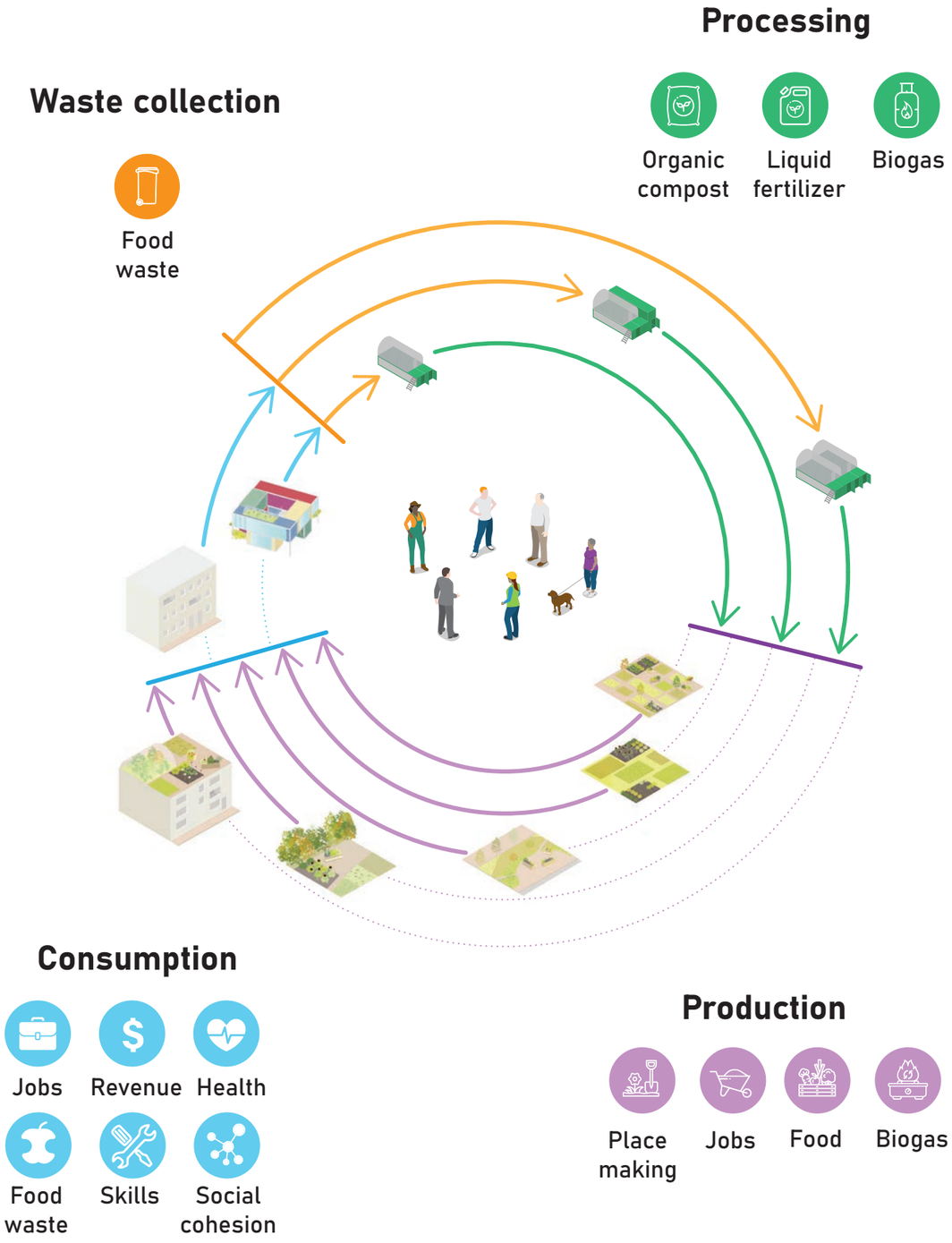
SOURCE

urban circular economy bioresource management

A guide for local authorities and developers

A blueprint co-designed by UniKent and LEAP Ltd.

Introduction



This publication presents a blueprint to implement SOURCE: a circular bio-economy system that combines food waste management and food production, designed for social housing estates. The blueprint is the outcome of a collaboration between industry and research partners, funded under the Design Exchange Partnership (DEP), an initiative promoted by the Arts and Humanities Research Council and the Future Observatory / Design Museum. The initiative offers the opportunity for early career researchers to work with SMEs, exchange knowledge and address specific industry problems through design thinking.

LEAP Micro AD is an enterprise developing solutions for decentralised urban food waste management that are accessible and useful. They have been prototyping the model at the Teviot social housing estate in London, receiving waste collected by the residents, for processing through anaerobic digestion and composting to generate biogas, liquid biofertilizer and compost. The prototype is set within the wider project R-Urban Poplar, an eco-civic hub based at the Teviot, which demonstrates at a small scale the integration of green infrastructure within housing estates. Kent School of Architecture and Planning co-designed with and for LEAP an approach to scaling up and integrating SOURCE within the Teviot's spatial environment. The blueprint presented here conceptualises this process, making it more replicable in other social housing estates.

Project overview

Aerial view of the Teviot Estate

In the UK, about 30% of the food bought is wasted, with households responsible for 67%. But food waste is a resource; when anaerobically digested it produces renewable energy (biogas) and liquid fertiliser, while composting produces soil organic matter, vital for soil health. Micro anaerobic digestion (AD) and composting technology is part of the emerging circular bio-economy.

In cities, this approach will give hospitals, universities and residential developments the opportunity to process food waste on-site, significantly reducing waste miles. However, while food waste collection / processing logistics can be rationally organised in institutions such as universities, it becomes complex in social housing estates where waste collection and waste management integration and operability within the communal spaces requires the participation of residents.

Food waste collection in Teviot started in May 2021, with local residents bringing weekly food waste for processing and new community mini-allotments created. The waste processing equipment is located in a container, forming with other containers, a multi-purpose community hub.

Several challenges must be resolved before the project can be scaled to serve the wider estate and repeated in other sites.

- Firstly, for the waste collection to be scaled up, it must be effectively designed, organised and explained to residents;
- Secondly, more space and effective spatial integration is required for scaling up the AD to serve the entire estate;
- Thirdly, to be fully circular, the food waste cycle must be completed with food growing areas to utilise the organic by-products, and this food, together with the other by-products, must generate sufficient income to make the system economically sustainable;
- Lastly, to ensure replicability across other social housing estates the entire process must be conceptualised and summarised in a blueprint illustrating phases, conditions and organisation.

The plan to scale up will increase the current treatment capacity of 100 kgs per week to 1,665 kg per week. This will be combined with intensive food production to utilize all by-products on site, generating green training and jobs in the process.

Table of Contents

The SOURCE blueprint is divided in four sections mapping the steps for implementation. It is partly informational, documenting relevant literature and studies, but mainly illustrates the activities necessary to establish the food waste circular bio-economy system and provides quantitative evidence of its viability.

The initial two sections focus on the waste collection infrastructure and the fundamental coordination with the residents, both necessary elements for the organisation of the circular food system. The following two sections describe the system and business model.
The sections are:

- *Community engagement*
- *Waste collection*
- *Food waste processing and storage*
- *Food production and circular business models*

Community engagement

This initial step is dedicated to engaging residents of a social housing estate – or any other development where food waste collection and recycling is implemented. **The engagement strategy** will vary depending on the context and resources available but its key elements must be information (knowledge transfer of the benefits of recycling food waste) and co-creation (designing with residents the system for food waste collection and recycling). Initiatives for both elements should be organised in the months before the new food waste collection scheme starts. A **literature review** of the most common and successful strategies for community engagement and waste food collection identified the following approaches;

Campaigning

- **Public debates**.
- **Presentations** in local schools to raise awareness about the issue among younger residents.
- One-to-one **contact with residents** with door-to-door campaigning, supported by leaflets and other information tools.
- **Social media campaigning**: this method includes distribution of visual material through mail, visual public advertisement, creating a page on any social media with informative material and asking residents to follow the page, involving the local media through themed reportages and even the creation of themed songs (Ljubljana, Slovenia).
- Another element to take into account is that communities can include diverse groups and therefore communications must be designed to reach them. For example, in the case of Salacea, Romania, and Parma, Italy, **communications** was made available **in different languages** for minority groups.

1

Incentives/Initiatives

- Recruiting individuals to become **campaign champions** (Besançon, France). Champions can attract followers and increase the outreach to local communities.

-**Local initiatives on food waste** such as the creation of a Food Hub with local stakeholders (Bruges, Belgium), or a one year challenge where 100 families documented the amount of food waste they produced and how it changed after attending workshops on zero-waste strategies (Rubaix, France).

-Co-creation, **engaging workshops** on reducing waste and recycling (Rubaix, France); programs with similar aims can also be implemented in schools where specific training for teachers can be made available (Vrhnika, Slovenia).

-**Distribution of waste collection equipment** to the population; volunteers will explain how to use it through door-to door demonstrations.

-Incentivising residents to participate in recycling their food waste with **access to mini allotment plots** having identified a strong interest in food growing on the estate (Teviot, UK).

Moreover, engagement activities should aim to:

Reduce waste at source:

-This requires **informing residents about food waste reduction strategies** and helping shift behaviour. Precedents can be found in Rubaix, France, where there were challenges in organising a food waste collection system. The city council created a campaign targeted to make citizens more aware of their wasteful food habits and provided workshops to teach them how to reduce food waste.

Workshop with Teviot residents, held on the 4th of November 2021 at the RUrban facility

Reward recycling:

-This was the case in most of the waste collection models that were reviewed. Most of the effort goes into informing residents how to **correctly separate** their waste and how to utilise the waste disposal equipment given.

This blueprint specifically targets social housing estates. Working in partnership with the community centre, the community cafeteria (typically present on many estates) or any representative of residents and local groups is an important step to reach a good number of residents.

