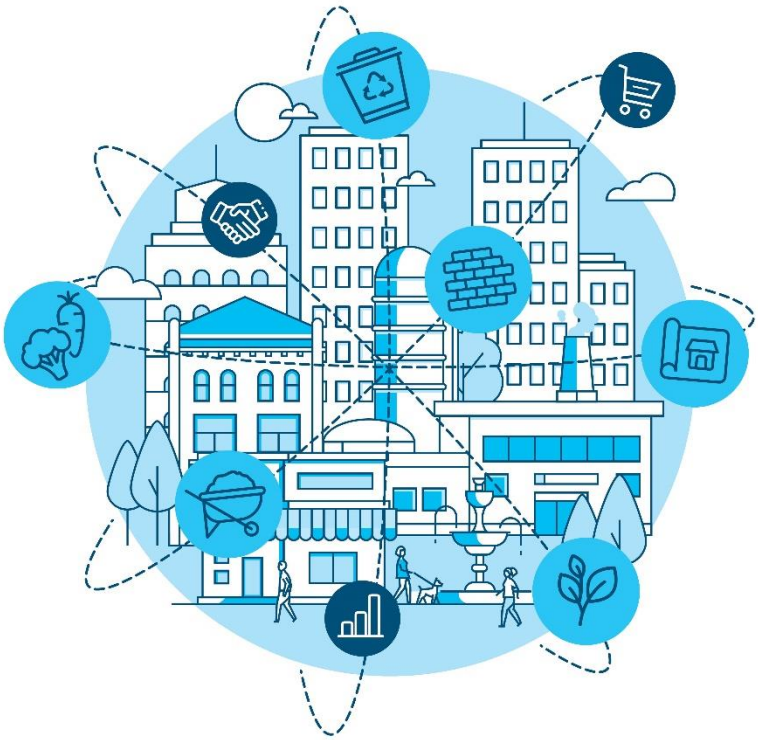
Apeldoorn

Optimised Implementation Plan – Biowaste

Apeldoorn
Wageningen Research



Version	1.0
WP	3
Deliverable	D3.3
Date	04.03.2021
Dissemination level	Public
Deliverable lead	Municipality of Apeldoorn
Authors	Edwin Keijsers (Wagening Research, WP leader 3) Adriaan Hellemans (Municipality of Apeldoorn, demonstration manager) Carmen Aalbers (Wageningen Research)
Reviewers	Simon Clement & Nikolai Jacobi (ICLEI)
Abstract	This Optimised Implementation Plan explains how the City of Apeldoorn will implement the tools and processes developed in the project preparation phase in its demonstration actions, and how relevant local stakeholders and CityLoops project partners will be involved.
Keywords	Demonstration; implementation; plan
License	 This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0). See: https://creativecommons.org/licenses/by/4.0/

Content

1. Demo action descriptions 1
   1.1. Bokashi production from leaves 1
   1.2. Biochar production 3
   1.3. Production of fibre based products 3
   1.4. 3D printing with organic fibre 5
   1.5. Municipal cleaning of grass 6
2. Activities 8
3. Preparation 9
4. Planned activities 10
5. Expected outcomes & evaluation 12
6. Evaluation plan 14
7. Risks 15

1. Demo action descriptions

Over the next 8 months, the Municipality of Apeldoorn will implement a series of demonstration actions designed to test business cases for five products created from biowaste collected by the city:

1. Bokashi production from leaves
2. Biochar
3. Fibre-based products
4. 3D printing with organic fibres
5. Municipal cleaning of grass

For each demonstration case, the financial return on investment will be calculated, together with an assessment of the environmental and societal impact.

The selection process for the five demonstrations took into account, among other factors, the technology readiness level, the amount of biomass in relation to the size of the industry, the interest of Apeldoorn and external stakeholders in the Municipality of Apeldoorn, and the options to recycle the products after use. All five offer potential opportunities for replication, and are at different levels of development. 3D printing with organic fibres and producing fibre-based products offer a potential second life to organic matter collected. Bokashi is being studied closely by the Dutch Ministry of Infrastructure and Water management and the Ministry of Agriculture, Nature and Food Quality currently as a means of avoiding the generation of waste. Biochar might allow both soil improvement as well as a carbon storage function. And grass cleaning? Although this might not sound important, the quantity of rubbish left on public grass patches may have a significant impact on the further use of that grass.

