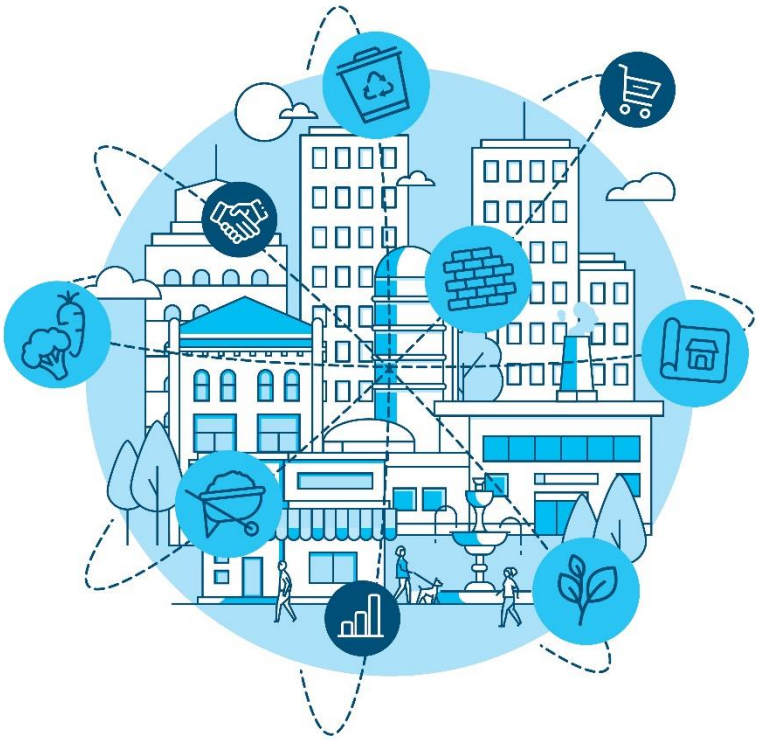
Evaluation Plan: Biowaste sector, Apeldoorn

Deliverable 6.2

Gemeente Apeldoorn / Municipality of Apeldoorn



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Abstract	This report details how the city of Apeldoorn will evaluate the impact of the CityLoops tools and demonstration activities aimed at improving the circularity of the biowaste
Keywords	Evaluation, Indicators, Apeldoorn, Biowaste
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Contents

1. Introduction

The objective of the CityLoops evaluation work is to ensure a comprehensive evaluation framework is established for all demonstration actions to assess their impact on sustainability and to assess the progress towards a more Circular Economy (CE).

This document will guide the practical evaluation work based on the evaluation framework and CE indicators presented in CityLoops Deliverable 6.1 Circular City Indicator Set (Vangelsten et al. 2021), see figure 1. The evaluation aims to cover all the four Vision Elements at the core of the CityLoops circular city definition from Vangelsten et al. (2021). Thus, the evaluation will monitor local level processes and behaviour aimed at improving circularity, impact in terms of more circular material flow and energy use as well as outcomes in terms of improvements on the environment and on human wellbeing. The evaluation will focus both on the demonstration actions and on impacts at city scale.

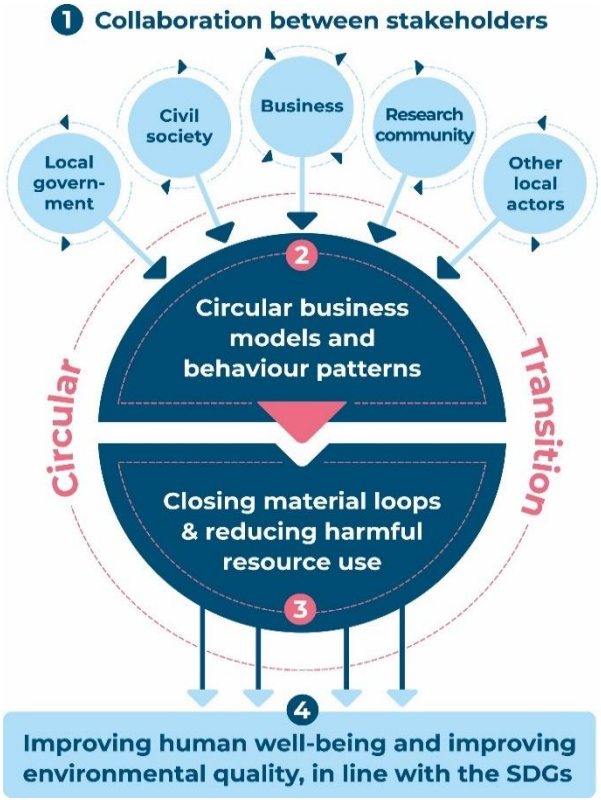

Figure 1. The four Vision Elements of the Circular City vision and causal links for CE transition.

This Evaluation Plan presents a list of specific indicators to be monitored over the duration of the Demonstration phase of the CityLoops project (Month 18-44). It further details what data needs to be collected, who is responsible for doing this, how it will be done, and when. The overall responsibility of the development of the Evaluation Plan and its implementation lies with the Evaluation Manager appointed in each city. The implementation of the Evaluation work will be documented in the Interim Evaluation Report to be submitted at Month 36 and the Final Evaluation Report to be submitted at Month 46. The Municipality of Apeldoorn (MoA) is one of six cities involved in the CityLoops Project. The MoA has identified two core work streams (construction and demolition waste & biowaste) in pursuit of more circular practices. This plan focuses on the biowaste workstream. By 2030 the MoA seeks to ensure up to 30% of its economic activities (in euros) will adopt circular economic principles and associated practices. In addition, the 'Werken voor de toekomst 2021 – 2024' [1] (Working towards our future 2021-2024) sets out a set of strategic targets and associated practices in transitioning towards more sustainable practices. These include improving the blue and green areas of the city, inclusive social policies and spaces for multi-generational social connectivity, sustainable and clean cityscapes, and creating an arena for a societal participation in these endeavours. Specifically of interest for this project is the aim of sustainably reducing and managing waste, improving civic spaces and transportation in pursuit of developing a healthy city,[1] and the mitigation of impacts from climate change.

[1] *Source:* Working towards the Future: https://apeldoorn.begroting-2021.nl/assets/docs/infographic2021.pdf

2. Demo action descriptions

In pursuit of these ambitions, Section 2 presents the demonstration actions for MoA and the CityLoops project. Collectively the demonstration actions form an exploratory study for the MoA and how to generate circularity from their **Biowaste (BW).** These iterative innovation activities seek to establish sound business cases for new processes, relationships, products, and services for BW. The following section gives a short overview of the reasoning behind the case study initiatives. Sections 2.1 – 2.5 offer a more detailed backdrop to the **five BW demonstration actions (i. Bokashi, ii. Biochar, iii. municipal cleaning of grass before collection, iv. production of fibre-based products, v. organic printed objects (3D).** The main focus of the BW demonstration actions is the development of business cases. DA6 will sum up the experiences and results of the previous 5 DAs.

