim Evaluation Report (D6.3). The tables in this section show the final, updated results. These results will also be presented, with additional commentary and analysis, in the CityLoops Final Evaluation Report (D6.4).

### 6.1 Bio-waste selective collection and local treatment model – Results and Impacts

Planned outcome: Improved awareness of citizens and stakeholders on circular BW management

*Table 8 - Results and impacts regarding indicators 4 and 5*

Bio-waste selective collection and local treatment model (community composting spaces)		
Indicator	Baseline result	Final result
Indicator 4. CE-related knowledge building campaigns (qualitative description)	Zero (only activities during the project are measured)	Door-to-door awareness campaigns in the 2 community composting selected areas (august 2021 and between december 2022 and february 2023); door-to-door awareness campaign in chosen areas for selective collection for 15 000 households;  Composting and Local farm to fork workshops;





Indicator 5. CE-related knowledge building campaigns (impact)	Zero (only activities during the project are measured)	2 workshops; 19 weeks (1week/month) of door-to-door awareness campaigns and 2 events for celebrate the first compost production and distribution;  1 700 people reached among workshops, door-to-door awareness campaign in the 2 areas selected;
<p><b>Outcome review:</b></p> <ul style="list-style-type: none"> <li>• The awareness campaigns developed for the street containers selective collection, door-to-door and also in the streets, supermarkets and commercial surfaces, took place during 6 months and it was possible to contact about 15 00 households. It can be concluded that the door-to-door actions developed were more efficient to attract people to the project, more than the ones developed for the streets and/or supermarkets. People proved to be more engaged with the project and also about environmental issues during the door-to-door contact.</li> <li>• An awareness campaign was developed to support community composting schemes for both areas (around 470 families/households). This awareness campaign was done with proximity in mind, since the community composting schemes need a higher commitment and knowledge from the households. 177 families/households are participating in these pilots.</li> <li>• For both campaigns, the community's adherence to the process was gradual and supported by the exchange of positive experiences among the participants, which motivated the participation of more households.</li> <li>• For both campaigns, the main difficulties founded during the door-to-door campaign was finding people at home. It is also important to note that the refusals were residual.</li> </ul>		

Planned outcome: Increased circular jobs, expected for the new bio-waste selective collection route means the creation of 3 new jobs.

Table 9 - Results and impacts for indicator 33.

Bio-waste selective collection and local treatment model (community composting spaces)		
Indicator	Baseline result	Final result



Indicator 33. CE-based employment	Zero (only activities during the project are measured)	4
<b>Outcome review:</b> <ul style="list-style-type: none"> <li>• 3 employees - for the new selective collection of food waste route</li> <li>• 1 employee - composting master, responsible for both community composting island</li> </ul>		

Planned outcome: Collection of 1,500 t/year of bio-waste (total of 3,250 tonnes by M44)

*Table 10 - Results and impacts for indicator 56, regarding selective collection.*

Bio-waste selective collection (new route)		
Indicator	Baseline result	Final result
Indicator 56. Quantity of material for centralised composting	Zero (only activities during the project are measured)	516,12 tonnes (141,67 t - between september and december 2021; 374,45 t in 2022)
<b>Outcome review:</b> <ul style="list-style-type: none"> <li>• It was considered a baseline value of zero, since the new collection route was implemented with CityLoops.</li> <li>• The implementation of the new selective collection route allowed to collect more 516,12 tonnes of food waste.</li> </ul>		

Planned outcome: 1 t/year/composting bin unit of local bio-waste treatment (15 bins in total)



Table 11 - Results and impacts for indicator 56, regarding community composting spaces.

Local treatment model (community composting spaces)		
Indicator	Baseline result	Final result
Indicator 56. Quantity of material for local composting	Zero (only activities during the project are measured)	9,16 tonnes (august 2021 to april 2023)
<p><b>Outcome review:</b></p> <ul style="list-style-type: none"> <li>• <i>A methodology to calculate the amount of bio-waste deposited on the composting bins was developed, based on bibliography. This methodology had the validation of a university and it will be adopted for the future.</i></li> <li>• <i>After 6 months of the composting process, a survey was made to verify the methodology used in the two composting sites. The values assessed were in accordance with the methodology.</i></li> </ul>		

## 6.2 Bio-waste circularity in the tourism and social sectors – Results and Impacts

Planned outcome: Capacity building of circularity models pilots' staff on circular procurement, to promote the new guidelines for BW circular procurement

*Table 12 - Results and impacts for indicators 4 and 5, regarding circular procurement training.*

Circular Procurement Training		
Indicator	Baseline result	Final result
Indicator 4. CE-related knowledge building campaigns: Qualitative description	Zero (only activities during the project are measured)	2 technical workshops and 1 for tourism and social sector
Indicator 5. CE-related knowledge building campaigns: Impact	Zero (only activities during the project are measured)	3 campaigns 58 people reached
<p><b>Outcome review:</b></p> <ul style="list-style-type: none"> <li>With the development of the circular procurement guidelines workshops to introduce the Circular Procurement practices tool were conducted and concluded (Municipality purchase departments; Tourism and Social sector).</li> </ul>		

Planned outcome: Application of two new tools to promote circularity in BW management: (1) Food demand management tool, (2) Decision making support tool, validated and ready for replication and upscaling.