1.1. Bokashi production from leaves

Bokashi is a process in which -in this case- leaves from the districts of Apeldoorn are collected, processed and returned to municipal green spaces, as a soil improver. After the collection of leaves, regenerative microorganisms and stone granules are added. This leaf mixture is then placed in a pile, compressed to

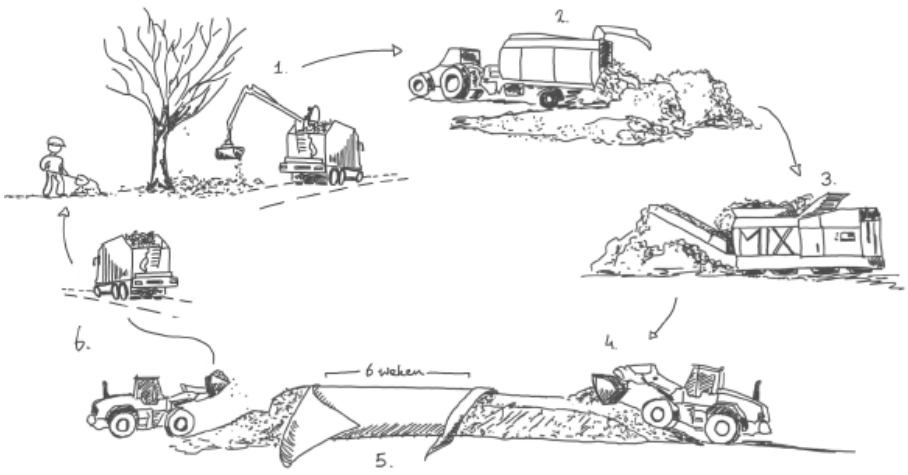


Figure 1. Bokashi as part of circular city Apeldoorn

remove air and covered with agricultural plastic for at least 6 weeks of anaerobic treatment. This results in the soil improver, Bokashi.

Why? Bokashi from leaves appears to be high in nutrients and to have a positive effect on soil quality, moisture management, carbon storage and plant growth. The process is faster than composting and the results seem promising.

Customer: the municipality is itself the customer of its own product.

Relationship of the municipality-customer: internal business operations.

Relationship with other projects/organisations: Ministry of Infrastructure and Water Management, Min Agriculture, Nature and Food Quality and Wageningen University and Research.

Figure 2 Compressing the bokashi heap prior to fermentation

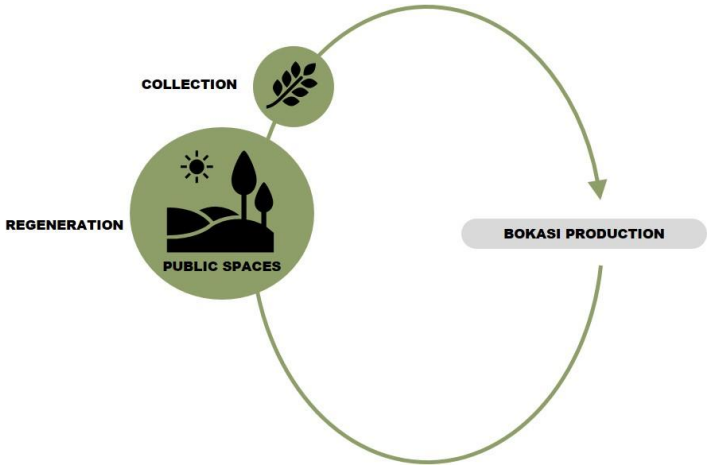


Figure 3. Bokashi: The circular system

1.2. Biochar production

Where the Bokashi process (demonstration 1) is most suited for leaves, biochar can be made from prunings, grass and plants such as Japanese knotweed. Biochar can be an alternative raw material for products in the agricultural, wastewater, health and cosmetics industries. Apeldoorn is a partner in a research project that produces biochar (charcoal) from biowaste on a small scale. In this demonstration the focus is on the use of biochar produced from biowaste as a soil improver. Biochar produced from different biowaste streams has been investigated and will now be tested in different locations around Apeldoorn, in collaboration with the Department of Maintenance and Green Spaces.

Why? Biochar is a promising product for improving the quality of the soil and for storing CO_2 within the biochar. The pyrolysis process used to produce biochar will destroy the seeds present in the biowaste and therefore prevent unwanted seed dispersal.

Customer: the municipality is itself the customer of its own product.

Relationship of the municipality-customer: internal business operations, except for the production of biochar, on a larger scale industrial partners will be needed.