Background: MoA identified a need to prolong the life of their biowaste in the value chain by exploring how this asset can be reused in ways which benefit both the environment and socio-economic activities within the municipality by value retention and generation. In addition, and due to invasive species control (Japanese Knotweed), some waste has specific legal requirements in how it is managed which affects how these products can be managed. Therefore, some activities both mitigate and enrich the environmental credentials of the city. In the long term, wider, more globally relevant environmental outcomes are also expected. E.g., reduction in GHG.

Approach: Diagram 1 illustrates the interactivity and connection of the DAs (i-v), with DA vi bringing together the evaluation and valorisation (or minimum viable product) of these activities in the business cases.

The business case process will evaluate various aspects suitable for determining a minimum viable product (MVP) and associated processes. This will include, but is not limited to, 1. determining viable quantities of for example: bokashi & biochar for processing; 2. optimum production quantities (short & long term) and how the various services can be managed, integrated, and developed into viable business case(s).

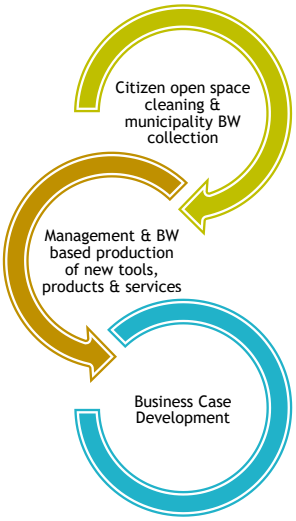

Diagram 1. DAs and flow of project

As this is an exploratory project and benefits from the collection of data from new initiatives, little data is available at the onset of the project. However, this innovative project will generate new information which will be evaluated and presented in the business cases at the end of the project. This new data can therefore, if successful, generate 'at scale' business models for MoA, which in turn could support further initiatives and projects in other cities with greater accuracy and assurance and data validity. The MoA initiatives are explained in the DAs in the next pages:

Bokashi: This is an initiative supported by the Ministry of Infrastructure and Water management and the Ministry of Agriculture, Nature and Food Quality. The initiative has been developed to explore sustainable and more circular ways for MoA to utilise their bokashi waste within the municipality area. In addition to benign BW, the policy restrictions on the removal and careful disposal of invasive species may be overcome by composting on site. It is envisioned that evidence will be developed which proves that the Bokashi can used as a soil improver.

Biochar: BW which is not suitable for Bokashi (hard leafy waste, sticks, trees, small measure of products 8mm-25mm, etc.) can be used for Biochar. By creating biochar from biomass, many benefits could be realised: 1. The removal of an invasive species; 2. Using a nature-based solution (NBS)[2] to dispose of the waste; and 3. Producing a by-product which potentially adds value (environmental, ecological, and socio-economic).

Cleaning of municipality grass waste for reuse: The MoA recognises that grass can be reused in new ways as an asset but that in order to do so it must first be cleaned. This activity seeks to prepare grass prior to cutting for secondary use (e.g. paper production or 3D printing).

Paper production: The MoA seeks to improve the circular economic credentials of their grass cutting disposal. By applying the Ladder of Lansink[3] or the R10, this initiative seeks to act as a catalyst for behaviour change (e.g. behaviour economics) in activities related to grass cutting disposal. By seeing the by-product of this municipality activity as an asset, they wish to explore ways in which they can retain the waste in the value chain, namely creating a second by-product - paper.

3D printing: The MoA recognises that certain BW assets (e.g. Japanese Knotweed) may be better suited to more robust products such as organic matter for card. These recycled products can replace virgin materials currently used in 3D printing.

Valorisation of BW: **Business Cases:** Collectively, these initiatives (i-v) could support some very interesting and innovative circular business models for MoA. To validate these innovative activities, five business cases (bokashi, biochar, fibre products, 3D printing, cleaning of waste) will be developed which explore the credentials of these innovation projects, validate the environmental, social, and economic credentials, and assess if these activities can be developed into viable new business ventures. The outputs from these activities could be used as examples or guidance for other cities.

[2] Source: Nesshover et al. (2017). The science, policy and practice of nature-based solutions: Science of the Total Environment, 1215-1227.

[3] https://www.recycling.com/downloads/waste-hierarchy-lansinks-ladder/

2.1. DA1: Bokashi production from leaves

The MoA is currently engaged in the production of Bokashi from the leaf waste generated from management of Apeldoorn's green spaces. This by-product is collected, processed, and returned to the municipality green spaces as a soil improver. The leaves are collected and moved to storage where regenerative microorganisms and primordial stone granules are added.

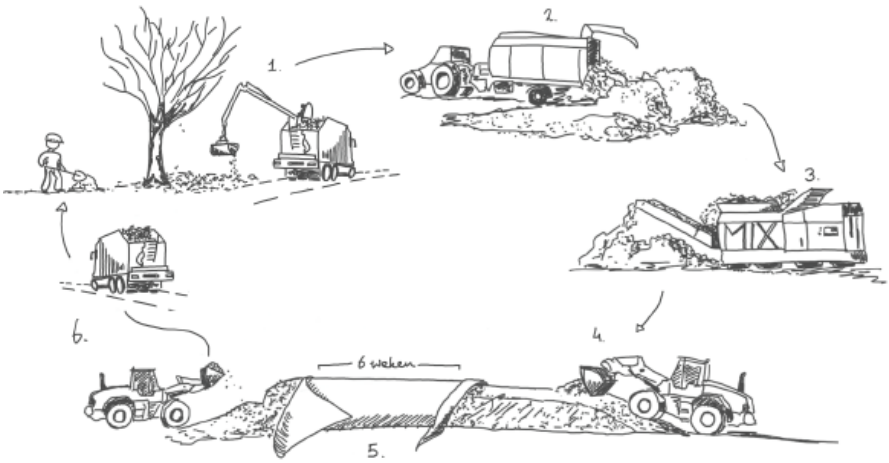

Figure 2. Bokashi as part of circular city Apeldoorn

This leaf mixture is then placed in a pile, compressed to remove air, and covered with agricultural plastic for at least 6 weeks of anaerobic treatment. The result is Bokashi, a soil improver (Fig. 2).