1

Piloting SOURCE at the Teviot

The Teviot estate is a social housing complex in Poplar, an area within the London Borough of Tower Hamlets. The estate accommodates 2010 people in 535 flats, over 60,000 m2. The demographics of the population consist of:

27.05 % aged 0-14
21.14 % aged 15-29
26.47 % aged 30- 44
15.3 % aged 45- 59
10.04 % aged 60+

The unemployment rate is 6%[1], while 22.6% of the adult population has a level 4 qualification, which is the highest for this sample. The cultural background of the inhabitants is white British, Bengali and Middle Eastern. **Currently, there is no food waste collection organised.**

LEAP started prototyping within the R-Urban project on the Teviot estate, which delivers engagement activities based on gardening, food, wellbeing, local energy production and upcycling. After setting up a micro anaerobic digester, composting unit and mini growing spaces, activities were planned to inform residents about waste food recycling and reduction, and teach practical urban food growing skills. One **workshop** focused on the design of a system of food waste collection, recycling and food production. Participants were asked to choose between different waste collection models presented to them, comment on the desirable appearance of the food recycling station, the food growing spaces, and on the management of these spaces.

The feedback received provides insights that can be used to design a food waste collection system. Participants liked the idea of establishing this system in their estate and highlighted points that should be addressed:

- **Ownership** of the food waste processing and production scheme: this should not be with residents but rather of a local organisation or the estate management, and part of a programme within which, residents could propose their own projects or initiatives;
- Ensuring **maintenance** and **good appearance** of food waste collection and processing infrastructure, which in the Teviot is located in shipping containers;
- The use of **ornamental plants** in food growing spaces to increase their attractiveness to residents who do not grow food;
- The importance of ensuring that food waste processing and production is **not competing** with common areas of the social housing estate, which are important to the community;
- A final remark was made on the **importance of communication** within the resident community for the positive outcome of initiatives.

In the following page: extracts of residents' feedback from the workshop held on the 4th of November 2021 at the RUrban facility in Teviot Estate

1. https://www.trustforlondon.org.uk/data/boroughs/tower-hamlets-poverty-and-inequality-indicators/#:~:text=6%25,unemployment%20rate%20in%20Tower%20Hamlets

I would like to see a tangible outcome of my work.

Decentralised solutions are preferable for waste management, however, they should be supervised.

We need an entrepreneurial backbone that residents can plug into to organise their activities.

Aesthetics is not an issue as long as the place is well-maintained.

Communal areas should be kept active through initiatives.

The more you get involved into gardening the more you get used to the looks of it.

Planting flowers on the edges of the allotments could make them look nicer for those people who are not used to urban agriculture.

Communication and sharing of information across the community is key to development.

Waste collection

A waste collection model was trialled at the Teviot where residents were asked to collect food waste in caddies and bring them regularly to the processing plant. This organisation has the advantage of making residents responsible for – and aware of – the waste food collection system. However, it is unlikely that a large share of households will participate in such an initiative. The UK government is committed to **mandatory weekly residential food waste collections from 2023**. This will increase pressure on local authorities to recycle increased quantities of organic waste through their recycling centres.

The trial is preparing the ground for a smooth transition by making people aware of the importance of food waste recycling and coordinating with the local authority and the social housing provider. Together, this partnership will optimise the interface between local food waste recycling and the proposed centralised collection system.

By scaling up and implementing a **localised waste collection**, recycling and food production system, the **SOURCE pilot** at the Teviot will demonstrate a replicable model designed to relieve pressure on local authorities and stimulate local green growth.

Types of collection

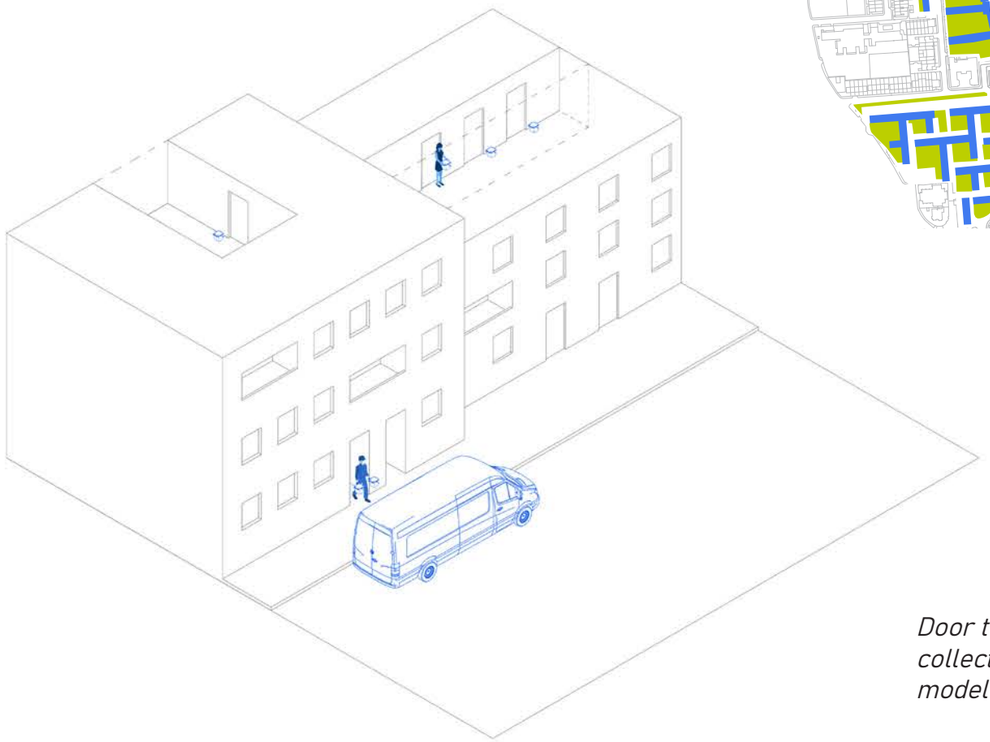
1. door-to-door

Residents leave **individual household recycling bins** in front of their homes at specific times and days of the week. The bins will be emptied by local waste management service operators into a truck or collected by dedicated services (such as in the case of the eco-wagon in Parma, Italy)

2. on-site

Residents take their pre-separated waste to **monitored recycling centres**. This system is established in Europe and can be found in cities such as Vrhnika, Slovenia, and Besançon, France, where it was successfully combined with home composting, practiced by 50% of the population.

2

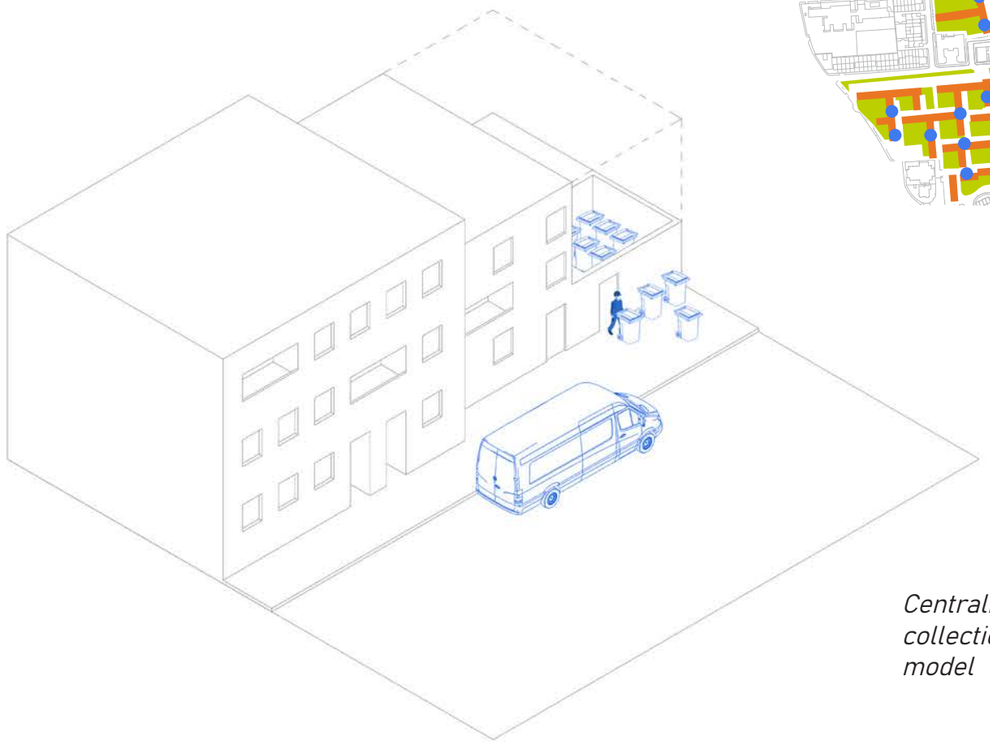


Door to door collection model

3. *integrated*

This solution is a combination of the previous two models and sees an implementation of a door-to door collection scheme, supported by recycling centres where citizens can dispose of their bulky items and refuse that has to be sorted into special categories such as hazardous waste, metals, plastic, waste electronic and electric equipment, garden waste, construction waste, car tires, wood (in Ljubljana, Slovenia and Parma, Italy).

At the Teviot, waste bins are located in a dedicated room in each block of flats, at ground floor level or in the basement. This enables independent waste collection by the operators, who could bring the food waste collected – or a share of it – to the local Teviot waste processing plant. Electric waste collection vehicles could minimise the carbon footprint of the entire operation.



Centralised collection model

Incentives:

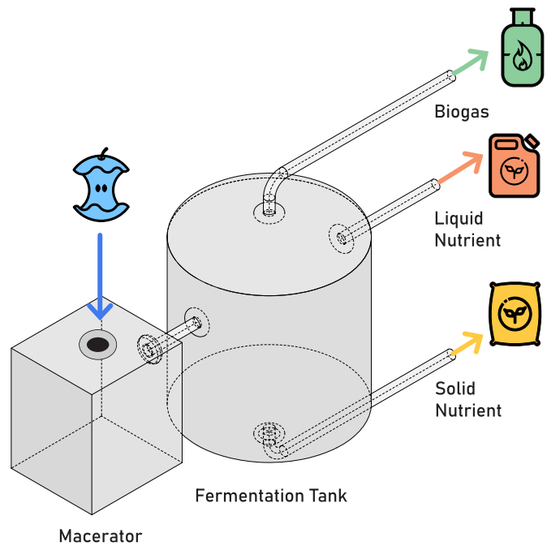
The implementation of waste recycling schemes requires residents' commitment, which may initially be low.
To encourage participation, two strategies were found in the review of case studies:
-**Low collection frequency of residual waste**: in the case of Ljubljana, Slovenia, residual waste collection was purposely less frequent than recyclable waste streams, so that citizens who didn't want their waste sitting around in their house would have an incentive to separate it at home.
-**Pay as you throw**: in this incentive model the cost of the waste collection service to the user is proportional to the amount of residual waste produced. The waste fee is split into an advanced payment based on parameters such as number of members for households or dimension of the house; and a variable balance based on the quantity of residual waste produced.