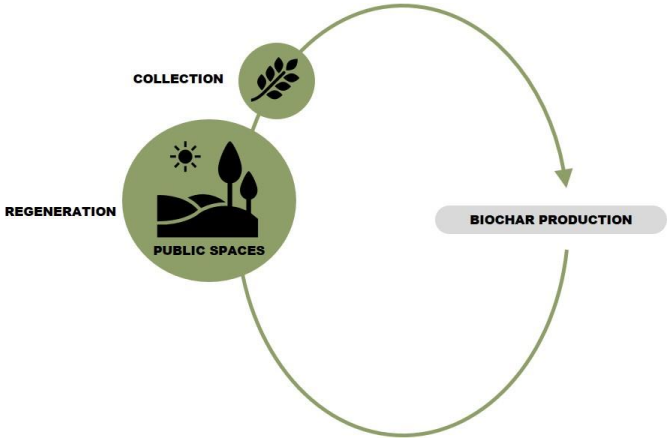


Figure 4. Biochar: The circular system

Figure 5: Biochar

1.3. Production of fibre based products

The biowaste from public spaces in Apeldoorn will be used in the production of fibre based products e.g. paper, board or products produced from paper and board. In this demonstration the

Figure 6. Board and paper from biowaste produced on labscale

municipality of Apeldoorn will work together with interested entrepreneurs. Apeldoorn will perform the collection of the biowaste, and part of the technical processing can be performed by WR. On a small scale, products will be produced together with interested entrepreneurs. During the demonstration action interested entrepreneurs will be contacted and decisions will be made on specific products to be produced. Apeldoorn will also serve as a launching customer. Paper products containing biowaste will be produced at the *Middelste Molen* (a paper museum and oldest paper Mill in the Netherlands) located in Apeldoorn, or on a larger scale in a paper mill. Board materials will be produced using biobased binders provided that the quality of the biowaste is sufficient.

Why? Fibers from biowaste could replace virgin wood-based fibres grown and processed outside Apeldoorn. After use these products can be recycled or composted.

Customer: Biowaste or produced fibres could be sold to fibre/pulp industry. Products can be sold to the citizens of Apeldoorn. Apeldoorn will be a launching customer for the paper products. During the stakeholder engagement entrepreneurs are invited to diversify the product portfolio.

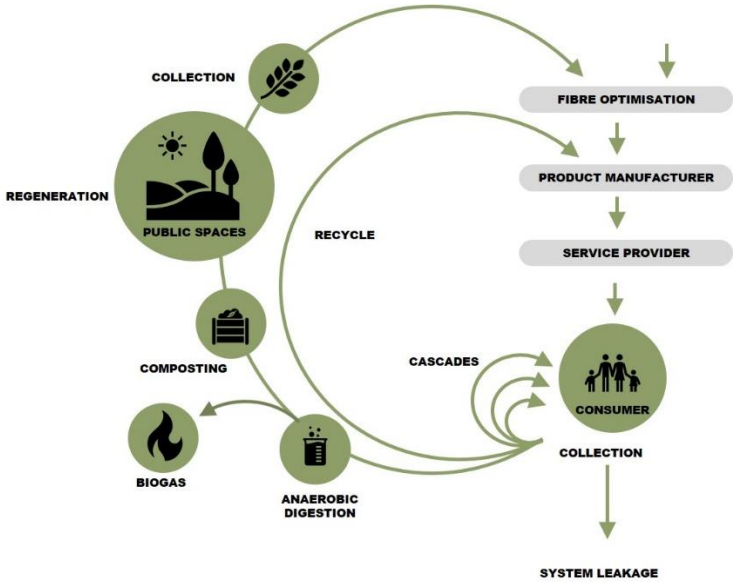


Figure 7. Fibre based products: The circular system

1.4. 3D printing with organic fibre

Figure 8 Compounding of composite materials

3D printed objects and injection moulded products can be made from composite material consisting of fibres and a matrix material e.g. bioplastics. Biowaste will be used as filler or fibre in composite materials. Fibres from virgin wood and fibre crops (hemp/miscanthus) are currently used in these composite materials. In this demonstration the municipality of Apeldoorn will work together with interested entrepreneurs. Apeldoorn will perform the collection of the biowaste, part of the technical processing will be performed by WR (fibre optimisation and compounding). Interested entrepreneurs will use 3D printing techniques and injection moulding to produce final products. Using local biowaste and 3D printing techniques Apeldoorn will produce ornamental objects and street furniture. Final selection of the objects to be printed will be based on the properties of the composite materials. As an alternative outlet composite materials could be used in injection moulded products, e.g. the small food waste garbage bins that are currently supplied to the citizens of Apeldoorn.