Value added: Bokashi as a product appears to be a highly nutritious soil improver, enriching the soil quality and improving moisture retention for the municipality open spaces. This process is faster than composting, offering many benefits for MoA (e.g. savings on space utilization for the process stage, creating value from a new product, and negating the need to purchase high nitrate fertilizers which have a significant carbon footprint (production and transportation stages) for MoA).

Customer: The municipality is both the provider and customer of this product.

Relationship of the municipality-customer: Internal business operations. Relationship with other projects/organization: Ministry of Infrastructure and Water Management, Ministry of Agriculture, Nature and Food Quality, and Wageningen University and Research.

Figure 3. Compressing the bokashi heap prior to fermentation

2.2. DA2: Biochar production

MoA is a partner in a research project developing small scale biochar (charcoal) production from BW. Biochar is a super charcoal made by heating any biomass[4] such as woody tree prunings and agricultural waste (crop husks, stalks, straw) without oxygen. All the cellulose, lignin, and non-carbon matter burns during the process stage. The final product is pure carbon, which retains 40% of the original carbon in the biomass[5]. This pyrolysis process also destroys seeds present in the BW, thereby preventing unwanted seed dispersal. In this demonstration activity, MoA will use biochar as a soil improver. Initial investigations have reviewed the types of biochar processes suitable for the project. Now determined, MoA has established several demonstration sites across Apeldoorn. In collaboration with the Department of Maintenance, an action plan has been developed to manage these activities.

Why? Biochar is an innovative product which can be used for soil improvement substrate in the MoA whilst also acting as a carbon capture activity.

Customer: The municipality is both producer and customer of this product.

Relationship of the municipality-customer: This is an internal business operation for MoA, future up-scaling of this activity will require a larger-scale industrial partner.

Figure 4. Biochar: The circular system

Figure 5. Biochar

[4] Source: Warm Heart Worldwide. (2021, July 06). Biochar. Retrieved from Warm Heart Worldwide: https://warmheartworldwide.org/biochar/?gclid=Cj0KCQjwu7OIBhCsARIsALxCUaOHyz1uyOea5f4MT_3Wi4nSbn3lVr7DLNzCtjmL_ph5mJ3iHlfG-zwaApWGEALw_wcB

2.3. DA3: Production of fibre-based products

MoA will also use BW for the production of fibre-based products, e.g. paper and cardboard-based products. This demonstration activity will be in collaboration with entrepreneurs.

Figure 6. Board and paper from biowaste produced on lab-scale

The MoA will be responsible for the collection of the BW and some aspects of the technical processing activities. In collaboration with local entrepreneurs, small-scale production activities will be explored. Recruitment of this group will take place in the demonstration phase of this activity by MoA, who will also serve as an initial launch customer. Paper products containing BW will be produced at the *Middelste Molen* (a paper museum and the oldest paper mill in the Netherlands) located in Apeldoorn, or on a larger scale in another, larger paper mill. If the quality of the BW is acceptable, the production of biobased cardboard binders will be explored (Fig. 6).

Why? Fibres from BW could be used to replace virgin wood-based fibre grown and processed outside the MoA. This project could reduce the global environmental impact of timber felling for this product and stimulate the material substitution from locally based resources, e.g., creating new products and services which are more circular. In addition, after their use, these products can be recycled or composted as part of the biochar practices.

Customer: A number of customers are identified for this BW product, including fibre which could be sold to the pulp industry. MoA will act as an initial customer for paper ordering via innovation in public procurement. New products could also be sold to citizens of MoA. Further diversification will be sought through collaboration with local entrepreneurs recruited during the stakeholder engagement process.

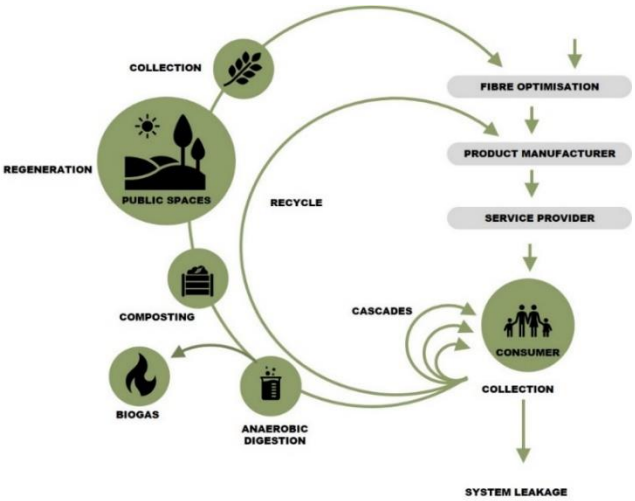

Figure 7. Fibre-based products: The circular system

2.4. DA4: 3D printing with organic fibre

Composting material (vegetation fibre) can be used for 3D-printed objects and injection-moulded products. This fibrous material can replace virgin wood and fibre crops (hemp) in the 3D production and manufacturing phase being used as a filler for composite material. In this demonstration, the MoA will work collaboratively with entrepreneurs to explore innovative products and the opportunity to continue these ventures 'at scale'.

Figure 7 Production of filament for 3D printing

The MoA will collect the BW, and as with paper production, some of the technical processing (fibre optimization and compounding) will be performed by Wageningen Research (WR). Interested entrepreneurs will use 3D printing techniques and injection moulding to create and produce the final products. MoA will form the initial customer market by using innovation in public procurement to produce and procure ornamental objects, street furniture, or small food waste garbage bins. This exploratory project will identify what materials are most suitable (robustness, longevity, etc.), and therefore, which products can be suitably made for sale (Fig 8).

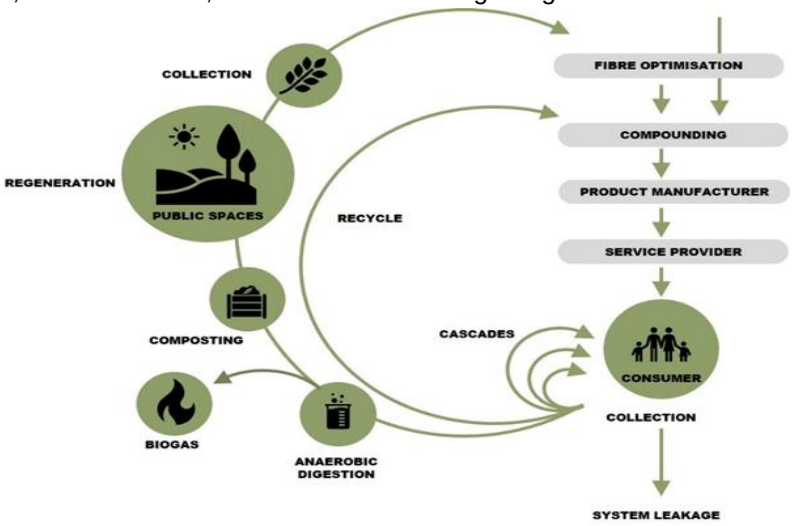

Figure 8. 3D objects: The circular system

Why? Utilising MoA BW as a new resource will build in more circular locally resourced products and replace globally sourced virgin timber and fibre crops in these products. The ventures, as described in the previous section, will also boost locally based innovation in products and services, creating more value locally. In addition to BW reuse, it is also envisaged that locally collected plastic waste (PE or PP) can be combined with the BW to fibrous waste to create the composite materials. It is envisaged, and will be part of the project activities, that these activities will reduce CO_2 emissions and other wider global environmental issues (e.g. deforestation and associated water and land-based impacts (flooding & soil erosion)).