Home composting:

A step towards waste reduction is represented by home composting, which can complement collection schemes. **The city of Pontevedera, Spain**, organised decentralised composting at three levels:
- **Individual composting** in home composters
- **Community composting** in 3 to 10 composting boxes located in communal areas
- **Local Composting Plants**

PAYT incentives can also be applied to home composting. In Treviso, Italy, home composting can be rewarded up to 30% reduction of the variable waste fees.
While some social housing residents have access to a garden where they can compost, many living in flats do not. For residents keen to manage their own waste, small indoor wormeries may provide a DIY household solution.

Food waste processing and storage



Anaerobic digestion is a renewable technology that transforms organic waste such as food waste, sewage, manure and crop waste into renewable biogas, and a liquid fertiliser (digestate), which is suitable for hydroponic growing, applying to the soil and can also help speed up the composting process. **Hydroponics** is a resource efficient method of growing food that uses 10x less water than conventional food production.

Composting produces compost, a growing medium that contains soil organic matter, which helps soil structure, water retention and long-term fertility. Composting can handle green waste, while AD is unable to process woody material. SOURCE combines AD with composting to process all types of organic waste while producing soil organic matter, bioenergy and liquid biofertiliser to support a regenerative approach to agriculture.
There are several benefits come from managing waste on-site:
- **Reduced** waste management **costs** and waste miles;
- Waste and greenhouse gas **emissions diverted from landfill**;
- Fossil fuels replaced with **renewable energy**;
- Green training and **enterprise opportunities** created;
- **Public engagement opportunities** created by making the value of waste tangible to help shift behaviour;
- **Affordable, locally-grown, nutrient-dense healthy food**.

3

The following issues must be considered when planning a food waste collection site with an AD:

1- Food waste availability
2- Site requirements and available footprint
3- Site ability to utilise by-products and storage required

Food waste availability

Food waste processing capacity is selected according to the volume of food waste to be processed and the ability of the site to utilize the by-products in real time. These factors determine the amount of gas, compost and digestate produced monthly.

SOURCE estimates below were based on a food waste processing **capacity of 333 kg per day** and a green waste processing capacity of 230 litres per day. The WRAP average for food waste is 2 kgs per person per week. Operating 5-days a week, this system will manage 1,665g kgs per week – serving approximately 832 people or 41% of the estate population – as shown in the Small footprint visualisation below.

In order to serve the entire population, the SOURCE system capacity would need to be increased to around 820 kg per day – as shown in the Large footprint visualisation in the next sections. With **forward planning,** this increase would not necessitate doubling the whole system footprint, requiring only an additional 10' containerised digester module. Tables 1 and 2 in the following page summarise the proposed system savings and benefits;

Units	SOURCE savings and benefits	per day	12 months
kgs	food waste diverted from landfill	333	**86,580**
litres	green waste diverted from landfill	438	**113,921**
m3	renewable biogas generated	13	**3,250**
kWh	energy value of biogas	83	**21,450**
litres	liquid fertiliser produced	158	**41,080**
litres	compost produced	302	**78,606**
kgs	Food produced for local consumption	360	**131,456**
kgs	Overall CO2e savings	176	**64,240**

Table 1 – Summary of savings and benefits generated through SOURCE

7,215 kgs
Food diverted from land-fill monthly

41%
of the residents of Teviot can be fully serviced with this AD

Table 2 - Food waste processing capacity for the proposed SOURCE pilot at the Teviot

3

Site-specific requirements and available footprint

After choosing the most appropriate system capacity, location and layout will have to be determined.
The standard site requirements are the following:
- **Minimum 60m2 footprint** – however, the more space available for food production, the better the business case
- **Food waste availability**
- Access to **water and drainage**
- **3-phase electricity** (under 30kW)
- **Daylight exposure**
- **Road access**
- Must be **10m from watercourse**

While these conditions are mandatory, there are no fixed rules for site layout. For the Teviot, the equipment will be housed in two **shipping containers** (2x 12x2.4m) with optional additional compost, fertiliser and biogas storage. Bespoke systems with footprints smaller than 60m2 can be designed if necessary.

Configuring the waste treatment facility

The images in the following pages show how containers can be assembled in three options (small, medium and large). This circular food model can be configured to meet site-specific requirements with modules including:

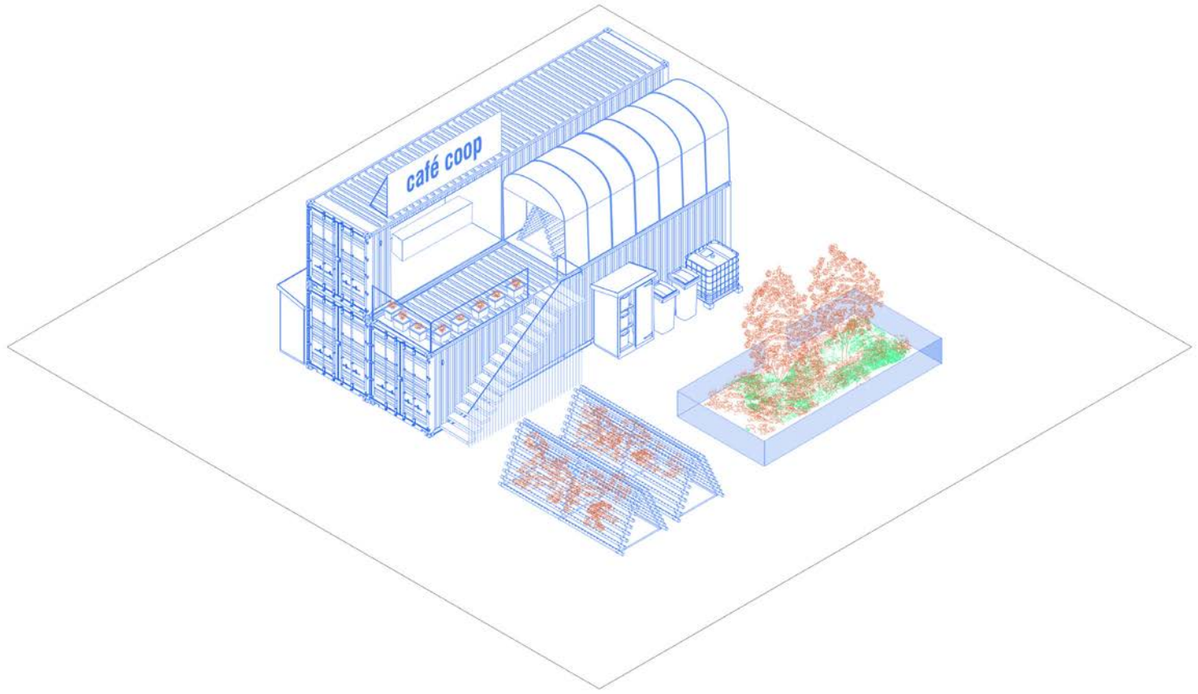
- **Anaerobic digestion and composting systems,**
- **polytunnel and raised bed food production,**
- **a café/shop,**
- **rentable circular enterprise workspace,**
- **additional storage for the compost and biofertiliser produced.**

The inclusion of these features transforms SOURCE into a circular bio-economy solution as well as a social space for residents and helps support the **business model** (see section Food production and Circular Business Model section).
The small option in the next page hosts all the equipment at the proposed pilot scale, plus a café/ shop area and circular enterprise workspace. The **medium and large option** offer more storage space, food growing areas and rentable working space. This helps keep storage tanks out of sight - more desirable for residents - and improves the business case.

Scaling up the pilot to treat all the food waste generated by the whole of Teviot's 2010 residents would require the medium or larger option. The system's modular design allows for flexibility, accommodating both increased and decreased food waste volumes over time.

3

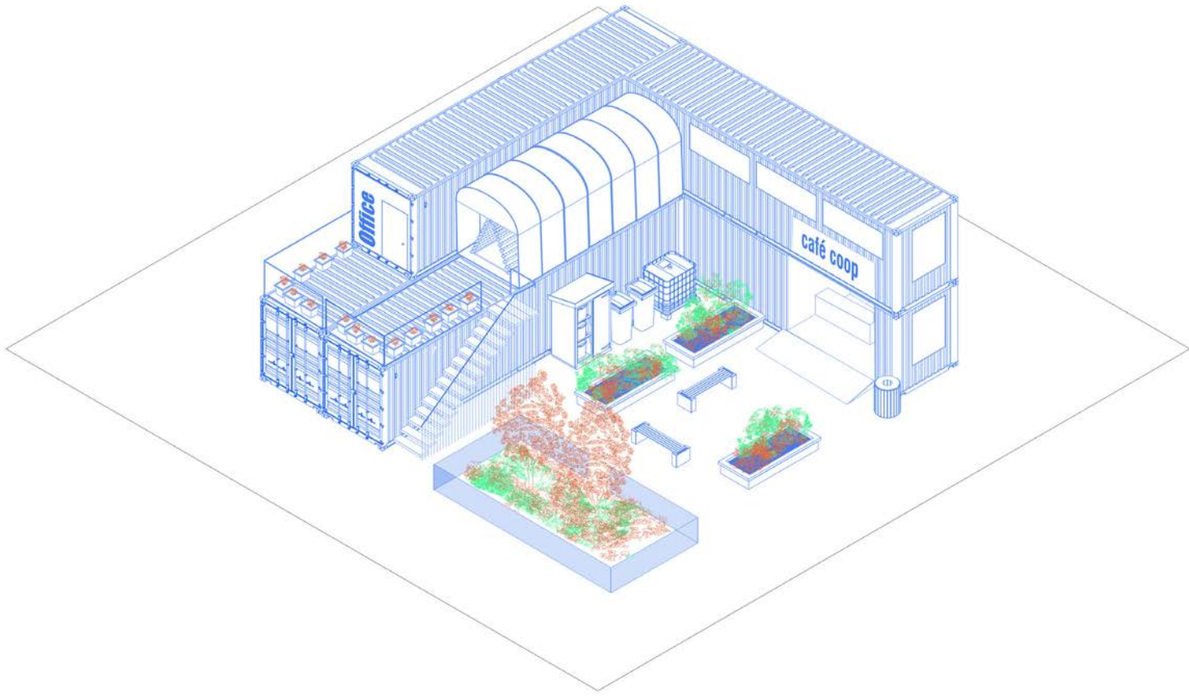
60 sm



Small footprint layout

This option provides a compact 60m2 solution, ideal when space availability is limited. **It features 2x 40' containers** housing the AD and composting system. Above these two containers, there is **workspace** availability for a circular enterprise (see Chapter 4) and/or a café/ shop (see Chapter 4) as well as a polytunnel for food production.