Why? The replacement of fibres from virgin wood and fibre crops by fibres from biowaste results in a reduction in CO_2 emission, water and land use. After usage composites made of fibres and e.g. PE, PP can be recycled. Combining biowaste fibres with a PLA matrix would result in an industrial compostable product.

Customer: Biowaste or produced fibres can be sold to the compounding industry. 3D printed or injection moulded products can be used in Apeldoorn.

Relationship of the municipality-customer: During the demonstration action Apeldoorn will be the launching customer for the products produced by external entrepreneurs. During the stakeholder engagement entrepreneurs are invited to diversify the product portfolio.

After the demonstration phase Apeldoorn will sell the fibres to the compounding industry.

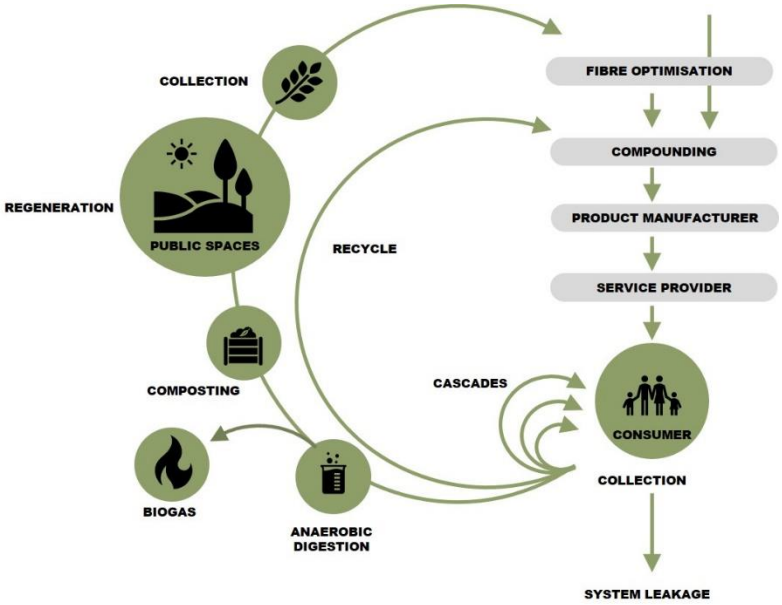


Figure 9. 3D objects: The circular system

1.5. Municipal cleaning of grass

Figure 9: Civilian cleaning public space

The use of biowaste as raw material for agricultural and industrial processes is depending on the cleanliness of the collected material. Most biowaste sources are polluted. E.g. mowed roadside grass can contain 40wt% of non-biological impurities (data WR). Involvement of citizens in the cleaning of public spaces will create enthusiasm for the circular economy and, when these cleaning actions are combined with planning of mowing of the grass will result in cleaner grass. In this demonstration the effect of combining municipal cleaning and mowing of grass in public spaces will be established, focussing on the cleanliness of the collected grass and the increased value of the cleaned grass for use in the circular economy.

Why? Working together towards a circular city may be beneficial for the wellbeing of the Apeldoorn community. Cleaning bio-waste at the source may be the best option.

Customer: Cleaned grass can be sold to interested industries at a higher price. Cleaned grass can be used as raw material in the demonstration actions 2, 3 and 4.

Relationship of the municipality-customer: Apeldoorn will supply the cleaned grass to interested industries.