Customer: MoA, and through this action the citizens of MoA, will act as initial customers through public procurement. Further customers will be sought once proof of concept (PoC) is established and market justification is established through the business model evaluation stage.

Relationship of the municipality-customer: As above plus after the demonstration phase MoA will sell fibres from the BW to the now established moulding and compound industry.

2.5. DA5: Municipal cleaning of grass

MoA wishes to recycle grass cuttings from the municipality BW for new products. However, before doing so, this fibrous material requires cleaning to ensure the product is suitable for production purposes. For example, grass cuttings from roadside mowing can contain 40% non-biological impurities (data from Wageningen University). In part, these impurities are attributable to in situ rubbish prior to grass cutting. This demonstration will recruit citizens for public space clean-ups. In addition, it is hoped that this citizen involvement will enhance and promote circular economy-based actions. In this demonstration action we will explore the effect of combining citizen-based rubbish collection activities and municipality-based grass cutting of public green space. The project will focus on the effectiveness of the rubbish collection, cleanliness of the collected grass, and therefore the increased value of the grass for future use in circular economic activities.

Figure 9: Civilians cleaning public spaces

Why? Working in collaboration across various societal groups in meeting circular city objectives and activities is beneficial for the wellbeing of those participating but also for the wider Apeldoorn community in terms of creating attractive green spaces.

Customer: The cleaned grass will be used as raw material in the demonstration actions 3 and 4, improving circular activities in the MoA and job and service creation as a result of maintaining BW in the value chain.

Relationship of the municipality-customer: MoA will initially act as a key customer through innovation in public procurement. In the future, new customers will be sought.

Business Cases

Five business cases will be developed from the DAs. These will be led by MoA and be used to determine the viability of the DAs in justifying future development of business practices and services. Each business case will look at the BW streams for MoA, calculate quantities required to establish suitable business opportunities from BW as well as other factors associated with business cases and developing an MVP.

Benefit for the MoA: Currently the MoA has identified innovative activities that could be used in developing the circular economic activities and profile of the city. However, in order to ensure that robust business models are developed, the process of investigating, exploring, and developing appropriate processes, systems, and management structures must be undertaken. The MoA will lead in developing these case studies, taking data and learnings from various actors in the DA i-v in order to establish if both individually and collectively these DAs can form a new service model and associated business activities.

Customers: Each separate DA will feed into the next (see diagram 1) to build a customer value chain for this new service model. Both the MoA, its sub-departments, entrepreneurs, and citizens involved in the open space cleaning could be counted as part of the customer chain.

2.6. Expected outcomes

For **each of the 5 demonstration actions** presented above,[5] MoA expects to achieve the following outcomes:

- Increased awareness and knowledge among stakeholders of the business case of the demo action.
- Network(s) established in the field of biowaste activities to disseminate and promote the business case of the demo action.
- The results of the validation of the business case of the demo action have provided information to be used in the adoption of circular procurement practices in MoA.
- The business case of the demo action has been tested and validated based on environmental, social, and economic considerations.
- Through the demo action, the GHG emissions (tCo2 eq. / tBW) of the associated business case have been clarified.

[5] 1. Bokashi. 2. Biochar. 3. Municipal cleaning of grass before collection. 4. Production of fibre-based products. 5. Organic printed objects (3D).

3. Indicators to be monitored

This chapter presents an overview of the indicators that will be monitored during the CityLoops Implementation Phase (see table below). The indicator selection has been made based on several criteria:

- Relevance to the city's circularity strategies and the Demonstration Actions and Tools: Each selected indicator will monitor specific processes and impacts related to the Demonstration Action activities (and if relevant the application of CityLoops tools outside the scope of the demonstration actions) and serve to evaluate against the expected outcomes of the action. Indicators may be monitored either at Demonstration Action scale or at City scale, or in some cases at both. For each evaluation scale, the indicator is paired with the expected outcome or target value listed in the table below. This will allow evaluation of the progress and impact of demonstration- and city-wide actions towards improved circularity as well as the effectiveness of activities and tools.
- Data availability and quality: Through dialogue with local stakeholders (internally at MoA and externally to the CityLoops consortium), data availability, accessibility and quality has been mapped to ensure that the evaluation process for the selected indicators can be carried out in a practical and timely manner.
- Cross-City comparison and adherence to the Circular City definition (Annex 2) and the Impacts projected in the Grant Agreement of the project (Annex 1): As part of the process of developing the Evaluation Plans continuous dialogue between the cities and the CityLoops partner coordinating the evaluation work has been carried out to ensure some overlap and consistency in the selection of indicator between cities to allow comparison where practical. This dialogue has also ensured that indicators are selected to monitor progress towards circularity in a broad sense covering as much as possible all four Vision Elements of the Circular City definition as described in Vangelsten et al. (2021).