90 sm

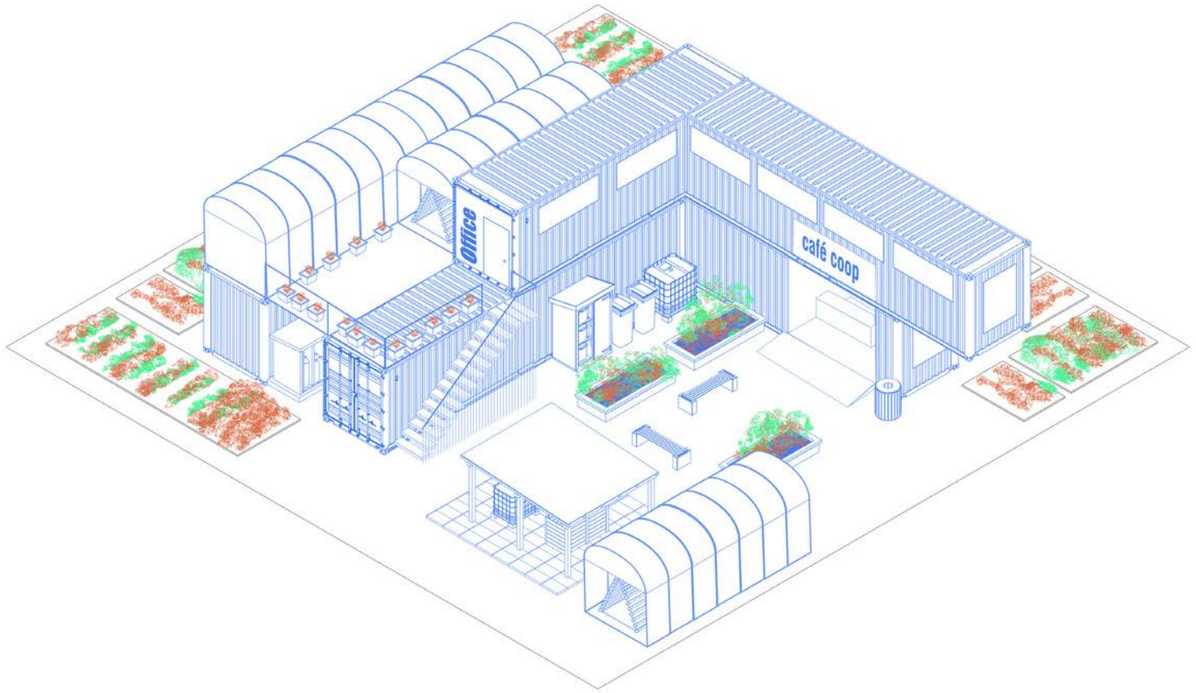


Medium footprint layout

This option has a core footprint of 90m2, which **includes 3x 40' containers** housing the AD and composting systems, and a café/ shop. On top, circular enterprise workspace containers with a polytunnel. With **additional growing areas** mixed with social spaces on the ground floor, this option doesn't require auxiliary storage spaces if production rates remain low.

3

120 sm



Large footprint layout

This option has a **core footprint of 120 m2** and expands on the medium option above with additional raised beds, an extra polytunnel on the ground level with hydroponics and more storage space between 2 containers housing the AD and the composting system. On top are circular enterprise workspace containers with a polytunnel. This option is designed to provide **maximum storage** space and to function as a place integral to the social life of the estate and used by residents.

Site ability to utilise by-products and storage space

Productivity scenarios	Biogas m3	Liquid fertiliser m3	Compost l	Compost m3
10%	27	0.34	655.05	0.66
25%	68	0.85	1,637.62	1.64
50%	136	1.71	3,275.23	3.28
75%	204	2.57	4,912.85	4.91
100%	271	3.42	6,550.46	6.55

Table 3 – Monthly quantities of by-products from anaerobic digestion

Storage requirements depend on how much compost, biofertiliser and biogas are produced, which depend on how much food and green waste is processed. In the case of the Teviot, we developed the following scenarios for the proposed 333kg per day system.
Table 3 shows the volumes of biogas, biofertiliser and compost generated at one tenth, one quarter, half, three quarters and full capacity.

The percentages indicate a range of organic waste capture rates. Space required for all by-product storage is dependent on its pattern of use with more regular, ongoing use requiring less storage. **The table above indicates the storage capacity** required for a month's worth of by-products arising the proposed pilot system.
When planning the site layout, it is important to take in account how of much storage will be required before being sold or utilised.

Production and consumption

Storage and application details for each of the by-products are summarised below:

Biogas
- storage in a gasholder
- 6.6 kW energy per m3
- Can be utilised for cooking, heating, electricity generation
- In larger quantities, it can be upgraded, compressed and used as a vehicle fuel

Liquid fertiliser
- storage in tanks
- used for hydroponics on-site at a 90-95 dilution rate
- can be mixed with woody waste to accelerate composting

Compost
- storage in bays/bags
- used on-site: 20-40 litres can be spread over 1 m2 per annum
- can be used for food production on-site or for local urban agriculture

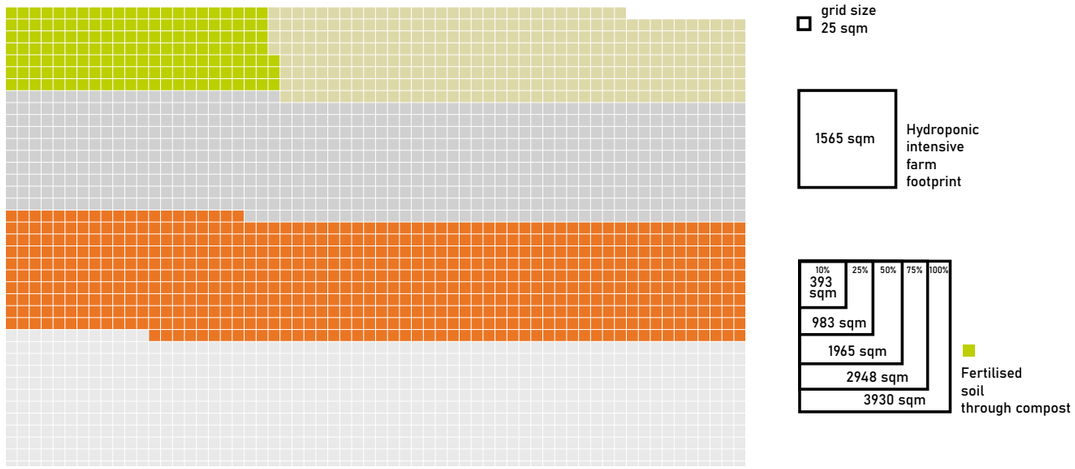
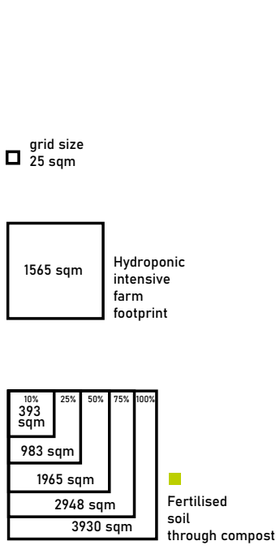


Figure 4a – Surface area fertilised within the Teviot estate, using 20L/m2

Application of compost can vary greatly depending on the method for growing (e.g. raised bed, on-soil, etc.), the composition and fertility of the soil and more. A study on 38 community farms and gardens found that the mean and standard deviation of compost use per m2 of food growing area was 9.6±11.6 L/m2. The median was 4.85 L/m2 and the maximum amount was 43.7 L/m2 (www.fewmeter.org). The map above shows the surface area that could be fertilised by applying 20L/m2.

The areas required for spreading compost are visualised in the next page in Figure 4b, where the various **productivity scenarios** are contextualised within the Teviot area. The map and diagrams show that in a scenario in which all the food waste is recycled, a large amount of land can be fertilised, enabling significant food production. Productive land can be strategically located, depending on the context and the design and planning principles for each social estate.