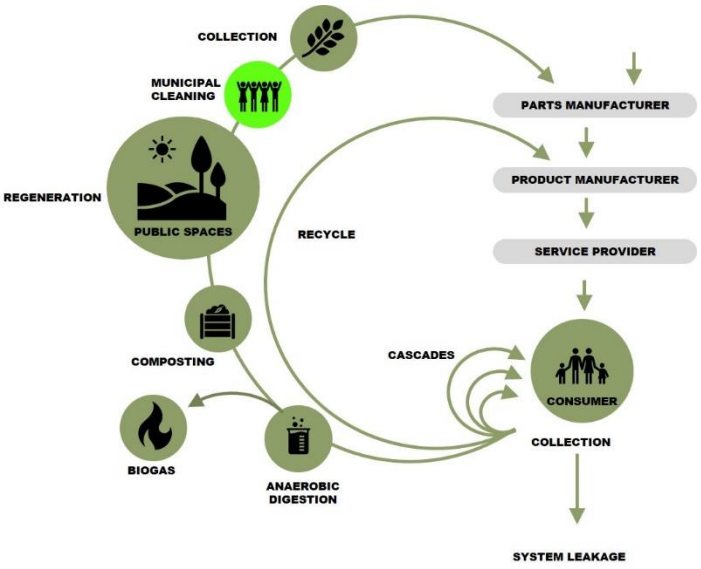


Figure 10. Municipal cleaning: The circular system

2. Activities

Every business case development has the same set up of activities, and so are presented in the combined table below. In these activities Wageningen has the primary responsibility in fibre products and 3D printing. The Municipality of Apeldoorn will led Bokashi- Biochar production and the cleaning of grass.

Activities	**Time box**	**Business case**				
		Bokashi	**Biochar**	**Fibre products**	**3D printing**	**Cleaning of grass**
Set up a canvas of the business case	March 2021 – April 2021	X	X	X	X	X
Stakeholder engagement (using valorisation decision tool)	April 2021 – May 2021	X				
	June 2021- Sept 2021		X	X	X	X
	October 2021 – May 2023	X	X	X	X	X
Collecting of technical and economic data	March 2021 – May 2023	X	X	X	X	X
Collection of biowaste, production of demo products and testing in laboratory and real life (using new sorting and treating tool)	April 2021 – Sept. 2021					X
	Oct 21 – March 2022	X				
	April 2021 – Dec 2022		X	X	X	X
	Oct 2022 – March 2023	X				
Business case development (using business case development tool)	April 2021 – May 2023	X	X	X	X	X
Deliverable: Business case	May 2023	X	X	X	X	X

3. Preparation

In preparation for the demonstration phase, a number of activities were carried out:

- **Development of a list of innovative sorting and treatment options for biowaste from green spaces**

A large number of different sorting and treatment processes have been tested at the laboratory scale. Following the collection of small samples of biowaste and the establishment of their chemical composition different sorting and treating processes were tested to show their potential for improving the quality of the biomass. . This has resulted in the production of a **list of innovative sorting and treatment options for biowaste from green spaces.**

The knowledge gained from developing this tool will be used to optimize the properties and cleanliness of the biowaste for each of the demonstration actions, and will be instrumental in obtaining the optimal raw materials from biowaste for application in biochar, fibres products and composites.

- **Development of a biowaste valorisation decision support tool**

The biowaste valorisation decision support tool describes how to select, collect, store and pre-treat biowaste for different industrial applications. It presents a decision tree which may be used a) by companies to identify potential local sources of biomass fit for their production processes, and the optimal steps to be taken to obtain this and b) by owners of biowaste (such as municipalities) to identify potential opportunities for valorising this waste.

This tool will be used in each of the demonstration actions and adapted when necessary based on the results. During stakeholder engagement with interested entrepreneurs the tool will be used to show the different properties and qualities of the biomass that can be obtained from Apeldoorn.

- **Development of the Business case development tool**

The business case development tool describes the selection process of the different demonstration actions. The tool will be used to prepare the business case for each demonstration action and to compare the initial assumptions with the results from the demonstration. The ultimate goal is a techno-economic, socially and environmentally sound business case.

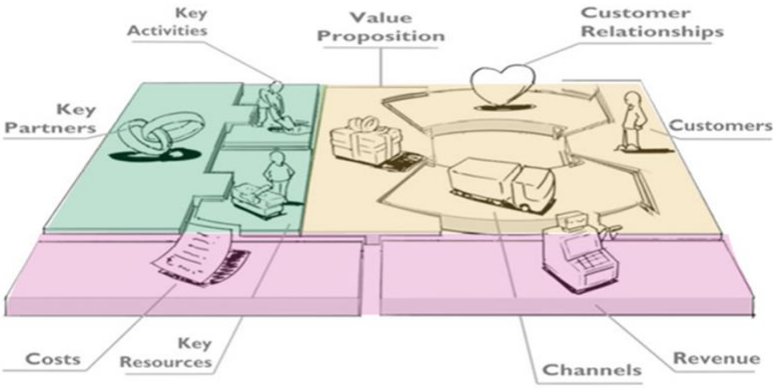


Figure 11: Business Model Canvas, Osterwalder

- **Selection of the five demo actions**

A long list of possible processes to convert biowaste into products was prepared. Promising valorisation options were selected, based on several co-dependent activities:

- Description of a business model from a city's viewpoint
- Description of a business model from an entrepreneur's viewpoint
- Overview of technical possibilities starting from biowaste
- Overview of biobased industries and initiatives interested in using biowaste
- Stakeholder engagement between cities, citizens and entrepreneurs
- Description of circular city selection criteria

The suitability of the biowaste for application in these different products was evaluated at the lab-scale.