Table 1 lists the expected outcomes and selected indicators for each of the four Vision Elements in the CityLoops circular city definition (Vangelsten et al., 2021). The table describes at which level the indicators will be applied (Demonstration Action or City level), which Demonstration Actions (and if relevant, application of CityLoops tools outside the Demonstration Actions) they will evaluate and to what expected outcomes they are contributing. We include relevant demonstration tools in these tables. The rationale behind this is that the tools are integral to the demonstration action as a learning process for the cities, and then, the outcomes of these actions will then inform the ability to apply learning 'at scale' (city and /or for other cities after the project is completed). In the demonstration actions for the biowaste sector, the following tools and processes are applied:

1. 5 business cases (based on a business case template): production of i. Bokashi, ii. Biochar, iii. fibre-based products, iv. 3D printing, and v. citizen collaboration project for municipal grass cleaning.
2. Valorisation decision tool
3. New sorting and treating tool
4. Guideline for circular procurement

Table 1: Expected outcomes and indicators

Vision Element	Expected outcome	Indicator no.	Indicator names	Scope	Demo Bokashi	Demo Biochar	Demo 3d printing	Demo fibre production	Demo cleansing grass before collection
1. Local Stakeholder Actions	Increased awareness and knowledge among stakeholders of the business case of the demo action	4	CE-related knowledge building campaigns: Qualitative description	D	X	X	X	X	X
		5	CE-related knowledge building campaigns: Impact	C					
		6	Circularity related stakeholder activities	D					
	Network(s) established in the field of biowaste activities to disseminate and promote the business case of the demo action	9	New formal CE-based collaboration platforms/networks	C	X	X	X	X	X
		10	Stakeholder contribution to improved circularity	D/C					
		11	Communication measures on circular transformations and waste prevention	C					
	The results of the validation of the business case of the demo action have provided information to be used in the adoption of circular procurement practices in MoA	12	Circularity requirements in procurement beyond existing levels	D	X	X	X	X	X

Vision Element	Expected outcome	Indicator no.	Indicator names	Scope	Demo Bokashi	Demo Biochar	Demo 3d printing	Demo fibre production	Demo cleansing grass before collection
2. Circular business models and behavioural patterns	The business case of the demo action has been tested and validated based on environmental, social, and economic considerations	23	Eco-innovation: Qualitative description	D	X	X	X	X	X
		24	Eco-innovation: Impact	D					
4. Improving human well-being and reducing environmental impacts	Through the demo action, the GHG emissions (tCo2 eq. / tBW) of the associated business case have been clarified	85	GHG emissions per year (with changed methodology, not per year, but per mass - see outcome)	D	X	X	X	X	X

4. Plan for monitoring

The tables below detail the monitoring plan for each of the selected indicators. This will guide the CityLoops Evaluation work to be carried out and documented in the Interim Evaluation Report in Month 36 and the Final Evaluation Report in Month 46 of the project. The 16 metadata categories described for each of the selected indicators is based on the Circular City Indicator Set (Vangelsten et al. 2021). Metadata categories 1-5 and 7-8 are standard for all cities/waste streams whereas the others (6 and 9-16) vary from case to case and are therefore customized by each city to fit the scope and focus of their demonstration activities and the tools they will test.

Before we will explain about the indicators, it is important to know what the transactions are in the city:

- *Clipping (grass) divided in 2 groups:*
    - *257 tonnes of > 350 kg/m3*
    - *701 tonnes of < 350 kg/m3*
- *Leaves: 4,139 tonnes*
- *Leaves/garden/Fruit & vegetables: 915 tonnes*
- *Outside built-up areas: 7,164 tonnes of grass and grass related materials*
- *Branches: 1,975 tonnes*
- *Stumps: 67 tonnes*
- *Wood chips: 1,130 tonnes*
- *Wooden logs: 59 tonnes*
- *Total cost of pruning, mowing and felling is approximately: € 540,000*
- *Total income of these activities is approximately: € 48,500 per year*

In the demonstration phase we will test, calculate and demonstrate the positive impact of changing our processes. Therefore we will use a fraction of the total supply of biowaste resources:

- *Bokashi: 8 tonnes of wet leaves.*
- *Biochar: 1 tonne of wet leaves makes 50% volume of Biochar (product) and 50% heat production.*
- *Paper out of grass: 100 kg grass will produce 20 kg of paper. In this case we will use 3 tonnes of wet grass to make 2.5 tonnes of paper.*
- *3D printing. There is zero experience making 3D products out of plants/leaves/branches. During business case development, 1,000 kg of wet knotweed 'deliver' 300 kg of dry knotweed.*

4.1.1. CE-related knowledge building campaigns

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	4
	2	*Indicator name*	**CE-related knowledge building campaigns: Qualitative description**
Link to Circular City Definition	*3*	*Vision Element*	X Local stakeholder actions Circular business models and behavioural patterns Closing material loops and reducing harmful resource use Improving human well-being and reducing environmental impacts
	4	*Category*	Engagement and capacity building
Indicator definition and description	*5*	*Definition / Description of indicator*	Description of knowledge building campaigns. The campaigns would normally be in the form of formalized education events, e.g. classes, courses, education workshops. Describe type of groups reached and type of knowledge building campaign.
	6	*Rationale*	The demonstration actions are designed to gather learnings, best practices and knowledge. Dissemination of this information to a wider audience is necessary to create awareness, adoption and uptake. For each demo action, the indicator relates to the following expected outcome: • Increased awareness and knowledge among stakeholders of the business case of the demo action
	7	*Methodology*	• Identify and categorise knowledge campaigns • Identify groups reached
	8	*Unit*	Qualitative data
Data	*9*	*Baseline data / definition*	Dissemination of knowledge and learnings is completely new, therefore the baseline is 0.
	10	*Data Sources / Relevant Databases*	• Research on quality conducted by Department of Maintenance • Interview with De Oorsprong, private business with expertise in the field
	11	*Overall accuracy*	Qualitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	BW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area in MoA
	14	*Reference period*	Febr 2022: completion of baseline data collection July 2022: completion of interim data collection Sept 2022: completion of interim evaluation report March 2023: completion of final data collection May 2023: completion of final evaluation report
	15	*SDG Reference*	17
Other	*16*	*Comments*	None

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	5
	2	*Indicator name*	**CE-related knowledge building campaigns: Impact**
Link to Circular City Definition	*3*	*Vision Element*	X Local stakeholder actions
			Circular business models and behavioural patterns
			Closing material loops and reducing harmful resource use
			Improving human well-being and reducing environmental impacts
	4	*Category*	Engagement and capacity building
Indicator definition and description	*5*	*Definition / Description of indicator*	Number of campaigns Number of people reached for each campaign
	6	*Rationale*	The demonstration actions are designed to gather learnings, best practices and knowledge. Dissemination of this information to a wider audience is necessary to create awareness, adoption and uptake. For each demo action, the indicator relates to the following expected outcome: • Increased awareness and knowledge among stakeholders of the business case of the demo action
	7	*Methodology*	1. Number of campaigns 2. Number of people reached
	8	*Unit*	Number of campaigns, Number of people
Data	*9*	*Baseline data / definition*	Dissemination of knowledge and learnings is completely new, therefore the baseline is 0.
	10	*Data Sources / Relevant Databases*	• Interviews with Department of Maintenance • Attendance lists in webinars/meetings • Newsletters (no. + email address in mailing lists)
	11	*Overall accuracy*	Qualitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	BW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area in MoA
	14	*Reference period*	Febr 2022: completion of baseline data collection July 2022: completion of interim data collection Sept 2022: completion of interim evaluation report March 2023: completion of final data collection May 2023: completion of final evaluation report
	15	*SDG Reference*	17
Other	*16*	*Comments*	None