3



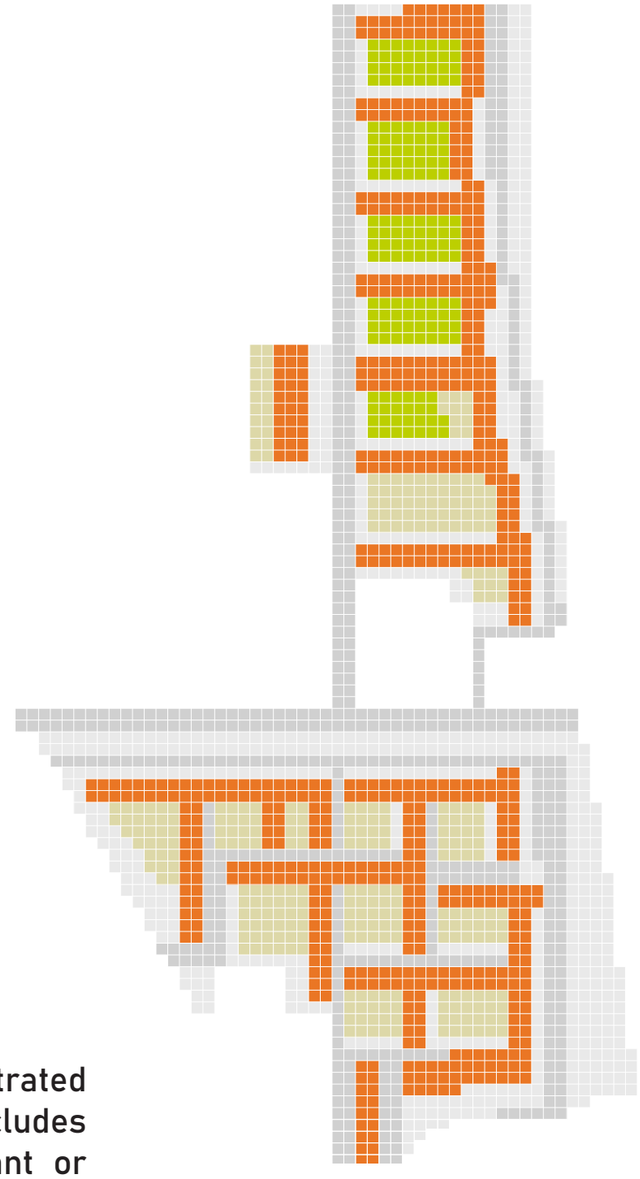


Figure 4b – Surface area fertilised within the Teviot estate, using 20L/m2

For example, it can be concentrated in a dedicated area which includes the AD and composting plant or distributed across the estate. In the map, the green squares (productive land, are located in between Teviot's residential blocks, offering the opportunity to residents to have their allotments next to where they live.

Digestate spatial requirement scenarios (Annual)					
Output %	10%	25%	50%	75%	100%
Hydroponic area (m2)	**156**	**391**	**782**	**1,174**	**1,565**

Table 4 – Digestate special requirements for hydroponics

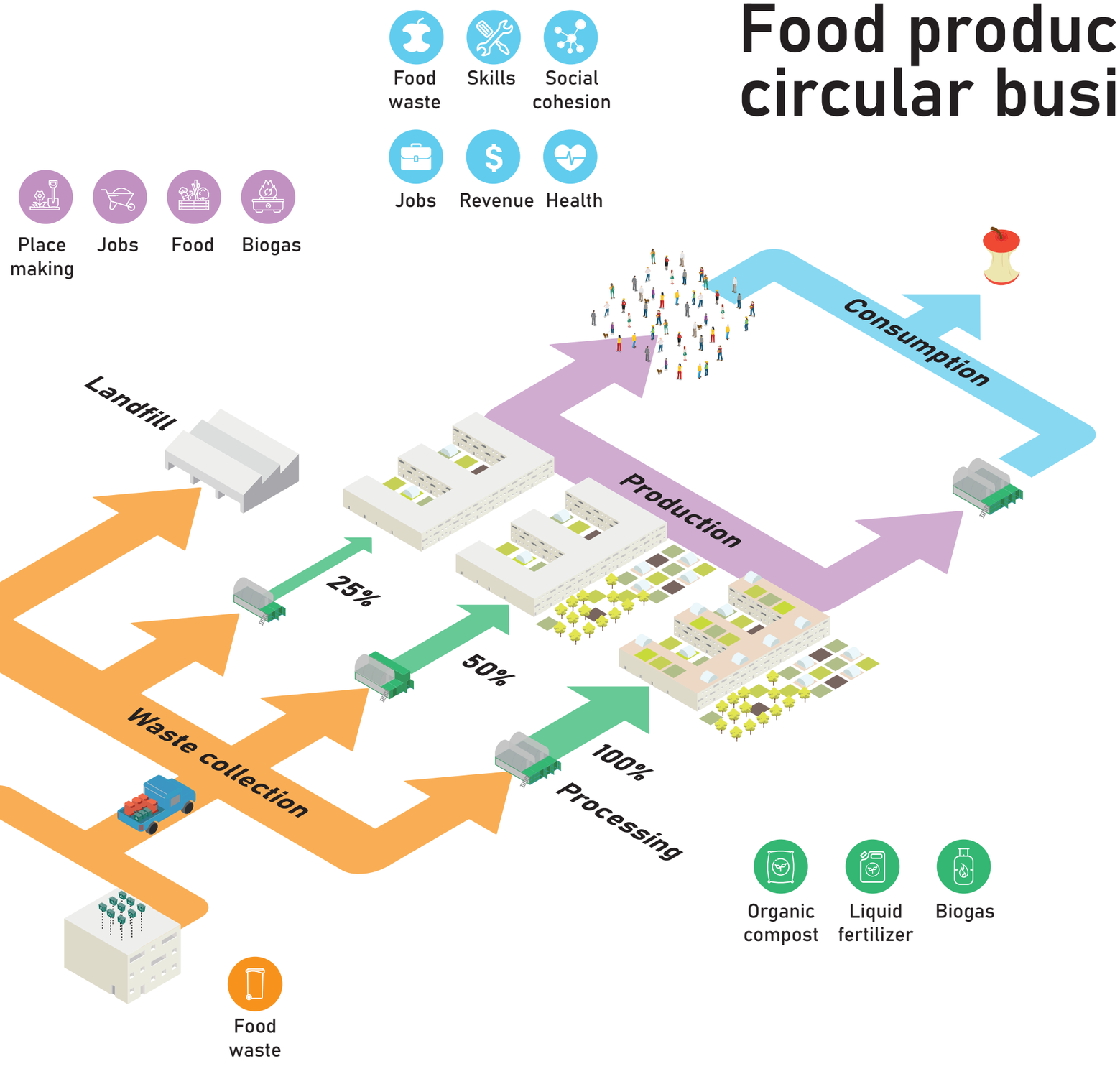
Using the liquid biofertilizer on-site avoids transporting a bulky product, which is 90-95% water. Biofertiliser volumes and spatial requirements have been calculated for hydroponics in polytunnels with the results summarised below using an application rate of 1 litre per 10 m2 p/day.

Compost spatial requirement scenarios (Annual)					
Output %	10%	25%	50%	75%	100%
Area (m2) **@20L/m2**	**393**	**983**	**1,965**	**2,948**	**3,930**
Area (m2) **@40L/m2**	**197**	**491**	**983**	**1,474**	**1,965**

Table 5 – Compost special requirements for on soil cultivation

The compost will be produced to PAS100 end of waste standard, so surplus material could be sold. The table below shows the area that compost produced over a year could be applied to, taking an application rate of 20 to 40 litres per m2 per annum (density of compost = 0.38).

Food production and circular business models



SOURCE must be **financially sustainable** and for this to happen, the food grown and to a lesser extent the value of surplus energy produced, must generate enough income to pay for the capital and operational costs over a reasonable timescale. Within the total available space identified for growing, the minimum area required for more commercially-based food production must be determined.

4

Our research (www.fewmeter.org) demonstrates that urban **farms are more productive than allotments** because the former are managed professionally and sell their produce, while the latter are cultivated by gardeners for leisure, predominantly interested in the health and physical wellbeing generated from healthy food and contact with nature. Modelling the **business case**, we can establish the minimum footprint required for more intensive urban farming to ensure enough income generation to support the circular model. Then, some or all of the remaining space can be allocated to residents for food production.

We envisage SOURCE farms operating according to some existing community gardens or social farm models, in which food production is led by trained farmers, supporting green volunteering, **training and employment for local residents** and hosting community food-related and environmental education activities. This type of urban agriculture ensures total integration of the farm/garden within the local communities.

Alongside the core waste management and food production activities, other modular additions and activities include:

- a **food coop**, a place where the farmers can sell the local produce to residents,
- a **community café** where produce is used to cook meals,
- rentable **circular enterprise** workspace enabling an ecosystem of circular enterprises to form,
- delivery of training and educational **workshops** teaching practical green skills, how to reduce and recycle, circular economy principles

Each element will generate extra income to support the model, while creating **social and environmental value**, leveraging the infrastructure to inform, educate and raise awareness and give people the tools to address the climate emergency.

Revenue p/a	Percentage of treatment capacity				
Income streams	10%	25%	50%	75%	100%
Compost	**982.57**	**2,456.42**	**4,912.85**	**7,369.27**	**9,825.69**
Food – maximum (retail)	**52,582.40**	**131,456.00**	**262,912.00**	**394,368.00**	**525,824.00**
Food – minimum (wholesale)	**26,291.20**	**65,728.00**	**131,456.00**	**197,184.00**	**262,912.00**
Total revenue - maximum	**£53,565**	**£133,912**	**£267,825**	**£401,737**	**£535,650**
Total revenue - minimum	**£27,274**	**£68,184**	**£136,369**	**£204,553**	**£272,738**

Table 6 – income streams generated by the waste food recycling process

In Table 6, we calculated the **income generated** by selling compost and fruit and vegetables across a range of productivity percentages (10%,25%,50%,75%,100%) on a monthly basis. Prices of compost and food vary greatly depending on the type of food and the revenue model. The case studies that follow the table provide examples of these models.
In our estimate, **compost is sold £5 for 40 litres**. Turnover from food ranges from minimum (£2/kg for wholesale) to maximum (£4/kg for veg boxes).

Sutton Community Farm


© Sutton Community Farm

Sutton Community Farm is a community-owned farm, on a 7.1 acre smallholding in South London. The farm produces high value crops that are sold through their veg box scheme as well as wholesale. The programme of activities includes educational and outreach activities for local communities and a training scheme for urban farmers. Although the farm partially relies on funding, income from food sales has steadily increased over the last 4 years. In the year 2021/2022, 22 tons were harvested, generating an income worth £83,000 (£3.78 per kg). This enables the farm to substantially reduce reliance on external funding. Due to the pandemic, demand for veg boxes increased 70 % over the previous year, with more than 90% of the total harvest sold through boxes.