Table 13 - Results and impacts for the food demand management tool.

Food Demand Management Tool		
Indicator	Baseline result	Final result
21. New planning instruments/tools for improved circularity: Qualitative description	0	Food Demand Management: developed and tested a food demand forecasting solution in two units, i.e. a workplace canteen and a school canteen. In the two settings, several forecasting algorithms were tested.
22. New planning instruments/tools for improved circularity: Impact	0	Food Demand Management: allows avoid foodwaste generation around 59% (this value was estimated with data from different entities during tool development)
<p><b>Outcome review:</b></p> <ul style="list-style-type: none"> <li>• The tool is concluded and available for been used by other entities or cities;</li> <li>• This tool can be used by any kind of canteens (from social entities, companies, hospitals, catering services) or restaurants (restaurants and hotels).</li> </ul>		

Table 14 - Results and impacts for the bio-waste circular models in the tourism sector.

Bio-waste Circular Models Tourism Sector (Hotel)		
Indicator	Baseline result	Final result

6. Circularity-related stakeholder activities - number of people involved	Zero (only activities during the project are measured)	20
89. Increased provision of local, sustainable and healthy food (kg)	Zero (only activities during the project are measured)	230 kg Demo Action Tourism Sector – GHP: 230 kg (during 2022)
56. Quantity of material for centralised composting (kg)	Zero (only activities during the project are measured)	30 803 kg of selective collection of Food waste (Grande Hotel do Porto - since january 2022 to april 2023)
88. Quantity of bio-waste for collection avoided (kg/year)	Zero (only activities during the project are measured)	1380 kg / year Food waste avoided: a) Demo Action Tourism Sector: GHP: 900 kg/year Castelo de Santa Catarina: 480 kg/year
<p><b>Outcome review:</b></p> <ul style="list-style-type: none"> <li>In tourism sector 2 pilots implemented the BW circularity model: Grande Hotel do Porto and Hotel Castelo Santa Catarina. had some operational difficulties and constraints that are being managed within the team.</li> </ul>		

Table 15 - Results and impacts for the bio-waste circular models in the social sector.

### Bio-waste Circular Models - Social Sector



Indicator	Baseline result	Final result
6. Circularity-related stakeholder activities - number of people involved	Zero (only activities during the project are measured)	20
89. Increased provision of local, sustainable and healthy food	Zero (only activities during the project are measured)	Demo Action Social Sector - Somos Nós Association): 7,5 kg (between February and April 2023)
56. Quantity of material for centralised composting	Zero (only activities during the project are measured)	5 704 kg of selective collection of Food waste (Somos Nós Association - since january 2022 to april 2023)
88. Quantity of bio-waste for collection avoided	Zero (only activities during the project are measured)	790 kg/year Demo Action Social Sector Food waste reduction: 20kg/year Biowaste local treatment: 770kg/year
<p><b>Outcome review:</b></p> <ul style="list-style-type: none"> <li>Methodology and its impacts for the social sector (Joaquim Urbano Temporary Reception Center) had some operational difficulties and constraints. For this reason, In September 2022, it was replaced by a new entity: Somos Nós Association.</li> <li>In social sector 1 pilots implemented the BW circularity model: Somos Nós Association.</li> </ul>		

## 6.3 Launch of Green Space Certification System – Results and Impacts

Planned outcome: A new certification of Sustainable Green Spaces, promoting sustainable management and maintenance practices, namely the use of compost produced by LIPOR, is in place, validated and ready to be replicated and upscaled.

*Table 16 - Results and impacts for the green space certification system.*

Green Space Certification System		
Indicator	Baseline result	Final result
67.1 The total area of green spaces divided by number of inhabitants multiplied by 100 000 (m <sup>2</sup> /100 000 inhab)	Zero (only activities during the project are measured)	2 163 000
67.2 Open certified green space area ratio per 100,000 inhabitants (m <sup>2</sup> /100 000 inhab)	Zero (only activities during the project are measured)	388
90. Reused nutrients present in compost on Green Spaces (kg NPK/m <sup>2</sup> )	Zero (only activities during the project are measured)	0,0122
56. Quantity of material for composting (tonnes)	Zero (only activities during the project are measured)	7 567
<p>Outcome review:</p> <ul style="list-style-type: none"> <li>The process of certification system testing, assessment and certification by the new CityLoops's Certification of Sustainable Green Spaces System was carried out in 4 distinct spaces comprising a total of 900 m<sup>2</sup> (the largest with 675 m<sup>2</sup> and the smallest with 24m<sup>2</sup>).</li> </ul>		



- At the moment, 350 l of compost were used in the 3 areas. Due to the experimental nature of this DA, gardeners were cautious using NUTRIMAIS so they can understand the soil and plants behaviour in the following months.
- The certification system was well received by the Green Spaces team, agreeing with the flaws assessed on the first phase and recognising the potential of the improvements proposed.
- The impacts of the improvements implemented and the certification system as a whole will only be visible after the CityLoops project. Improvements were made in April 2023 so the changes are expected to be seen after at least six months.