4.1.2. Circularity-related stakeholder activities

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	6
	2	*Indicator name*	**Circularity-related stakeholder activities**
Link to Circular City Definition	*3*	*Vision Element*	X Local stakeholder actions
			Circular business models and behavioural patterns
			Closing material loops and reducing harmful resource use
			Improving human well-being and reducing environmental impacts
	4	*Category*	Engagement and capacity building
Indicator definition and description	*5*	*Definition / Description of indicator*	Description of activity type and dialogue methods, which stakeholder groups and when in the process Number of people involved
	6	*Rationale*	Who does what, when, for which reason, and where in the circular process? Stakeholder analysis and stakeholder contributions, to map the process, are essential for the viability of business cases. For each demo action, the indicator relates to the following expected outcome: • Increased awareness and knowledge among stakeholders of the business case of the demo action
	7	*Methodology*	• Identify stakeholder activity • Describe process and when stakeholders are involved • Identify dialogue methods used • Number of people involved
	8	*Unit*	Qualitative data, Number of people
Data	*9*	*Baseline data / definition*	Baseline 0.
	10	*Data Sources / Relevant Databases*	Meetings held with stakeholders (entrepreneurs) / presentations given / CLN network members / research conducted by educational institutes
	11	*Overall accuracy*	Qualitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	BW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area in MoA
	14	*Reference period*	Febr 2022: completion of baseline data collection July 2022: completion of interim data collection Sept 2022: completion of interim evaluation report March 2023: completion of final data collection May 2023: completion of final evaluation report
	15	*SDG Reference*	17
Other	*16*	*Comments*	None

4.1.3. New formal CE-based collaboration platforms/networks

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	9
	2	*Indicator name*	**New formal CE-based collaboration platforms/networks**
Link to Circular City Definition	*3*	*Vision Element*	X Local stakeholder actions Circular business models and behavioural patterns Closing material loops and reducing harmful resource use Improving human well-being and reducing environmental impacts
	4	*Category*	Engagement and capacity building
Indicator definition and description	*5*	*Definition / Description of indicator*	Number of CE-based collaboration platforms/networks Number of members in CE-based collaboration platforms/networks
	6	*Rationale*	Rationale is that by setting up formal CE-based collaboration platforms /networks, this will contribute to knowledge exchange, sharing of information, learnings and findings and boost potential partnerships/ collaborations between different stakeholders. For each demo action, the indicator relates to the following expected outcome: • Network(s) established in the field of biowaste activities to disseminate and promote the business case of the demo action
	7	*Methodology*	• Number of formalised CE-based collaboration platforms/networks • Number of people in formalised CE-based collaboration platforms/networks
	8	*Unit*	Number of networks, Number of people
Data	*9*	*Baseline data / definition*	0, as there is currently no CE-based collaboration platform/network
	10	*Data Sources / Relevant Databases*	Meeting memos (#no of references to CE); participant lists to workshops/webinars (#no of participants reached); list of other networking meetings and interviews (date and participants)
	11	*Overall accuracy*	Quantitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	BW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Febr 2022: completion of baseline data collection July 2022: completion of interim data collection Sept 2022: completion of interim evaluation report March 2023: completion of final data collection May 2023: completion of final evaluation report
	15	*SDG Reference*	17

Metadata group	#	Metadata category	Description/comments
Other	*16*	*Comments*	None

4.1.4. Stakeholder contribution to improved circularity

Metadata group	#	Metadata category	Description/comments
Identi-fier	*1*	*Indicator number*	10
	2	*Indicator name*	**Stakeholder contribution to improved circularity**
Link to Circular City Definition	*3*	*Vision Element*	X Local stakeholder actions Circular business models and behavioural patterns Closing material loops and reducing harmful resource use Improving human well-being and reducing environmental impacts
	4	*Category*	Engagement and capacity building
Indicator definition and description	*5*	*Definition / Description of indicator*	Qualitative description of input from stakeholder activities and how it has contributed to improved circularity
	6	*Rationale*	Who does what, when, for which reason, and where in the circular process? Stakeholder analysis and stakeholder contributions, to map the process, are essential for the viability of business cases. For each demo action, the indicator relates to the following expected outcome: • Network(s) established in the field of biowaste activities to disseminate and promote the business case of the demo action
	7	*Methodology*	• List inputs from stakeholders • Describe how it has been used by those that invited the stakeholder activity • Describe how it has contributed to improved circularity
	8	*Unit*	Qualitative data and potentially quantitative impact data
Data	*9*	*Baseline data / definition*	0
	10	*Data Sources / Relevant Databases*	MoA project information (meetings held with stakeholders (entrepreneurs)) / presentations / CLN network / information University / Research collected on this subject (research WUR)
	11	*Overall accuracy*	Qualitative and quantitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	BW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Febr 2022: completion of baseline data collection July 2022: completion of interim data collection Sept 2022: completion of interim evaluation report

Metadata group	#	Metadata category	Description/comments
			March 2023: completion of final data collection May 2023: completion of final evaluation report
	15	*SDG Reference*	17
Other	*16*	*Comments*	None

4.1.5. Communication measures on circular transformations and waste prevention

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	11
	2	*Indicator name*	**Communication measures on circular transformations and waste prevention**
Link to Circular City Definition	*3*	*Vision Element*	X Local stakeholder actions
			Circular business models and behavioural patterns
			Closing material loops and reducing harmful resource use
			Improving human well-being and reducing environmental impacts
	4	*Category*	Engagement and capacity building
Indicator definition and description	*5*	*Definition / Description of indicator*	Describe type of communication measures, e.g. campaigns, provision of information, events for the public/companies.
	6	*Rationale*	Rationale is that through communication on CE towards the general public (as stakeholders), the public tends to be more aware and more engaged. The knowledge base grows capacities of internal and external stakeholders on CE. For each demo action, the indicator relates to the following expected outcome: • Network(s) established in the field of biowaste activities to disseminate and promote the business case of the demo action
	7	*Methodology*	• Number of communication measures towards general public on CE transformation • Number of people reached
	8	*Unit*	Number of communication measures Number of people
Data	*9*	*Baseline data / definition*	0
	10	*Data Sources / Relevant Databases*	MoA project information (meetings held with stakeholders (entrepreneurs) / presentations / CLN network / information University / Research collected on this subject (research WUR)
	11	*Overall accuracy*	Qualitative and quantitative data will be collected during demonstration phase.