Growing Communities


© Growing Communities

Growing Communities is a community-led organisation based in Hackney, North London, started 25 years ago with a Community Supported Agriculture veg box scheme. Over this period, they expanded their activities which now include growing spaces in Hackney and Dagenham where they cultivate part of the food sold, a training scheme for urban farmers, a Farmers' Market, and the Better Food Shed, a wholesale hub for traders in support of organic farms. A study based on their activities, developed by the New Economic Foundation, found that each £1 of food sold generates a value of £3.7 for farmers and the planet generally. In 2021, Growing Communities generated more than £2M turnover and £82,000 profit.

Cultivate London


© Cultivate London

Cultivate London started out training young people to grow food and amenity horticulture plants for sale into the local community, supermarkets, local authority etc. They developed NVQ accredited training and expanded across several unused sites in London. However, they found the supply chain became the biggest challenge to the sustainability of their enterprise. For example, supermarkets could change their criteria very quickly, leaving produce without a customer. Over time, they adapted their business model to provide more commercial horticultural services, while continuing to deliver community engagement and NVQ training, reducing their reliance on funding, which now covers only the latter activities.

CAPEX model			SOURCE benefits			
System capacity kg/d	Capex* £	Opex £ p/a	CO2e savings tonnes p/a	Total income** £ p/a	Net proft £ p/a	Payback years
333	261,080	36,663	64	96,046	59,413	4.39
1000	566,900	72,014	193	271,643	199,629	2.84

**Includes AD and composting systems, hydroponics, polytunnel, circular enterprise workshop space*
***Includes produce sold at retail price, compost sales, CE rental, heat export and RHI*

LEASING model		SOURCE benefits
System capacity kg/d	Monthly cost £/m	Net proft £ p/a
333	4,714	2,845
1000	11,810	57,904

N.B. 333 kg p/d system includes 165m2 hydroponics and sells produce at retail price (£4/kg). 1000 kg/d system includes 1200m2 hydroponics and sells produce at wholesale price (£2.25 p/kg).

Table 7 & 8 – Capex model and SOURCE benefits

From the above examples, it can be seen that establishing a robust local supply chain is critical to the success of the model. For the Teviot, it may be wise to incorporate a local veg box scheme to increase revenue, create short local supply chains and strengthen the local economy.

There are several **ownership options** for the infrastructure from leasing to full capex models. The pilot will involve stakeholders such as the social housing provider Poplar Harca, LB Tower Hamlets and various local food-related and community-based organisations to identify the best model going forwards.

Tables 7 and 8 show the **capital and operating** costs as well as the CO2 savings, net income, potential savings and payback periods for SOURCE at a) the scale proposed for the Teviot (333 kg/day), and b) scaled up to meet the needs of the whole population at the Teviot (1000 kg/day).

Urban agriculture in Teviot

A key element for a successful circular bio-economy food system is its **physical integration within the social housing estate**. This is a particular socio-physical context that offers opportunities and challenges. Frequently, residents in these estates have developed strong community bonds, making it easy for community-based initiatives to connect with individuals and groups. Estates are also designed for high dwelling density and to provide open spaces for social interaction. However, there can be security issues and neglect, resulting in these spaces being abandoned or underused.

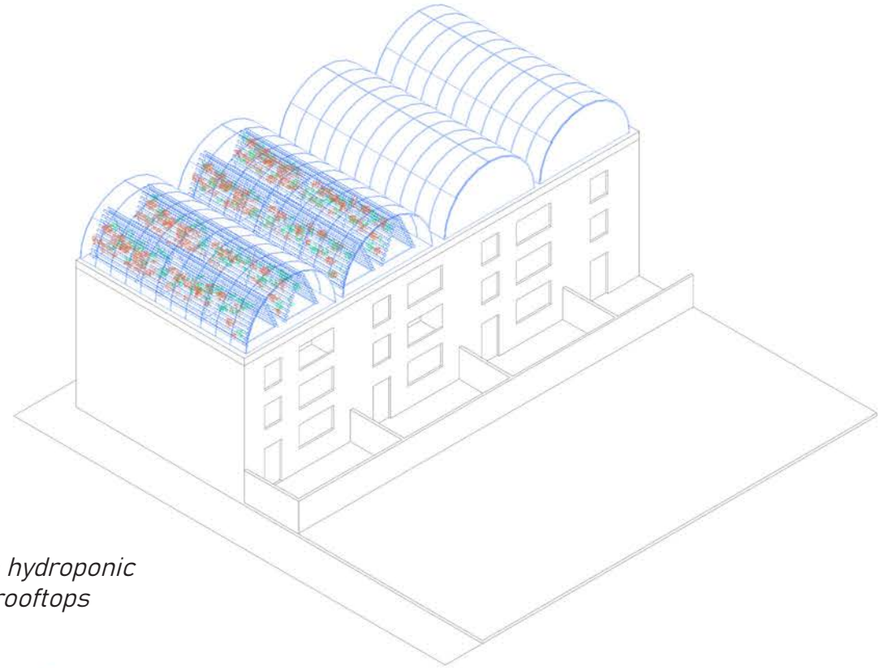
The establishment of a combined food waste collection, processing and food production model is therefore an invaluable opportunity to improve the spatial quality of the communal spaces and increase the residents' sense of belonging and ownership of such spaces. We have provided here a catalogue of possibilities that conflates food production areas with green infrastructure and healthy spaces.

It can be applied to any high-density residential development although it is particularly appropriate for social housing estates, which often present similar logistics of space organisation.

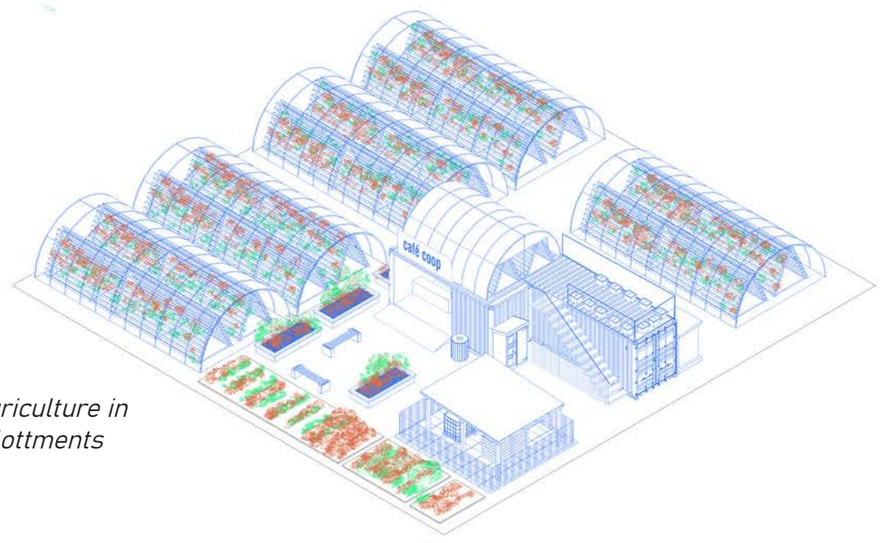
The following growing options were identified:

- **Production on sidewalks**: raised beds and flowerbeds
- **Production in parks**: neighbourhood park with recreational areas, urban agriculture, hydroponics and raised beds
- **Production in farms**: intensive urban agriculture
- **Production at your door**: plots in the proximity of dwellings
- **Production on roofs and green walls**: raised beds, hydroponics, recreational areas

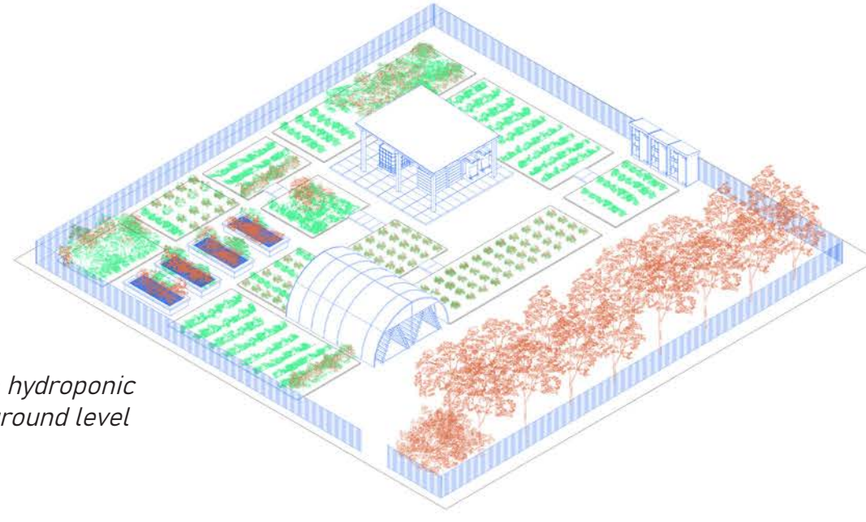
Areas not used for intensive food production could be developed as **communal green spaces** featuring biodiverse planting or become permaculture-inspired forest gardens / orchards where residents can harvest a variety of fruits, berries and nuts. Regular applications of compost and fertiliser will ensure long term productivity and healthy soil ecologies, which in turn will support water retention to mitigate flash flooding.