All CityLoops biowaste tools and reports can be found here: *CityLoops - Biowaste*

4. Planned activities

The timing of the planned activities is given in section 2.

- **Set up a canvas of the business case**

For each of the demonstrations an overview will be created to show the different circular aspects, the role of the different stakeholders, the necessary developments and the goal of the demonstration. These canvasses will be used in communication with the stakeholders.

- **Stakeholder engagement**

For each of the five demonstration actions several online meetings will be held to discuss the demonstration activities. Interested entrepreneurs, citizens and other owners and processors of biowaste will be consulted and invited to take part in the demonstration and/or increase the amount of processed biowaste, e.g. by finding new product outlets.

- **Collecting of technical and economic data**

During the demonstrations technical and economic data on the collection of biowaste, the processing and use will be gathered. This data will be used in the techno-economic evaluation of the demonstrations, which is part of the business case.

- **Collection of biowaste, production of demo products and testing in laboratory and real life**

The physical part of the demonstrations consist of several stages:

  - Collection

Biowaste is collected from the public spaces of Apeldoorn under optimal conditions. These conditions are selected using the valorisation decision tool.

  - Cleaning and pre-treatment

The new sorting and treating tool is used to optimise the properties of the collected biowaste for the different applications. For the 3D printed products and the fibre based products pre-treatment of the biowaste will be partly performed at WR. Other pre-treatments are performed in Apeldoorn.

  - Production of the demo-products

The actual production of the demo-products will be performed as described in Chapter 1. For Bokashi the production will be done in Apeldoorn on site. Biochar will be produced on a pilot scale by an external company. Fibre based products and 3D printed objects will be produced by industry partners to be identified during the stakeholder engagement activities.

  - Testing on lab-scale and real life

The application of Bokashi and Biochar will be tested at different sites in Apeldoorn. Fibre-based products and 3D printed objects will be used in Apeldoorn. WR will test the products in the laboratory.

- **Business case development**

The business case development tool will be used to prepare the business case for each demonstration action. The ultimate goal is a techno-economic, socially and environmentally sound business case.

5. Expected outcomes & evaluation

For every business case we will develop a business model canvas. The most well know business model canvas has the regular 9 steps as shown on the page before. But in a circular economy we also have to be aware of the social value and the environmental value. The triple business model canvas (or perhaps the Circular model canvas) will be developed as an expected outcome to show and validate that an innovation of a new product of process may not only have a financial return on investment. It can also have an important return of investment in social or environmental value.