Metadata group	#	Metadata category	Description/comments
Context	*12*	*Sector coverage*	BW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Febr 2022: completion of baseline data collection July 2022: completion of interim data collection Sept 2022: completion of interim evaluation report March 2023: completion of final data collection May 2023: completion of final evaluation report
	15	*SDG Reference*	17
Other	*16*	*Comments*	None

4.1.6. Circularity requirements in procurement beyond existing levels

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	12
	2	*Indicator name*	**Circularity requirements in procurement beyond existing levels**
Link to Circular City Definition	*3*	*Vision Element*	*X* Local stakeholder actions
			Circular business models and behavioural patterns
			Closing material loops and reducing harmful resource use
			Improving human well-being and reducing environmental impacts
	4	*Category*	Regulation and incentives
Indicator definition and description	*5*	*Definition / Description of indicator*	Description of requirements in procurements going beyond what is current standard practice
	6	*Rationale*	Currently, circularity requirements in MoA procurement are limited. Through the demonstration actions, and interactions with different stakeholders, learnings are retrieved on CE practises to be requested during procurement phase. With this information, MoA can explore the adoption of CE-related procurement practices. For each demo action, the indicator relates to the following expected outcome: • The results of the validation of the business case of the demo action have provided information to be used in the adoption of circular procurement practices in MoA
	7	*Methodology*	1. Decide which procurements are relevant for analysis (e.g. demo action-focused procurements only or a wider range of procurements) 2. Describe current standard practice in terms of CE requirements

Metadata group	#	Metadata category	Description/comments
			3. For each procurement case, describe additional requirements beyond standard practice 4. In case of several relevant procurements, summarize relevant progress beyond existing levels
	8	*Unit*	Qualitative data and potentially quantitative impact data
Data	*9*	*Baseline data / definition*	Baseline is 0
	10	*Data Sources / Relevant Databases*	Knowledge information you get from scaling activities (MOA) / meetings held with stakeholders (entrepreneurs) / presentations / CLN network / information University / Research collected on this subject (research WUR)
	11	*Overall accuracy*	Qualitative and quantitative data will be collected during demonstration phase
Context	*12*	*Sector coverage*	BW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Febr 2022: completion of baseline data collection July 2022: completion of interim data collection Sept 2022: completion of interim evaluation report March 2023: completion of final data collection May 2023: completion of final evaluation report
	15	*SDG Reference*	11, 16
Other	*16*	*Comments*	None

4.1.7. Eco-innovation: Qualitative description

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	23
	2	*Indicator name*	**Eco-innovation: Qualitative description**
Link to Circular City Definition	*3*	*Vision Element*	☐ Local stakeholder actions ☒ Circular business models and behavioural patterns ☐ Closing material loops and reducing harmful resource use ☐ Improving human well-being and reducing environmental impacts
	4	*Category*	• Private investments, jobs and gross value added • Circular design and business models
Indicator definition and description	*5*	*Definition / Description of indicator*	Describe the business model, including how it contributes to moving up the waste hierarchy
	6	*Rationale*	Innovation is a process where products or processes become better than products or processes in the current situation. Eco innovation is about a product or process which is also better than the current

Metadata group	#	Metadata category	Description/comments
			situation but must reflect an awareness of the environmental and social impact. In biowaste, we explore and innovate processes and products which are new in the Netherlands and perhaps also new in Europe. In this indicator we will measure and describe the quality aspects to innovating in an ecological and social way. The output will be a description of an integral circular model. Business models tell us something about how we can create a better value proposition. Running a business implicates that it must have a proper return on investment. But what we actually pursue is that the value proposition of environmental, social, and economic aspects must have a proper balance. With these 5 business cases, we want to demonstrate: – Increase of circularity in the biowaste processes, more specifically increase in the use of organic material in the waste stream – Decrease of costs in these business cases (or more income) – Increase of human resources in CE For each demo action, the indicator relates to the following expected outcome: • The business case of the demo action has been tested and validated based on environmental, social, and economic considerations
	7	*Methodology*	Number of new CE business models For each model: 1. a qualitative description of the model 2. its circular strategy
	8	*Unit*	Qualitative data
Data	*9*	*Baseline data / definition*	Baseline is zero. Currently no work processes are designed in accordance with a business case.
	10	*Data Sources / Relevant Databases*	Experimental work currently conducted. Data will be retrieved from the circular supply chain and the science input of the WUR
	11	*Overall accuracy*	Qualitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	BW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Febr 2022: completion of baseline data collection July 2022: completion of interim data collection Sept 2022: completion of interim evaluation report March 2023: completion of final data collection May 2023: completion of final evaluation report
	15	*SDG Reference*	8, 9, 12

Metadata group	#	Metadata category	Description/comments
Other	*16*	*Comments*	None

4.1.8. Eco-innovation: Impact

Metadata group	#	Metadata category	Description/comments
Identi-fier	*1*	*Indicator number*	24
	2	*Indicator name*	**Eco-innovation: impact**
Link to Circular City Definition	*3*	*Vision Element*	Local stakeholder actions
			X Circular business models and behavioural patterns
			Closing material loops and reducing harmful resource use
			Improving human well-being and reducing environmental impacts
	4	*Category*	– Private investments, jobs and gross value added – Circular design and business models
Indicator definition and description	*5*	*Definition / Description of indicator*	For each case of implementation of CE business models in indicator number 23, describe impact in terms of value creation and material flow
	6	*Rationale*	Business models tell us something about how we can create a better value proposition. Running a business implicates that it must have a proper return on investment. But what we actually pursue is that the value proposition of environmental, social, and economic aspects must have a proper balance. With these 5 business cases, we want to demonstrate: – Increase of circularity in the biowaste processes, more specifically increase in the use of organic material in the waste stream – Decrease of costs in these business cases (or more income) – Increase of human resources in CE For each demo action, the indicator relates to the following expected outcome: • The business case of the demo action has been tested and validated based on environmental, social, and economic considerations
	7	*Methodology*	For each case of implementation of CE business models: 1. Turnover 2. Materials impacted
	8	*Unit*	Monetary value, Tonnes / year
Data	*9*	*Baseline data / definition*	Baseline is zero. Currently no work processes are designed in accordance with a business case.