Intensive hydroponic farm on rooftops

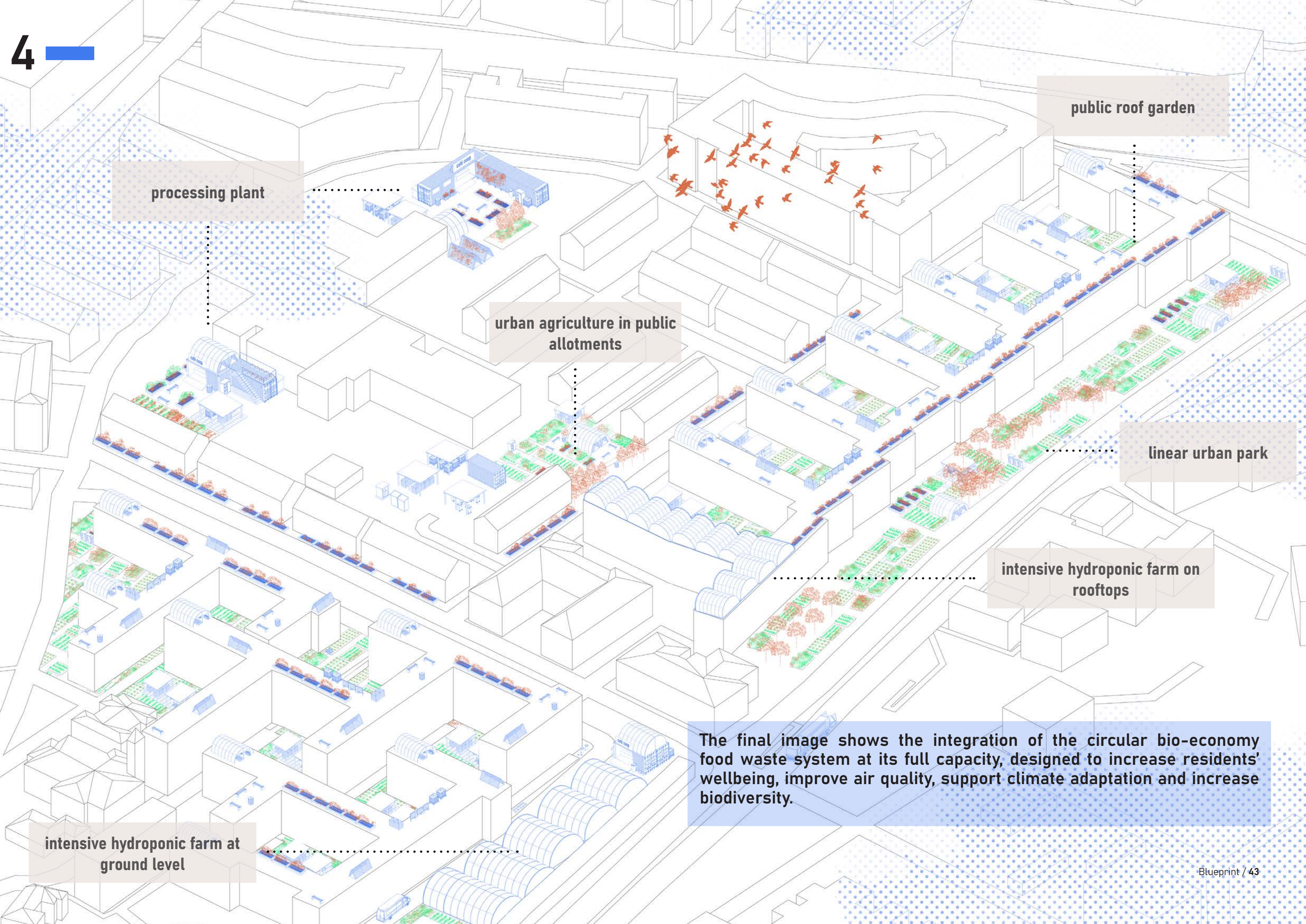


Urban agriculture in public allottments



Intensive hydroponic farm at ground level

4



The final image shows the integration of the circular bio-economy food waste system at its full capacity, designed to increase residents' wellbeing, improve air quality, support climate adaptation and increase biodiversity.

5 Appendix

Case studies

Here below are described the most outstanding features of the 13 case studies that have been examined for this publication, followed by a section of individual files that explore in greater detail the features of each project.

city **Capannori (IT)**
population **46,700**
year **2007**

- 2004-2013 the overall volume of waste generated per person dropped by 39%
- The rate of unseparated or residual waste per capita went from 340 kg per year in 2006 to 146 kg in 2011

city **Argentona (ES)**
population **12,000**
year **2004**

- Door-to door consultations were held. Awareness campaign was run before the launching of the program.
- Free waste separation kits distributed by volunteers a few weeks before the door-to-door collection started.

city **Parma (IT)**
population **190,284**
year **2012**

- The council saved €450000 in a year. Revenues of recycled waste reselling went from €0.8 m in 2013 to €1.3 m in a year. Annual costs of waste disposal have been reduced by almost €3.5 m.Creation of 44 job positions in the sector.

city **Rubaix (FR)**
population **95,866**
year **2014**

- Awareness raising through campaigns in schools.
- 1 year challenge where 100 families were trained through specific workshops on how to consume less and where asked to weight their residual disposal as time went on.

city **Besançon (FR)**
population **224,186**
year **2008**

- Increased social contacts among neighbours and the sense of ownership of a project. In some cases, people have decided to take a step further and make a small collective garden next to the community composter.

city **Oristano (IT)**
population **32,000**
year **2004**

- In this network of municipalities, the target is set slightly above what has been previously achieved and the cities that produce more residual waste have higher taxation.
- The town has reached 75.6% separate collection and 117 kg per inhabitant of residual waste a year in 2016.

city **Vrhnika (SVN)**
population **18,000**
year **2004**

- Education campaign on food waste disposal in schools.
- Involvement of the media and launch of themed magazine.
- Launch of recycling center in 2014 where people can buy upcycled items.

city **Treviso (IT)**
population **554,000**
year **2005**

- Pay-as-you-throw fee for waste generation is splitted in two parts:
  - fixed, depending on the number of people in the household;
  -variable, calculated over the number of residual waste retrives, minus the amount of compost generated.

city **Bruges (BE)**
population **117,000**
year **2015-2021**

- The city, together with the local stakeholders, created a local council on sustainable food called “The Bruges Food Hub”
- The food-waste recycling initiative served as a base for a network of restaurants using food surplus and employing vulnerable people.

city **Sălacea (RO)**
population **3,181**
year **2017**

- Creation of a recycling center.
  Four weeks education programme at the beginning of the collection campaign.
  Multi-lingual communication.
- Total waste generated fell from 106.7 tonne to 47.93, a drop of 55%.
  Waste that went to landfill dropped from 105 tonne (98%) to 26.3 (55%).

city **Ljubljana (SVN)**
population **395,328**
year **2006**

- In 14 years, the quantity of recovered materials in this city increased from 16 kg per person in 2004 to 220 kg per person in 2018.
- By 2018, the average resident produced just 358 kg of waste, 68% of which was recycled.

city **Gipuzkoa (ES)**
population **732,468**
year **2002**

- Organic waste is collected three times a week; Light containers are collected twice a week; Paper and card-board are collected once a week;
  Residual waste is collected every two weeks.

city **Pontevedra (ES)**
population **960,000**
year **2017**

- Public meetings where explanation of the project is provided.
  Clear schedule communication.
- Composted biowaste per year went from 200 tons to 1200 tons over 2 years.

5

city **Capannori (IT)**
population **46,700**
year **2007**

Motivations:
Incinerator planned nearby.

Community engagement:
Preliminary meetings held in public places. Free waste separation kits distributed by volunteers a few weeks before the door-to-door collection started. Distribution of printed information. Volunteers were trained to answer the citizen's questions.

Collection:
Door-to-Door.

Frequency:
n.a.

Containers:
n.a.

Incentives:
Pay-as-you-throw

Economic impacts:
The council saved over €2m in 2009.
This allowed to reduce fixed waste tariffs for residents by 20%.
Creation of 50 job positions.

Social impacts:
The municipality opened its own Reuse Centre in the village of Lammari in 2011, where items such as clothes, footwear, toys, electrical appliances and furniture that are no longer needed but still in good condition can be repaired where necessary and sold to those in need, thereby diverting them from landfill and serving a vital social function.

Overall impacts:
Between 2004 and 2013 the overall volume of waste generated per person dropped by 39% (from 1,92kg to 1,18 kg/person/year)
The rate of unseparated or residual waste per capita was reduced from 340 kg per year in 2006 to 146 kg in 2011, a drop of 57%.

city **Argentona (ES)**
population **12,000**
year **2004**

Motivations:
Incinerator reached saturation.

Community engagement:
Door-to door consultations were held.
Awareness campaign was run before the launching of the program.
Free waste separation kits distributed by volunteers a few weeks before the door-to-door collection started.

Collection:
Door-to-Door.

Frequency:
Residents put out their waste at a specific time – between 8 and 9pm, with collection starting at 10pm.
3 times weekly collection of organic waste;
2 times a week for lightweight packaging;
daily collection service for used, disposable nappies.

Containers:
Containers depend upon users' choice.

Incentives:
Pay-as-you-throw;
113 composting bins for gardens;
15 wormery bins;
Training.

Economic impacts:
The city council saved 35000 €.
Job creation.

Social impacts:
Another co-benefit of the door-to- door collection system was the boost in local employment, which tripled the number of jobs and improved social inclusion.

Overall impacts:
The recycling rate rose from below 20% in 2003 to 68,5 % in 2012.

5

city **Vrhnika (SVN)**
population **18,000**
year **2004**

Motivations:
Incinerator planned nearby.

Community engagement:
Education campaign on food waste disposal in schools.
Training of teachers to raise awareness among pupils.
Collection trucks were made more aesthetically pleasing and decorated with pro-recycling phrases.
Involvement of the media and launch of themed magazine.
Launch of recycling center in 2014 where people can buy upcycled items.

Collection:
Door-to-Door combined with home composting and disposal of bulky materal in eco-islands.

Frequency:
n.a.

Containers:
n.a.

Incentives:
Pay-as-you-throw.

Economic impacts:
n.a.

Social impacts:
n.a.

Overall impacts:
Production of residual waste went from a 201kg/capita per year in 2004 to 80kg/capita per year in 2012.

city **Treviso (IT)**
population **554,000**
year **2005**

Motivations:
Political vision
Public company Contarina

Community engagement:
n.a.

Collection:
Door-to-Door supplemented by eco-islands.

Frequency:
The collection of different waste streams takes place in different days of the week; food waste has the highest frequency in collection; paper, green waste and other recyclables are collected between once and three times per week; residual waste is collected the least often.

Containers:
Dedicated bins for each waste stream, various dimensions according to dimension of household and type of urban context.

Incentives:
Pay-as-you-throw
In this case, the fee for waste generation is splitted in two parts:
- fixed, depending on the number of people in the household;
-variable, calculated over the number of residual waste retrives, minus the amount of compost generated.

Economic impacts:
Creation of 26 job positions.

Social impacts:
For many of the services provided, the company partners with social cooperatives who work in employing disadvantaged people.