## 6.4 Circular Entrepreneurship Initiatives – FoodLoop – Results and Impacts

Planned outcome: Accelerate the transition to a circular economy through the understanding and the application of circular economy principles to the bio-waste sector, and more broadly to the food system and through the promotion of synergies between several sectors and actors, mainly the social and tourism sectors.

*Table 17 - Results and impacts regarding FoodLoop*

Contest for Circular Ideas - FoodLoop		
Indicator	Baseline result	Final result
4. CE-related knowledge building campaigns:	Zero (only activities during the project are measured)	BootCamp on circular and impact economy to the 20 teams chosen after applications. The BootCamp is based on a practical and theoretical methodology emphasizing the different parts of a project: problem, causes, solution, impact and pilot. During the BootCamp there was a



Qualitative description		<p>dedicated moment to frame the contest in CityLoops and a lecture about circular economy, it's principles and examples of application.</p> <p>Mentorship on circular and impact economy to improve circular business models and develop a pilot project applied to the 5 winner teams. The mentorship lasted for 6 months. This was dedicated to each of the projects and according to their specific characteristics and needs.</p> <p>The participants of the Bootcamp were the promoters of the ideas (citizens, entrepreneurs and researchers).</p>
5. CE-related knowledge building campaigns: Impact	Zero (only activities during the project are measured)	<p>Number of campaigns: 1 knowledge campaign at BootCamp + 4 masterclasses on european funding; application elaboration, and negotiations/partnerships at Mentorship</p> <p>Number of people reached: 26 participants/15 projects in bootcamp; 10 participants/5 winner projects at mentorship</p>
23. Eco-innovation: # of new CE business mod-els/cases.	Zero (only activities during the project are measured)	<p>5 business models after mentorship:</p> <p>Portotype - using small, shipping container size anaerobic digestors, Portotype would take care of all implementation, operation and formation of people to use the anaerobic digestors. Biodigestors would not be developed from the start by the company, but be imported instead. Outputs of bioigestion would be electricity, gas, hidrogen and fertilizer to be used locally, sold or with a shared revenue model with the institution usign the biodigestor.</p> <p>Groud4Food - coffee grounds recovered from restaurants would give the restaurans "credit" on buying the vegetables grown with their own waste. Collection of coffee grounds would be optimized with deliveries of fresh vegetables.</p> <p>Simbiose agricultura indústria -Implementing green houses in industrial facilities allows heat and carbon dioxide (industries with high heat consumption from fossil sources) to be directed to the plants. In the green houses, photossynthesis would be optimized with artificial lights, CO2</p>



		<p>concentration and temperature controls allowing optimal growth of small greens. Greens sales would be directed to the promoter or shared with the company implementing the greenhouses.</p> <p>UPCYCLING Porto - A social economic model was developed democratising food access with Porto city card. A joint pilot was proposed between one of the biggest supermarkets' chain in Portugal, the promoters and Porto city. Small data obtained from Porto card use would then be turned to big data and feed into the city and the region biowaste flows.</p> <p>AgriTech4Youngsters - the promoters pretend to ally automation and robotic education with urban smart farming on a local and small scale. The robotic arms, based on machine learning, to collect vegetables on urban grow beds would be placed in professional and IT schools and be used as demonstration place for students while collecting vegetables for the school canteen.</p> <p>FHLUD and ZeroWaste HUB resigned from the mentorship and AgriTech4Youngsters was the substitute to participate in the mentorship.</p>
<p><b>Outcome review:</b></p> <ul style="list-style-type: none"> <li>• The pandemic situation obliged universities and research institution (important target audiences) to work remotely, preventing synergies and spontaneous connections between people, which led to a negative impact on the number of applications;</li> <li>• Closer partnerships and ideation workshops proved to be fundamental and good practices for the success of the contest;</li> <li>• The Vice-Mayor's presence in the most relevant sessions was important for the participants and the involved organisations to recognize the Municipality's commitment to the purpose of the contest: to contribute to a real transformation towards a circular and regenerative food system;</li> <li>• The contest is on its third phase - the Mentorship - and there are 5 teams participating in this phase, all of them winners of the contest.</li> </ul>		



## 6.5 Reducing food waste by a donation network – Results and Impacts

Planned outcome: Food donation network increment achieving at least 75 tonnes/year of food donation and 2.000 benefited families.

Table 18 - Results and impacts regarding food donation network.

Food Donation Network (Zero Desperdício)		
Indicator	Baseline result	Final result
6. Circularity-related stakeholder activities (number of supported families)	Zero (only activities during the project are measured)	14 961 (from January 2021 to May 2023)
88. Quantity of bio-waste for collection avoided (tonnes)	Zero (only activities during the project are measured)	144 tonnes (01/01/2021 a 19/05/2023)
<p><b>Outcome review:</b></p> <ul style="list-style-type: none"> <li>As a result of the LIPOR Protocol it is possible to have access to the information available in a specific Power Business Intelligence, mainly to the results of the network at Porto Municipality: food donors, food receivers (social entities), families supported and volunteers, tonnes of food waste avoided.</li> </ul>		



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.



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