Metadata group	#	Metadata category	Description/comments
	10	*Data Sources / Relevant Databases*	Experimental work currently conducted. Data will be retrieved from the circular supply chain and the science input of the WUR.
	11	*Overall accuracy*	Qualitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	BW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Febr 2022: completion of baseline data collection July 2022: completion of interim data collection Sept 2022: completion of interim evaluation report March 2023: completion of final data collection May 2023: completion of final evaluation report
	15	*SDG Reference*	8, 9, 12
Other	*16*	*Comments*	None

4.1.9. GHG emissions per year

Metadata group	#	Metadata category	Description/comments
Identi-fier	*1*	*Indicator number*	85
	2	*Indicator name*	**GHG emissions per year**
Link to Circular City Definition	*3*	*Vision Element*	Local stakeholder actions
			Circular business models and behavioural patterns
			Closing material loops and reducing harmful resource use
			X Improving human well-being and reducing environmental impacts
	4	*Category*	Environment impacts (local)
Indicator definition and description	*5*	*Definition / Description of indicator*	The indicator measures annual emissions of the so called 'Kyoto basket' of greenhouse gases. The indicator should be calculated at city level and when relevant, for demonstration actions. Focus is on direct emissions.
	6	*Rationale*	Greenhouse gasses are one of the indicators which can theoretically be measured and also calculated during the demonstrations. We can, for example, calculate exactly how often a truck/tractor moves from A to B. Besides a quantitative measure of this indicator, we also would like to set up a measurable framework for how we can calculate GHG in projects in the coming years. This indicator will contain not only how many GHG will be expelled per project, but also what can be stored in the ground or how many GHG emissions were 'saved' (by not doing the activity). For each demo action, the indicator relates to the following expected outcome:

Metadata group	#	Metadata category	Description/comments
			• Through the demo action, the GHG emissions (tCo2 eq. / tBW) of the associated business case have been clarified
	7	*Methodology*	85 GHG emissions per year (with changed methodology, not per year, but per mass - see outcome)
	8	*Unit*	Tonnes of CO2-equivalents / tonnes of biowaste
Data	*9*	*Baseline data / definition*	Baseline is zero
	10	*Data Sources / Relevant Databases*	- Calculating the transport movements per tonnes produced - 3 locations will be measured to compare one with another and to see a linear difference in CO2 emission
	11	*Overall accuracy*	Qualitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	BW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Febr 2022: completion of baseline data collection July 2022: completion of interim data collection Sept 2022: completion of interim evaluation report March 2023: completion of final data collection May 2023: completion of final evaluation report
	15	*SDG Reference*	7, 13
Other	*16*	*Comments*	None

5. References

Vangelsten, B.V., Bjarne Lindeløv, Nhien Nguyen, Jens Ørding Hansen, Are Jensen, Nikolai Jacobi, Simon Clement, Carolin Bellstedt, Aristide Athanassiadis, Pernille Kern Kernel, Edwin Keijsers (2021). Circular City Indicator Set. CityLoops Deliverable 6.1. 2021.

6. Annex 1: CityLoops impacts as listed in the Grant Agreement

Scientific impacts

- Sector and City-Wide Material Flow and Stock Accounting Methodology
- Development of an open-source urban metabolism data repository
- Circular Procurement tools and indicators
- Operationalisation of EC circular economy monitoring framework to small and medium cities
- IT decision making support tools
- Planning and decision-making framework for reuse and recycling of CDW

Innovation/economic impacts

- Increased CE jobs potential in demonstration and replication cities
- New innovative CE related procurement partnerships and dialogues in demonstration and replication cities
- Growth in green economy (e.g. increase in reuse / recycling infrastructure capacity)
- Business cases for valorisation of CDW and soil
- Increased use of new decision-making support tools to improve circular management practices
- Optimised and new links between the social economy and other sectors, promoting circularity (e.g. links between food distribution sector and the social economy sector decreasing food waste production)

Societal impacts

- Sustained community benefits including skills, training and green jobs
- Improved Well Being (e.g. QoL indicators)
- Provision of food support to economically disadvantaged families in the social economy sector
- New jobs for currently unemployed people due to development of CE

Environmental impacts

- Increased reuse and recycling of CDW and soil resulting in reduced energy consumption, improved resource efficiency, reduced heavy-duty transport
- Recycling of OW
- Reduced landfill
- Reduced greenhouse gas emissions

7. Annex 2: Strategic objectives defined in D6.1

Vision Element 1 “Local stakeholder actions”: Strategic Objectives

- Facilitation of repair and reuse platforms, and the secondary materials market
- Increased capacity building on CE for public employees and other local stakeholders
- Increased collaboration with local and regional stakeholders in CE planning and implementation, and the promotion of regional upscaling
- Increased engagement with national and international policy makers and researchers on the CE
- Increased provision of information on CE to local stakeholders
- Improved regulatory framework to support circularity
- Increased use of economic incentives and fiscal measures to promote circularity as well as removal of subsidies hindering circularity
- Integration of circularity principles into public procurement and financing processes
- Existence of city-wide strategy on CE with measurable objectives translated into targeted actions
- Integration of circularity principles into asset management, including publicly owned land, buildings and infrastructure
- Integration of circularity principles into urban planning decisions such as zoning and planning decisions, construction and demolition permits, and mobility planning

Vision Element 2 “Circular business models and behaviour patterns”: Strategic Objectives

- Increased asset lifetimes, including through flexible design and use
- Increased provision of local, sustainable and healthy food
- Increased rate of exploitation of assets (including equipment, machinery, buildings, infrastructure)
- Increased sustainable urban mobility options
- Enhanced waste collection, treatment and processing systems, including increased on-site reuse and treatment of waste
- Increased cooperation among sectors
- Increased use of repair and reuse platforms, and the secondary materials market
- Localisation of supply chains
- Increased gross value added of circular economy activities (repair, reuse, sharing, recycling)
- Increased number of jobs in the local circular economy (repair, reuse, sharing, recycling, ecodesign)

Vision Element 3 “Closing material loops and reducing harmful resource use”: Strategic Objectives

- Reduced (harmful) raw material consumption
- Reduced overall energy demand and increased share of renewable energy
- Increased share of renewable and secondary raw materials in overall material demand
- Increased self-sufficiency / self-reliance
- Increased quantity of materials available for the next cycle
- Reduced waste generation
- Reduced incineration and landfilling activities and amounts subjected

Vision Element 4 “Improving human wellbeing and reducing environmental impacts”: Strategic Objectives

- Improved education
- Improved public health
- Improved recreational services
- Improved access to basic services
- Reduced unemployment
- Reduced poverty and inequality
- Human-centred land-use and urban planning
- Biodiversity loss and deforestation
- Improved water quality
- Improved air quality
- Reduced soil degradation
- Mitigate climate change
- Reduce global adverse environmental impact of local consumption
- Transformed, sustainable local economy
- Increased resilience of local economy
- Reduced risk of urban infrastructure against natural disasters

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.

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