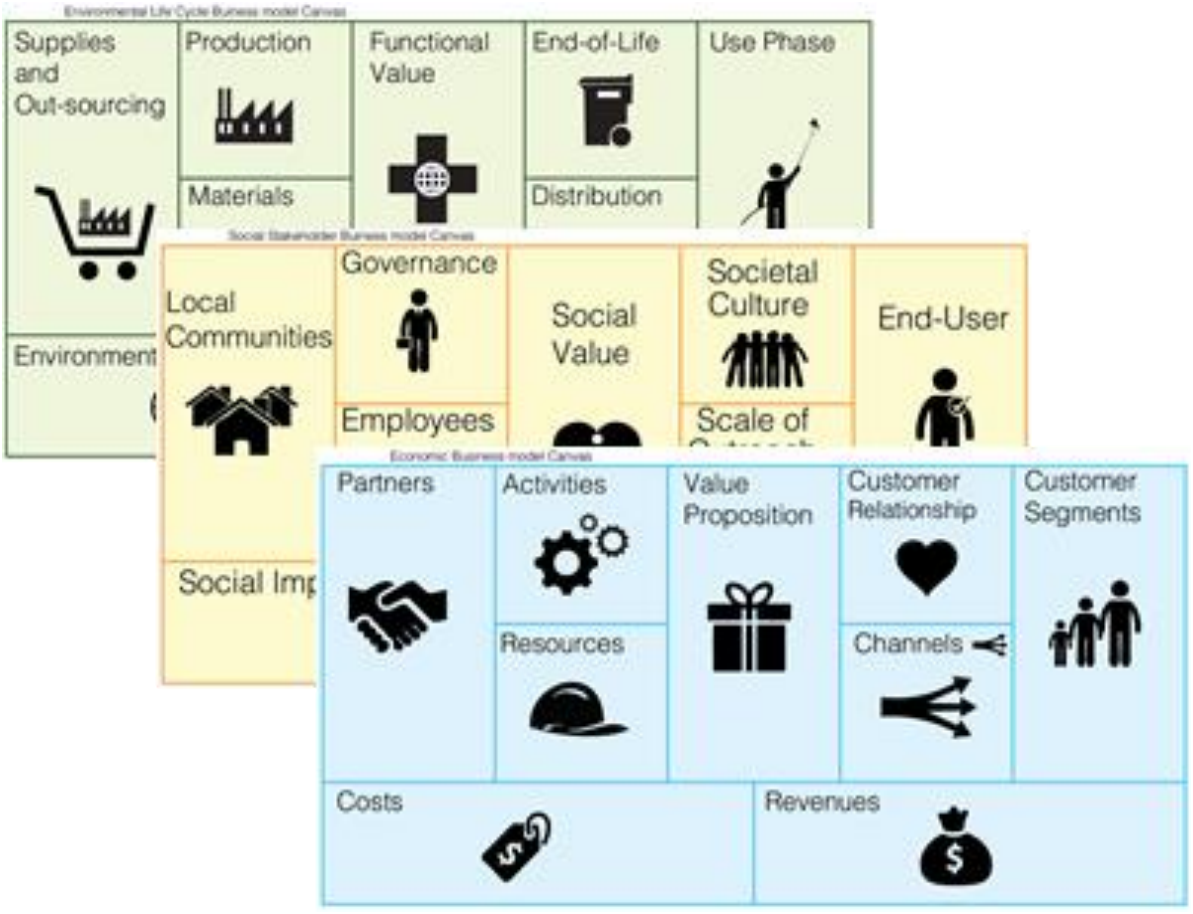
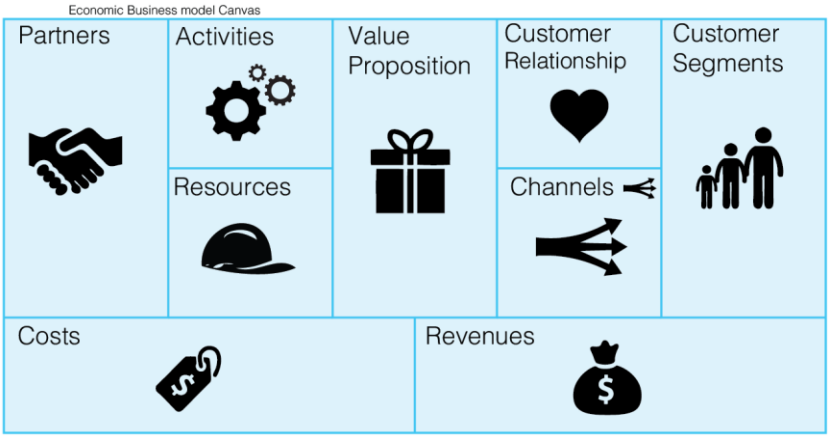
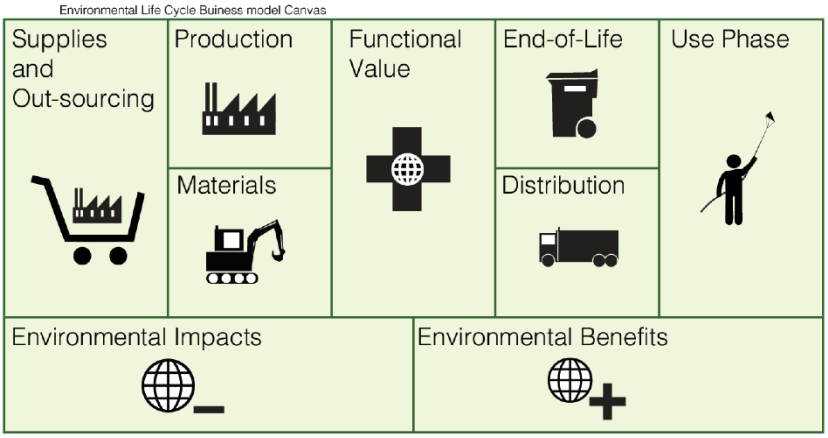
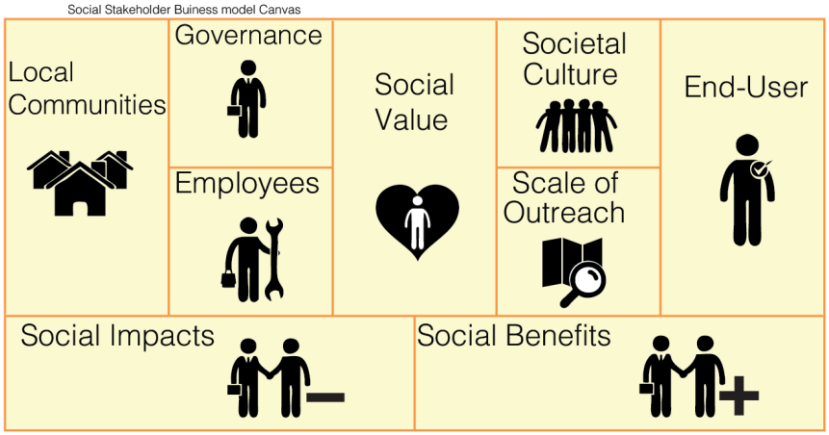