Overall impacts:
Recycling of up to 85% of waste generates only 53kg of residual waste per inhabitant a year.

5

city **Ljubljana (SVN)**
population **395,328**
year **2006**

Motivations:
Political vision.
Incinerator planned nearby.

Community engagement:
Involvement of the media in visits at recycling plants.
Involvement of media and local NGOs.
Campaign focused on waste reduction and better sorting of waste.

Collection:
Door-to-Door supplemented by eco-islands.

Frequency:
While the collection for recyclables remained constant over time (between one and three times a week), the collection of residual waste was pushed to once every three weeks for low density areas and once a week for high density areas.

Containers:
n.a.

Incentives:
Residual waste is collected less often than recyclables.

Economic impacts:
n.a.

Social impacts:
n.a.

Overall impacts:
In 14 years, the quantity of recovered materials in this city increased from 16 kg per person in 2004 to 220 kg per person in 2018. By 2018, the average resident produced just 358 kg of waste, 68% of which was recycled, composed or else- how recovered. This means that the amount of waste being sent to landfill decreased by 95% until 2018, and total waste generation decreased by 15%.

city **Gipuzkoa (ES)**
population **732,468**
year **2002**

Motivations:
Incinerator planned nearby.
Citizen mobilisation and the political will to build a better alternative.

Community engagement:
Public meetings for co-design of collection timetables.
Awareness campaign.

Collection:
Door-to-Door.

Frequency:
Organic waste is collected three times a week;
Light containers are collected twice a week;
Paper and card-board are collected once a week;
Residual waste is collected every two weeks.

Containers:
n.a.

Incentives:
n.a.

Economic impacts:
Job creation.

Social impacts:
In response to the local economic crisis, a wide array of social initiatives has been organised: e.g. a charity food bank that assists vulnerable people.

Overall impacts:
In 2002 80 % of waste would be sent to landfill, while after 10 years 70% of the waste gets recycled.

city **Parma (IT)**
population **190,284**
year **2012**

Motivations:
Incinerator planned nearby.

Community engagement:
Public meetings for co-design of collection timetables and feedback on startegy.
Multi-lingual communication.

Collection:
Door-to-Door supplemented by eco-islands and eco-trucks.

Frequency:
The collection system is modulated according to the population density of the neighbourhood, with bio-waste and residual waste being collected more often in the city centre than in residential areas.
In the city centre collection is done during the night, while in residential areas waste is collected in the morning.

Containers:
Dedicated bins for each waste stream, various dimensions according to dimension of household and type of urban context.

Incentives:
Pay-as-you-throw

Economic impacts:
The council saved €450000 in a year. Revenues of recycled waste reselling went from €0.8 m in 2013 to €1.3 m in a year. Annual costs of waste disposal have been reduced by almost €3.5 m.Creation of 44 job positions in the sector.

Social impacts:
n.a

Overall impacts:
In 4 years this city has managed to reduce total waste generation by 15% and increase significantly separate collection, moving from 48.5% in 2011 to 72% in 2015. Residual waste has also decreased significantly in the city, from 313 kg per inhabitant a year in 2011 to 126 kg a year in late 2015, a reduction of 186 kg of waste per inhabitant, meaning a 59% reduction in 4 years.

city **Rubaix (FR)**
population **95,866**
year **2014**

Motivations:
Citizen mobilisation;
Political vision.

Community engagement:
Awareness raising through campaigns in schools.
1 year challenge where 100 families were trained through specific workshops on how to consume less and where asked to weight their residual disposal as time went on.

Collection:
n.a.

Frequency:
n.a.

Containers:
Food waste is directly processed in tower gardens by the users or is taken to community composting sites.

Incentives:
n.a.

Economic impacts:
Local economy is being supported as part of this city's strategy.

Social impacts:
A network of local actors was created through the food-waste recycling initiative.

Overall impacts:
n.a.

5

city **Besançon (FR)**
population **224,186**
year **2008**

Motivations:
Incinerator reached saturation.
Political vision.

Community engagement:
Awareness raising campaigns.
Lifestyle challenge where 20 families where invited to document their waste reduction strategies at home.

Collection:
1. Individual composting
2.Community composting
3.Local Composting Plants

Frequency:
n.a.

Containers:
n.a.

Incentives:
Pay-as-you-throw
In this case, the fee for waste generation is splitted in two parts:
- fixed, depending on the size of the bin;
-variable, calculated over the number of retrives.

Economic impacts:
After an initial investement of 2000 €, these small composting sites are managed at very small costs in this case.

Social impacts:
Increased social contacts among neighbours and the sense of ownership of a project. In some cases, people have decided to take a step further and make a small collective garden next to the community composter.

Overall impacts:
150 kg of residual waste per personper year and 58 % of separate collection.

city **Oristano (IT)**
population **32,000**
year **2004**

Motivations:
European targets on waste managenment.
Surrounding towns already practicing it.

Community engagement:
n.a.

Collection:
Door-to-Door

Frequency:
n.a.

Containers:
n.a.

Incentives:
In this network of municipalities, the target is set slightly above what has been previously achieved and the cities that produce more residual waste have higher taxation.

Economic impacts:
n.a.

Social impacts:
n.a.

Overall impacts:
The town has reached 75.6% separate collection and 117 kg per inhabitant of residual waste a year in 2016.

5

city **Bruges (BE)**
population **117,000**
year **2015-2021**

Motivations:
Political vision.

Community engagement:
The city, together with the local stakeholders, created a local council on sustainable food called “The Bruges Food Hub”

Collection:
n.a.

Frequency:
n.a.

Containers:
n.a.

Incentives:
n.a.

Economic impacts:
For every euro invested the city council claims that 8 euros are being saved.

Social impacts:
The food-waste recycling initiative served as a base for a network of restaurants using food surplus and employing vulnerable people.

Overall impacts:
n.a.

city **Sălacea (RO)**
population **3,181**
year **2017**

Motivations:
Political vision

Community engagement:
Creation of a recycling center.
Four weeks education programme at the beginning of the collection campaign.
Multi-lingual communication.

Collection:
Door-to-Door, with five different waste streams

Frequency:
n.a.

Containers:
Dedicated bins for each waste stream, various dimensions according to dimension of household and type of urban context.

Incentives:
Pay-as-you-throw

Economic impacts:
Bio-waste is processed and re-sold as fertiliser.

Social impacts:
n.a.

Overall impacts:
Total waste generated fell from 106.7 tonne to 47.93, a drop of 55%.
Waste that went to landfill dropped from 105 tonne (98%) to 26.3 (55%).

city **Pontevedra (ES)**
population **960,000**
year **2017**

Motivations:
Excessive disposal costs.

Community engagement:
Public meetings where explanation of the project is provided.
Clear schedule communication.

Collection:
1. Individual composting
2.Community composting
3.Local Composting Plants

Frequency:
n.a.

Containers:
1. Individual composting (COIN): home composters for households with enough space to host them.
2.Community composting (CCC): These are made of composting boxes (called UMC) and a community will have access to either 3, 5, 6 or 10 composting boxes together in one location.
3.Local Composting Plants (PCC): For areas too densely populated for home com-posting or community composting.

Incentives:
n.a.

Economic impacts:
n.a.

Social impacts:
n.a.

Overall impacts:
Composted biowaste per year went from 200 tons to 1200 tons over 2 years.

Bibliography

- *Condamine, P. (n.d.). Zero Waste Europe_ The story of Pontevedra. Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2019/09/zero_waste_europe_CS13_pontevedra_en.pdf
- *Ferran, R. (n.d.). Zero Waste Europe_The Story of Parma. In Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2019/10/zero_waste_europe_cs7_parma_en.pdf
- *Oblak, E. (n.d.). Zero Waste Europe_The Story of Ljubljana. In Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2019/10/zero_waste_europe_cs5_ljubljana_en.pdf
- *Rastei, E., & McQuibban, J. (n.d.). Zero Waste Europe_The Story of Salacea. In Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2019/09/zero_waste_europe_cs12_salacea_en.pdf
- *Rosa, Feran, & Chatel, L. (n.d.). Zero Waste Europe_The Story of Roubaix. In Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2019/11/zero_waste_europe_cs8_roubaix_en.pdf
- *Rosa, Ferran. (n.d.-a). Zero Waste Europe_ The Story of Sardinia. In Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2019/11/zero_waste_europe_cs10_sardinia_en.pdf
- *Rosa, Ferran. (n.d.-b). Zero Waste Europe_The story of Besançon. In Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2019/11/zero_waste_europe_cs9_besancon_en.pdf
- *Rosa, Ferran, & FoodWIN. (n.d.). Zero Waste Europe_The story of Bruges. In Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2018/09/zero_waste_europe_cs11_bruges_en.pdf
- *Simon, J. M. (n.d.-a). Zero Waste Europe_ The Story of Contarina. In Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2019/10/zero_waste_europe_cs4_contarina_en.pdf
- *Simon, J. M. (n.d.-b). Zero Waste Europe_ The story of Gipuzkoa. Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2019/10/zero_waste_europe_cs6_gipuzkoa_en.pdf
- *Van Vliet, A. (n.d.-a). Zero Waste Europe_ The Story of Argentona. In Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2019/10/zero_waste_europe_cs2_argentona_en.pdf
- *Van Vliet, A. (n.d.-b). Zero Waste Europe_ The story of Capannori. In Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2019/10/zero_waste_europe_cs1_capannori_en.pdf
- *Van Vliet, A. (n.d.-c). Zero Waste Europe_The story of the story of Vrhnika. Zero Waste Europe.* https://zerowasteeurope.eu/wp-content/uploads/2019/10/zero_waste_europe_cs3_vrhnika_en.pdf

SOURCE: URBAN CIRCULAR ECONOMY BIORESOURCE MANAGEMENT – A GUIDE FOR LOCAL AUTHORITIES AND DEVELOPERS

This publication was made possible thanks to the work of:

Dr. Silvio Caputo
Kent School of Architecture

Rokiah Yaman
LEAP Micro AD

Valentina Manente
Kent School of Architecture

With the support of:

Design Exchange Partnership (DEP), an initiative promoted by the Arts and Humanities Research Council and the Future Observatory / Design Museum.

Published in April 2022