Figure 12: Triple business models

(Larger scale next page)


Economic Business model Canvas
Partners
Activities
Resources
Value Proposition
Customer Relationship
Channels
Customer Segments
Costs
Revenues


Environmental Life Cycle Buiness model Canvas
Supplies and Out-sourcing
Production
Materials
Functional Value
End-of-Life
Distribution
Use Phase
Environmental Impacts
Environmental Benefits


Social Stakeholder Buiness model Canvas
Local Communities
Governance
Employees
Social Value
Societal Culture
Scale of Outreach
End-User
Social Impacts
Social Benefits

6. Evaluation plan

During the demonstration phase the following indicators will be used to manage the process, as detailed in the Evaluation Plan.

- New material passports**:**
- New material passports impacts
- New material passports qualitative
- New tools for better mapping of resources and their location: Qualitative description
- CE related knowledge
- CE-related knowledge building campaigns
- CE-related knowledge tools
- Circular procurement ambition set out in strategy / policy documents
- Progress towards circular city strategy objectives
- Eco-innovation
- New digital material databank/marketplace:
- Qualitative description
- Import and export of materials
- Import of materials
- Export of waste materials
- GHG emissions per year

Further information on Apeldoorn's demonstrations can be seen at:

https://cityloops.eu/cities/apeldoorn

7. Risks

During the development of the process some risks may occur. We describe them in the tables below.

BOKASHI		
Potential risk	**Description of risk**	**Mitigation approach**
Technical risks	Machines are not working	Responsibility of the contractor
Economical risks	Budget limit is reached	Monthly budget management is needed.
Environmental risks	Too many minerals and gasoline from machines enter the Bokashi process	Use different technological approach in producing Bokashi

BIOCHAR		
Potential risk	**Description of risk**	**Mitigation approach**
Technical risks	The properties of Biochar from biowaste are not suited for the envisaged application	-
Environmental risks	Contamination in biowaste may introduce risks in water treatment	Thorough testing on lab scale

Fibre products		
Potential risk	**Description of risk**	**Mitigation approach**
Technical risks	Larger scale trials will need to be performed by interested industries	Reduce the scale of the trials
3D printing		
Potential risk	**Description of risk**	**Mitigation approach**
Technical risks	Larger scale trials will need to be performed by interested industries	Reduce the scale of the trials

Cleaning of grass		
Potential risk	**Description of risk**	**Mitigation approach**
Technical risks	Materials to clean up the meadows are not available	4 weeks before the start of the demo all products and materials must be in house.
Social Risks	No one wants to participate in the demonstration	Start as soon as possible to recruit volunteers to cooperate. If no one reacts, 2 opportunities are available: 1. We try to recruited people and give them expenses 2. Internal colleagues join the demonstration

CITYLOOPS

CityLoops is an EU-funded project focusing on construction and demolition waste (CDW), including soil, and organic waste (OW), where seven European cities are piloting solutions to be more circular.

Høje-Taastrup and Roskilde (Denmark), Mikkeli (Finland), Apeldoorn (the Netherlands), Bodø (Norway), Porto (Portugal) and Seville (Spain) are the seven cities implementing a series of demonstration actions on CDW and 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 aspect of CityLoops are stakeholder engagement and circular procurement.

CityLoops runs from October 2019 until September 2023.

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